Legal Technology Future Horizons
Technology Timeline

	Technology	Description	Earliest Adoption
End User Devices, Tools and Trends			
1.	Digitization of work	Information and communications technologies (ICT) are transforming the nature of work and working practices in almost every sector. It is reasonable to assume that task automation will extend to ever-more knowledge-intensive, analytical and judgment-based work activities over the next decade and beyond.	Now
2.	Mobile phones[1]	The mobile phone penetration rate – the proportion of the population with a mobile phone subscription – has been rising steadily. By 2017, subscriber penetration in developed countries is projected to surpass 80%. Subscriber penetration across developing economies is forecast to increase from 39% in 2012 to 47% by 2017, leading global mobile phone market growth.	Now
3.	Tablet computers[2]	The widespread development and uptake of tablet computers is expected to continue, driven mainly by ever-more enhanced functionality products, increasing affordability and users replacing outdated tablets over time. McKinsey (2012) forecast that the number of tablets in use could surpass 350 million by 2016. Europe is expected to account for one third of tablet demand by 2016, followed by North America and Asia.	Now
4.	Bring your own device (handheld/phone)	The growing trend towards individuals buying - or at least choosing - and being responsible for their personal handheld devices such as smartphones used at the workplace to complete work tasks and access company information	Now
5.	Bring your own device (computer)	The growing trend towards individuals buying - or at least choosing - and being responsible for their personal computers used at the workplace to complete work tasks and access company information.	Now
6.	Mobile workforce	Mobile workforce refers to the increasing number of people working from remote locations due to the uptake of portable devices and high speed internet.	Now

7.	Quick-response (QR) codes[3]	These are 2D bar codes designed to be read by the cameras on mobile phones equipped with a reader application. Typical applications include accessing key documents, text display, capturing contact information, connecting to a wireless network, opening a web page and downloading vouchers and discount codes, or creating user-viewable augmented reality graphics.	Now
8.	Augmented reality devices	Augmented reality (AR) devices enhance physical world experiences by overlaying physical objects with digitally generated content such as text, maps, sounds and video. This is currently done via devices such as smartphones and tablets but will extend to a range of wearable and portable devices such as special purpose AR headsets, contact lenses and glasses. Markets and Markets predict that the AR market will experience exponential revenue growth, rising from $181 million in 2011 to $5.2 billion by 2016[4].	Now
9.	Virtual reality	Virtual reality (VR), also known as immersive multimedia, is a computer-simulated (normally 3D) environment designed to simulate the experience of being present in real or virtual environments. . Most such experiences today are predominantly visual and audio and over time these are being enhanced by the provision of additional and multi-sensory information such as tactile (touch) feedback. Such tools are being used in applications as diverse as computer gaming, medical training and military simulation exercises.	Now
10.	Wearable technologies	Computing and communications devices that can be worn or are embedded in clothing or other objects e.g. wrist worn computers, eyewear such as Google Glass	Now
11.	Augmented reality glasses	These are smart glasses using augmented reality. AR glasses developed by Meta allow users to control virtual objects in 3D space using hand gestures. The aim of the meta project is to go one step further than other augmented reality prototypes that simply offer superimposed digital readouts with limited control. [5] Google Glass has slightly different functionality - it is a camera, display, touchpad, battery and microphone built into spectacle frames allowing users to perch a display in front of their eyes, film, take pictures, search and translate on the go.[6]	Google Glass released to developers and pilot users (Meta currently in prototype)

12.	Embedded / implanted technology	A natural evolution from wearable technology is the notion of embedding a variety of devices in the human body. Already millions of people have been fitted with pacemakers and cochlear implants. A combination of permanent and biodegradable devices could be embedded within the human body - with applications ranging from credit card chips and personal identifiers to health monitoring sensors and memory augmentation.	2018
13.	Near field communication[7]	A telephone communication standard designed in Europe for data exchange such as micro-payments, with the potential to exchange contact information in a standard manner as simply as waving a phone over a contact or tapping two phones together.	Now
14.	Smart watches[8]	Apart from telling the time, smart watches function like smartphones for the wrist. One example is Sony's latest wrist-worn communication device. It runs numerous apps, acts like a remote for a music player, email and text messages. Sony's smart watch is designed to be paired with any smartphone running Android 2.1 or higher.	Now
15.	Life-logging / quantification of self	Life-logging is the practice of recording and quantifying every aspect of a person's daily life (e.g. conversations, images, steps walked, exercise undertaken, work done, calories consumed) with information captured using devices such as wearable cameras, smartphones and smart watches . A range of dedicated devices have also emerged such as the Nike Fuelband and Fitbit Activity Tracker. The data captured with these devices is stored, analysed and compared using web applications and social media. Narrato (2013) predicts that growth in the wearable computing market, directly or indirectly related to life-logging, will lead to a huge increase in life-logging and tracking.[9]	Now
16.	Picoprojectors[10]	This is an emerging technology enabling the use of an image projector from a handheld device. It is a response to the emergence of compact portable devices which have sufficient capacity to handle presentation materials but little space to accommodate an attached display screen. These tiny built-in projectors allow users to project images on any flat surface from their pico-projector-equipped mobile devices.	Now
17.	Mobile language translation	Mobile translation refers to automated translation for hand-held devices based on computational linguistics. The Japanese company NTT DOCOMO provides an automatic voice translation service both as screen text and voice readouts between Japanese, Chinese, English and Korean. NTT DOCOMO's Augmented Reality app also translates foreign menus and signage by placing a smartphone camera in front of the text[11].	Now

18.	Miniaturization	Computing devices are getting progressively smaller and more mobile while providing increasing access to centrally held information. Miniaturization leads to a greater convenience but there are concerns about potentially unknown and unpredictable behaviours when operating at a radically reduced footprint.	Now
19.	Personal tech ecosystem jacket[12]	Personal tech ecosystem jackets are enabled by wireless technology that creates a limited field high-definition Wi-Fi data transfer network. The technology allows various devices in the pockets of a jacket to interconnect and synchronize.	(currently in prototype)
20.	Wrist-worn flash drives[13]	These are bendable flash drives that can be worn on the wrist like a bracelet. StormFly is one such wrist-worn flash drive. The 16GB device is encrypted and based on an open source technology. By plugging StormFly into a computer, the user can access a personal operating system without having to connect to a server.	(currently in prototype)
21.	Flexible-paper-like tablets[14] (PaperTabs)	PaperTabs are tablet computers that look like actual pieces of paper. They are designed to work in clusters of up to 10 tablets and allow the user to control various screens at once. Rather than relying on buttons or swipe gestures, PaperTabs respond to the flexing of the actual screen in certain ways. For example, the user can bend the right side of the display to page forward and the left side to page backward.	2015 (currently in prototype)
22.	Power amplifier for extended phone battery life[15]	A power amplifier is the device found in phones that turns electricity into radio signals. A range of projects are underway to try to extend the battery life of mobile devices by a significant amount. For example, MIT spinoff Eta Devices has developed a new power amplifier design that could double the battery life of smartphones. Eta's research could also lead to a single power amplifier able to cope with different global wireless communication standards.	2015 (currently in prototype)
23.	Intelligent interfaces	Intelligent interfaces are a natural evolution of the current limited functionality voice control tools such as Siri for the iPhone. They will allow users to converse in natural language with smartphones and smart computers directly without using traditional interfaces like keyboard and mouse. These interface will learn about the user's behaviour over time and adapt their functionality to streamline the most commonly performed tasks. Intelligent interfaces are likely to be enabled by advances in speech recognition, artificial intelligence (AI), and increasing computer power.	2019[16]

Interfaces and Displays

24.	Proliferation of personal display devices	The range and nature of available display types is expected to proliferate with the emergence of pullout screens, roll-up screens, projection screens and glasses free 3D displays.	Now
25.	Natural user interfaces	Natural user interfaces (NUI) have enabled us to use speech, gesture, and touch to interact with computing systems. The real benefit of making interaction natural is enabling computers to get a better understanding of what users need or want. As NUI functionality improves, using a computer in the future might be like working with a trusted specialist who anticipates needs and provides helpful guidance.	Now
26.	Gesture recognition technology[17]	Gesture recognition enables devices such as computers to be controlled through human gestures rather than via keyboard, mouse or voice entry. Gesture recognition devices sense three-dimensional movement by illuminating areas with a particular wavelength of light. Capturing the reflection with a camera, they interpret the data with sophisticated software and firmware. Gesture recognition enhances our ability to manipulate images and data for business, home-entertainment and personal-computer applications. A range of gesture and touch control devices are emerging. For example, the Genius Ring Presenter[18] is a ring-style mouse which slides on the finger and uses "touch control air presenter technology". The gadget gives a user full access to Power Point slides, including a laser pointer which operates at a maximum distance of 10 meters. Functions such as cursor movement in any direction and options to drag and scroll along are available.	Now
27.	Large scale display boards[19]	Large scale boards are meter-sized interactive displays that serve many purposes. In the office these can be used as bulletin boards or flip charts. A board might serve as an electronic bookcase from which one can download text to a pad or tab.	Now

28.	Mind control headsets	Mind control headsets use a range electrodes to pick up the patterns in the brain's electrical signals and enable users to control computers, video games and even physical objects.[20] Users train the system to learn the signal patterns associated with different discrete commands such as open, close, up, down etc.	Now
29.	Tactile user interfaces[21]	These are application-controlled and transparent physical buttons that appear to 'rise up' from the touch-screen surface on demand. When buttons are enabled, users can push and type or rest their fingers as they would with any physical button or keyboard. When the buttons are disabled, they recede into the screen. An example would be the tactile interfaces developed by Tactus Technology.	Now
30.	Finger tracking technology[22]	Technology that enables users to control electronic devices by tracking their finger movements. A small device, such as that recently developed by Leap Motion, adds intuitive gesture control to computers and mobile devices. Using such tools, mid-air 'swipes, pokes, and grabs' can be used to control software and 3D environments.	Now
31.	Transparent smartphone touchscreens[23]	The screens of transparent phones are made of liquid crystal molecules in an OLED display. When powered down, the crystals have a cloudy white appearance. When the display is on, they display text and images in some parts of the screen while remaining clear in others. The battery, SIM and SD-cards are non-transparent and will remain covered on the devices until such time as transparent batteries / SIM cards have been developed.	Now
32.	Personalized interactive displays	These displays, responding to individual user presence and actions, have already found an application in the retail sector. For example an interactive display was used to transform the storefront window of the Parisian luxury shoe retailer Repetto into a stage with dancing holographic ballerinas. Passers-by on the sidewalk could interact with the display[24].	Now
33.	Holographic displays	Displays that use holographic content to project a 3D image that floats above a screen like a hologram (or appears when using 3D glasses).	Now
34.	Heads-up displays[25]	Heads-up displays (HUDs) project data at eye level. HUDs were initially used in military aircraft, then in commercial aircraft. HUDs are now also used in automobiles to enable drivers to view the information while keeping their eyes on the road. The next stage of development is expected to deliver a range of HUDs for personal use across a range of contexts from mobile working to gaming.	Now

35.	Digital Globes[26]	Digital globes are spherically shaped display screens. Controlled by a keyboard or tablet computer, a digital globe toggles between static images (e.g. the world's topography) or animated depictions of complex phenomena such as weather systems. Images are changed with the touch of a button. Digital globes are currently used in public spaces such as museums. As prices fall, digital globes could be deployed in business to display global performance information, on the web for uses such as real-time flight tracking and in domestic contexts for applications such as geo-tagging vacation photos.	Now
36.	Intelligent brain-computer interfaces[27]	One stage beyond the concept of mind control headsets is the notion of fully Intelligent brain-computer interfaces (BCIs). These would enable people to communicate a full range of commands and ideas wirelessly with computers, distant objects and other people. A BCI system records the brain's electrical activity using EEG signals, which are detected with electrodes attached to the scalp. Machine-learning software is then used to recognize the patterns generated by each user as they think of a certain concept. Recent experiments of "collaborative BCI" connected two people together to simulate navigational controls for a virtual spaceship. Results showed that two minds working in tandem had a higher success rate simulation flights strongly favoured two-brain navigation.	Prototype now[28]
37.	Function-specific headsets	These are headsets designed for use in specific contexts. For example, Police Pro[29] is a headset developed specifically for law enforcement. It allows police officers to scan license plates instantly, identify suspects and see in the dark using an attachable night vision camera. ''Golden-i is a Bluetooth headset with a 15-inch virtual display and hands-free, natural-speech-recognition interface for wireless remote control over mobile phones, PCs and wireless systems. If connected to a PC, users see their PC desktop screen on the virtual display and can control it using voice commands in several languages'' Another example is the Orb[30] - an ear-ring which easily transforms into a Bluetooth headset capable of hands-free calling. The Orb provides high quality bone conduction audio with no need to place the device inside the ear. A more expensive edition also features a Flexible Organic Light Emitting Device (FOLED) screen to display details like caller ID or calendar reminders.	Prototype now

38.	Fabric / clothing embedded screens[31]	These are miniature electronic devices worn by the user under, with or on top of clothing. Such wearable technologies have been developed for general and special purpose information technologies and media development.	Prototype now
39.	Fingernail displays[32]	Fingernail displays will essentially turn a user's nails into displays. Engineers in Taiwan are investigating ways to coat fingernails in organic light emitting materials, so that they could display useful content.	In Lab
40.	Eyewear-embedded screens[33]	These are miniaturized displays offering functionality similar to HUDs, embedded in the user's eyewear.	2015
41.	Next generation (glasses free) 3D displays	3D displays project three-dimensional images. A variety of 3D systems have come on the market for TVs, standalone projection, and mobile phones. Most currently require special glasses to view them. Estimates suggest the next generation of 3D displays (glasses free) could be on the market by 2015[34].	2015
42.	Eye tracking interfaces	Interfaces enabling users to control software, devices and games by tracking the movement of their eyes.	2015
43.	Haptic technology[35] [36]	Haptic interfaces allow users to 'touch' and manipulate virtual objects on a computer, giving the sensation of touching surfaces and moving objects around.	2015[37]
44.	Flexible screens / Flexible electronics	Advances in plastic electronics and glass technology offer the potential for ultra-thin display devices that can be rolled up or folded. Flexible electronics are built on substrates like plastic or metallic foil and can be folded, wrapped, rolled, and twisted. Applications might include corporate documents and promotional materials, expansion screens for mobile phones, portable displays and advertising posters, next generation e-readers, journals and newspapers.	2015
45.	Virtual retinal displays	A virtual retinal display (VRD) broadcasts images directly onto the retina of the human eye. Images are projected with lasers and LEDs. The user perceives information as if floating in front of the eye. Some of the benefits associated with VRD are energy efficiency, reduced reading time, the possibility of the display to augment the real world. [38]	2015
46.	Courtroom dashboards	Courtroom dashboards are large screen courtroom displays enabling the presentation of complex multi-format information, images, and video drawn from multiple sources.	2016
47.	Volumetric displays	Displays that form visual representations of objects in three physical dimensions rather than the 2D format usually seen on computers and smartphones.	2016

| 48. | Brain-link technologies | These build on the idea of mapping the function of the brain and the idea of directly uploading and downloading to and from the human brain. This could lead to "mental telepathy". In the far future, brain-linked technologies could be used to manipulate the brain, to spot bad behavior, or possibly to reengineer somebody's brain to stop him/her from carrying out criminal behavior. | 2030+ |

Internet and Social Media

49.	Wireless broadband[39]	Wireless broadband is the technology that delivers wireless high-speed internet access or computing access, thus negating the need for fixed line connections and facilitating internet access to mobile devices such as laptops, tablet computers, and smartphones.	Now
50.	Ubiquitous internet access	Ubiquitous internet access is a fast and affordable Wi-Fi that is available anytime, anywhere. The EU Commission defines ubiquitous internet as a key enabling technology of the information society. [40]	Rollout now - 2020
51.	Universally available high-speed bandwidth	High-speed internet bandwidth is seen as a key enabler to other technologies. It could improve web speed and processing speeds as well as lead to increasingly limitless data access.	Rollout now - 2020
52.	Virtual worlds	Virtual worlds are a genre of online community that often takes the form of a computer-based 3D simulated environment, through which users can interact with one another. Virtual worlds can either be a representation of the real world, such as in Second Life, or a fantasy world, such as World of Warcraft. Virtual worlds can be used for e-learning and business applications such as online conferences, promotional sites and meeting spaces. The main current uses are for entertainment, leisure, gaming and social networking[41].	Now
53.	The Internet of Things	The 'Internet of Things' is the idea that any physical object can connect to the internet and communicate with other objects or relay information to people. Forecasts suggest that in the future most everyday objects will be connected to the internet, which means that many tasks / information exchanges will be automated[42]. Some estimates suggest we could see 50-100 billion internet connected devices by 2020.	Now[43]
54.	Machine-to-machine (M2M) technology[44]	M2M technology enables machines to communicate and exchange of information with each other. It allows electronic devices to communicate with one another for management and monitoring, and for service delivery via the internet, wireless sensors and SIM cards. M2M is the technology behind the Internet of Things that could enable smart cities of the future.	Now

55.	Digital currencies	Digital currency is money in an electronic form that allows instant transfer between accounts. There are currently no controls on who issues digital currencies and they sit outside government regulatory frameworks. A wide range of digital currencies already exist such as Bitcoin and Litecoin. A number of high visibility frauds have already been reported - highlighting the immaturity and vulnerability of the entire digital currency environment at present. For example, in February 2014 a Major digital currency exchange Mt Gox reported that it had suffered a theft of over 750,000 Bitcoin worth around $450m - only to subsequently discover 200,000 worth around $116M in its systems. It subsequently declared itself bankrupt. Digital currency is being used by several companies including Liberty Reserve, Pecunix and WebMoney[45]. Some suggest that digital currency could eventually replace all digital money, first in the U.S. and Canada, and later everywhere else[46].	Now[47]
56.	Cloud computing[48]	Cloud computing provides computing as a service, where data content and applications are stored and accessed remotely over a network, typically the internet, rather than housed on a user's own servers. A recent study by Verdantix forecasts that cloud computing could help large U.S. companies realize $12.3 billion in energy savings alone annually by 2020[49].	Now[50]
57.	Infrastructure as a Service (IaaS)	IaaS is the first major layer of cloud computing. It allows firms to outsource key hardware requirements to a third party provider. IaaS companies provide off-site server, storage, and networking hardware, which can be rented and accessed over the Internet. Amazon, Microsoft, VMWare, Rackspace are among the prominent providers of IaaS[51].	Now
58.	Platform as a Service (PaaS)	PaaS is the second major layer of the cloud providing tools for a wide range of application development. PaaS companies offer a variety of solutions for developing and deploying applications over the Internet, such as virtualized servers and operating systems[52].	Now
59.	Software as a Service (SaaS)	SaaS is third layer of the cloud - offering a software distribution model in which applications are hosted by a vendor or service provider and made available to customers over the internet[53]. Commonly used SaaS applications include sales force management, CRM, contact list management and a variety of research tools.	Now

60.	Virtualization	Virtualization refers to technologies designed to provide a layer of abstraction between computer hardware systems and the software running on them. Virtualization tricks operating systems into thinking that a group of servers is a single pool of computing resources. Servers then allow the running of multiple operating systems simultaneously on a single machine[54].	Now
61.	Virtual data centers[55]	A virtual datacenter is a pool of cloud infrastructure resources including computing capability, memory, storage and bandwidth. A key feature of next-generation virtual data centers is the ability to scale servers vertically rather than horizontally by increasing the size of individual servers on demand, instead of taking the traditional path of scaling horizontally by adding additional virtual servers.	Now
62.	Hybrid cloud computing	A hybrid cloud is composed of at least one private cloud and at least one public cloud. Essentially, hybrid cloud computing refers to an environment in which an organization provides and manages some resources in-house and has others provided externally. The hybrid approach allows a business to take advantage of the scalability and cost-effectiveness that a public cloud computing environment offers without exposing mission-critical applications and data to third-party vulnerabilities.[56][57]	Now
63.	Personal cloud	The personal cloud is a personal storage capability housed on a server in the home or a small personal network that can be accessed over the internet. Personal clouds are currently used for applications such as sharing photos and videos. The primary selling point of personal clouds is their easy installation[58]. Gartner believes that users in the future will be focused on personal services and will increasingly define their digital lives in a personal cloud[59].	Now
64.	Social media	Social networks are increasingly becoming key business platforms for sales, service and customer engagement as they penetrate every aspect of our lives. One survey suggests 73% of European internet users use social network sites[60]. *Trendstream* reports that the global average is just over 50% of all active internet users, with Asian countries topping the list and some exceeding 70% penetration[61].	Now
65.	Enterprise social networking	These are social networking platforms based on dedicated intuitive (Facebook-like) social software for closed group use within an organization.	Now

66.	Temporary social media	Temporary social media refers to messages exchanged on social platforms that quickly self-destruct to enhance the privacy of online communication. For example, it allows users to be more candid and spontaneous, as they would be able to decide for how long their photos or videos should be visible to the recipient. [62] A popular current example is Snapchat that is being used by consumers and by businesses for instant marketing applications. Concerns are growing over the potential untraceable exchange of insider information using such platforms.	Now
67.	Social analytics	Social media analytics is the practice of gathering data from blogs and social media websites and analyzing it to make business decisions. A common use of social media analytics is to mine customer sentiment in order to support marketing and customer service activities[63].	Now
68.	Knowledge graphs	Knowledge graphs provide large scale maps of the interconnections between millions of nodes and data points by drawing on developments like big data. Google's Knowledge Graph is a knowledge base that will enhance Google's search engine results[64]. The Graph includes 500 million persons, places and things, and their billions of relationships to one another. New search results were initially rolled out in the United States in 2012[65].	Now
69.	IP Telephony	IP telephony (Internet Protocol telephony) is a general term for the technologies that use the Internet Protocol's packet-switched connections to exchange voice, video, fax, and other forms of information that have traditionally been carried over the dedicated, circuit-switched connections of the public switched telephone network (PSTN). Using the internet, calls travel as packets of data on shared lines, avoiding the charges of the PSTN. The challenge in IP telephony is to deliver the voice, fax, or video packets in a dependable flow to the user. Much of the work being done on enhancing IP telephony focuses on that challenge[66].	Now
70.	Immersive web[67]	The next generation of the internet is likely to be shaped by immersive technology that delivers multi-sensory sensations, experience and emotion to users in rich online worlds[68]. The Institute for Global Futures forecast annual revenues for immersive web applications of $8-10 billion by 2015[69].	2015
71.	Intelligent web[70]	The intelligent web is part of the next stage of the evolution of the internet. By exploiting advances in AI, the internet could evolve into an intelligent system that understands spoken inquiries, gathers relevant information, and forms meaningful, focused answers. AI could revolutionize the way in which humans interact with computers, and the output we receive back from them.	2016[71]

72.	Semantic web[72]	The Semantic Web is the extension of the World Wide Web. the goal is to offer a new way of creating and sharing content by connecting seemingly random bits of information on the internet in new ways. It provides a standardized way of expressing the relationships between web pages, to allow machines to understand the meaning of hyperlinked information.[73]	2018+
73.	Parallel secure internet	One future vision sees the emergence of one or more highly secure webs of sites - running in parallel to the existing World wide Web - in which all users, sites and networks are validated.	2020
74.	Auto e-mail review	This is a range of functionality that would enhance the security and accurate transmission and targeting of emails. For example, messages would be validated for security of content prior to transmission. Auto email review would enable the searching of text in incoming messages to route them to appropriate person / team in the firm automatically. Workflow could be improved significantly as a result.	2016
75.	Collective blanket licenses[74]	Collective blanket licenses' legalize and unlock legitimate access to basic content services via any digital network. Starting in Asia, these will emerge around the world, and are likely to take over as the primary means of content consumption. Just like water and electricity, which are readily available when moving into a new home, the basic access to content could be bundled into access to digital networks, i.e. via ISPs, operators, telecoms and portals.	2020

Communications, Collaboration and Networking Tools and Developments

76.	3G/4G smartphones	Smartphones are mobile phones that run on mobile computing platforms with an ever increasing range of functionality such as touch screens, cameras, voice recognition, GPS navigation, internet connectivity and high-speed data access via Wi-Fi and mobile broadband. With smartphones now outselling PCs[75], Ovum predicts that by 2016 the global smartphone sector could control 40% of the overall global mobile business[76].	Now
77.	Growth of mobile traffic[77]	Total worldwide mobile traffic is forecast to reach more than 127 Exabytes (EB) by 2020, representing an 33-fold increase compared with the 2010 figure. By 2020, Asia is projected to represent 34.3% of total world mobile traffic, Europe 22%, and the Americas 21.4% (UMTS Forum, 2011).	Now
78.	Function-specific smartphones	These smartphones have built-in features (or apps) that allow them to perform specific functions and tasks. Early examples are already on the market and a range of others are expected in the coming years. For example, LifeWatch V[78] is a healthcare smartphone for patients and health-conscious consumers. What differentiates LifeWatch V from standard Android phones is a range of medical sensors powering seven health tests, combined with wellness-related applications and cloud-based health monitoring services.	Now
79.	Intelligent software for smartphone keyboards	In this context, intelligent software refers to the algorithms that automatically identify misspelled words or support predictive text entry for smartphone keyboards. The software is being developed continuously. For example, going beyond auto-correction, the program Flexi[79] writes new forecasts for touch screens. Flexi detects what the user wants to capture by analyzing models and seizure and allows users to send accurately spelt text messages.	Now
80.	5G wi-fi chips[80]	The family of 5G wi-fi (802.11ac) chips are three times faster and up to six times more power efficient than their 802.11n predecessors. Dual-band routers supporting the new 5G Wi-Fi standard boast speeds of up to 1,300 Mbps on the 5 GHz band and 450 Mbps on 2.4 GHz. 5G wi-fi.	Now
81.	5G phones / communications	5G phones are the next generation of smartphones. They could offer ultra-fast download speeds, artificial intelligence, low power consumption, 3D displays and pervasive access, enabling the user to connect to multiple wireless networks simultaneously[81].	2016

82.	6G phones / communications	One vision for 6G phones is that they will integrate communications systems with users' bodies to connect them to the internet wherever they are.	2020
83.	Pervasive video	Pervasive video is available to anyone, anywhere on multiple devices and improves collaboration with co-workers and clients.	Now
84.	Remote Presence / Telepresence[82]	Telepresence is the use of high quality video conferencing solutions or lower functionality personal applications such as Skype to conduct meetings virtually, for business or personal reasons. Forecasts suggest that the telepresence market could be worth $4.7 billion in 2014.	Now
85.	Telepresence robots	Robotic devices enabling users to be visually present in a remote location by combining auto-navigation and a high definition or 3D screen. For example, Beam is a 'bot' equipped with 2 cameras and 17-inch LCD display. A wireless connection gives its remote operator a wide-angle view of the bot's surroundings. A microphone array provides sufficiently high quality audio to allow the operator to converse with the people in the distant location.	Now
86.	Immersive telepresence	Telepresence solutions are evolving through the application of 3D and Holographic techniques to provider a higher degree of 'immersion' - delivering a greater sense of the other person being physically present. Telehuman[83] is a prototype example for a video communications system enabled by Microsoft Kinect sensors and a 3D camera. Telehuman allows a user to speak with a three-dimensional representation of another person.	Prototype
87.	Touchable holographs[84]	Touchable holographs allow users to 'feel' the size / shape / texture of objects they see on a screen. A 'touchable holograph' display adds tactile feedback to 3D images hovering in space by using techniques such as vibration of the air surrounding the 3D image or through an ultrasound device positioned below the holograph display and concave mirror from which it is projected[85].	2015[86]
88.	Real time multi-party document editing	Software / programs allowing many users to work on the same document simultaneously from different locations. While a variety of such platforms exist today, future generations will build in increasingly intelligent features - such as automatically alerting contributors if an key concept or clause has been altered in a document, offering alternative text / clauses based on similar past documents and hyperlinking to related documents or content on the web.	Now

89.	Mobile Ad-hoc Network (MANET) [87]	A Mobile Ad-hoc Network or MANET is a form of ad hoc self-configuring network consisting of mobile devices that are connected to each other wirelessly. MANETs have no fixed physical infrastructure and can change locations and reconfigure themselves on the fly as devices come in and out of the network. Network connection can be via standard Wi-Fi, or another medium, such as a cellular or satellite transmission.	2015
90.	Mesh networking [88]	A type of networking where nodes capture and disseminate their own data and also serve as relays for other nodes. Each node collaborates to propagate the data in the network.	2016 - 2017

	Software Tools, Techniques and Trends		
91.	Open source development[89]	Open source refers to freely distributable programs for collaborative development. Gartner suggests that 85% of enterprises have already made use of open source development, and Forrester Research reports that 45% of all companies using open-source software use it for mission-critical applications[90].	Now
92.	Digital assets	A digital asset is any form of digitally stored content and / or media, including the right to use it.[91] Such assets might include music, literature, computer games or other intellectual property. The development of virtual immersive worlds suggests that virtual spending on digital assets could increase as users purchase objects for use in those worlds, with value creation becoming de-linked from physical objects.	Now
93.	Grid computing[92]	Grid computing is the application of the computer power of many computers in a network to a single problem at the same time - usually to a business, scientific, mathematical or technical problem that requires a great number of computer processing cycles or for access to large amounts of data. Such approaches are already in use for projects to analyse vast amounts of data in fields as diverse as geological mapping and the search for extra-terrestrial intelligence(SETI).	Now
94.	Gamification	Gamification is the process of using game techniques to engage users to solve problems[93]. Already popular in advertising, gamification could be applied in a legal context as well for example in encouraging users to learn a system's functionality or training new lawyers, on the details of a client domain and to think through the diverse aspects of complex matters.	Now
95.	Facial expression analysis [94]	This is a type of software that can read the feelings behind facial expressions. For example, a program called MindReader interprets expressions on the basis of a few seconds of video. The software tracks 22 points around the mouth, eyes and nose, and notes the texture, color, shape and movement of facial features. Machine learning techniques have been used to train the software to tell the difference between happiness and sadness, boredom and interest, disgust and contempt. In 2012, Affdex, a commercial version of the system, was used to test viewers' responses to advertisements.	Now

96.	Instantaneous automatic language translation Universal translators	The goal is to translate between languages in real-time using devices such as smartphones, wearable devices and computers. These universal translators are intended to provide instant translation from any language to any other. For example, in Japan the telephone company NTT Docomo has launched a translator phone that converts between several languages and is working on translator glasses that will overlay translations on text such as documents and menus. A prototype device developed by Microsoft handles Spanish, Italian and Mandarin Chinese translations, converting English speech into these languages in the speaker's own voice in real time. Microsoft reports that it has achieved a high degree of accuracy, cutting word error rate by around 30% - usually only one word in 7 or 8 is incorrect. Microsoft's goal is to improve the translator for commercial launch[95].	Currently in prototype
97.	Workflow optimization	Technologies improving the transparency, monitoring, speed and efficiency of core business processes and workflows in the organization.	Now
98.	E-invoicing	An E-invoice is sent and received electronically. It consists of both data and an image that are used to automate invoice processing and archiving[96]. Prizm Capture[97] is an example of cloud-based software that combines online and offline functions - it extracts data from paper invoices and posts the results to QuickBooks.	Now
99.	Admin dashboards	An admin dashboard is a user interface that organizes and presents information in an easy-to-read way. For example, Hours Tracking[98] is a web-based time and billing application targeted at small businesses. HoursTracking allows lawyers to enter billing data in real-time and switch projects with one click. Users are able to edit time entries and view at a glance how their billable time is applied in a simple Weekly Dashboard.	Now
100.	Ultra-high speed data transmission[99]	A major IT research focus is the acceleration of data transmission rates. NEC and Japan's National Institute of Information and Communications Technology both report experiments yielding speeds of over 100 terabits per second[100]. The highest data transmission speed recorded to date is 26 terabits per second - demonstrated by Germany's Karlsruhe Institute of Technology (2011). Researchers encoded data at a rate of 26 terabits per second on a single laser beam. Data was then transmitted over a distance of 50 km (31 miles). This is the largest data volume ever transported on a laser beam and would enable the transmission of 700 DVD's worth of content in just one second.	Now

101.	Automatic content recognition (ARC)	ARC technology gives smart devices the ability to become content-aware and 'know' what content is being watched. The devices can then deliver complementary and fully synchronized content associated with the document, image or video content being viewed to enhance the user experience.[101]	Prototype
102.	Context-aware computing[102]	Context-aware computing enables computers to both sense and react based on their environment. For example, context-aware monitoring devices may be able to bring up clause related content specifically associated with the legal environment in a particularly country as a lawyer works on a matter. In health, such tools might make assumptions about the user's current health status based on data they are collecting, and adapt or respond accordingly.	2020
103.	Complex event processing	Complex event processing combines data from multiple sources to infer more complex events or patterns. Such tools could for example be used to infer in real time a pattern of sophisticated frauds being perpetrated against a firm's systems across a range of geographies.	2020
104.	Enterprise app stores (EAS)	An enterprise app store (EAS) is a place where a company's employees can go and get the apps they need, similar to public app stores such as Apple's iTunes App Store. Forecasts suggest that enterprises will develop a range of apps on which their employees will depend. EAS could therefore help enterprises distribute, secure and control the apps their employees use[103]. Gartner believes that EAS will become more mainstream in 2014; mobile and cloud based EAS solutions are expected to converge beyond 2014[104].	Now
105.	Crash-proof code	Software development techniques designed to deliver ultra-reliable applications for critical systems (e.g. medical devices). A critical challenge in software development is to be able to verify beyond doubt that complex software applications are verifiably error free and crash proof. Whilst testing techniques are improving, the notion of formally proving that code is 100% crash proof have proved elusive to date - but numerous research initiatives are focusing on this goal.	2020
106.	Procedural storytelling[105]	This is a context sensitive automated approach to software development that draws on intelligent algorithms to generate content automatically – drawing on techniques used in computer game development. This creates the possibility of systems that can learn, adapt and update themselves automatically over time.	2019 - 2020

Artificial Intelligence (AI) and Intelligent Systems

107.	Artificial intelligence (weak AI)	Artificial Intelligence (AI) is the creation of computer-based algorithms and analytical applications that exhibit human-like intelligent reasoning and behavior. AI systems are being improved continuously and manifest in the form of smart systems or intelligent robots. Recent developments in deep learning have given hope that AI could reach a human-level breadth of intelligence over time[106]. In business, AI tools and neural network software products are already being used for applications like bankruptcy and cost prediction, revenue forecasts and risk evaluation[107]. Increasingly, these systems will capture the skills of people and use those skills in the delivery of information to others within the organization. Lawyers might pose questions based on the information stored in smart systems. This will support a firm's competitive advantage in how they respond in terms of the speed and quality of information provided.	Now
108.	Artificial General Intelligence (AGI)	A distinction is made between true AI and so called 'weak AI' applications which can perform tasks such as inference and pattern matching but which are not sentient or self-aware. True AI or Artificial General Intelligence (AGI) as it known is the concept of developing software that can display genuine human like intelligence and that is sentient, capable of learning in a wide range of contexts in it is not specifically programmed for, displays consciousness and is self-aware.	2025 - 2040
109.	Expert-level decision systems	These are typically rules based inference systems that emulate or exceed the decision-making ability of human experts in certain areas such as scanning, analysing and pattern matching large volumes of case information. In 2011 IBM's robot Watson outperformed its human competitors at the American television quiz show Jeopardy. The subsequent performance of Watson in medical diagnosis applications hints at the level of intelligence expert decision systems might reach in the future.[108]	Now

110.	Legal expert systems	Although expert systems have been use in a wide variety of applications such as credit scoring for some time, there has historically been a reluctance to adopt them for legal use. There is a growing awareness and belief that expert systems could have a huge impact on the delivery of legal services and especially on client service. Systems could make the client experience as easy as 'Googling' for something. Clients will be able to get a reliable service very quickly without even picking up the telephone and talking to a lawyer. A variety of consumer level expert legal systems are beginning to appear.	Now
111.	Intelligent personal assistants / avatars[109]	Intelligent software assistants can increasingly help users complete tasks beyond mere information collection. Software assistants have already been incorporated into human teams to increase joint task planning and decision-making capabilities[110]. Software assistants can act as autonomous entities which observe and act upon and potentially learn from the environment to achieve their goals. Software agents can pursue tasks such as data mining, monitoring and surveillance. An example is Premier[111] an intelligent assistant consisting of a crowd of human workers controlled by smart software that responds intelligently to any kind of request. Tasks handled by Premier include compiling reports, replying to emails and grading assignments. Performing complex tasks such as compiling reports usually consists of several people scanning the Web, several others summarizing the results, and another group of workers compiling the report.	Now
112.	Intelligent speech understanding	Systems capable of understanding both the words and deeper levels of meaning and context of spoken language.	Now
113.	Neural Networks	Artificial neural networks (ANNs) are software systems modelled on the design of the human central nervous systems and in particular the brain. These are designed to perform human like cognition tasks such as learning and pattern recognition. These systems are typically structured as an interconnected network of "neurons" that can respond to and process different inputs by feeding information through the network - learning and adapting their behavior over time.	
114.	Natural language question answering	Systems / software providing increasingly meaningful and human-like answers to questions posed in a natural language.	Now

115.	Reality mining	Reality mining is the collection and analysis of machine-gathered environmental data. Personal reality mining refers to the gathering of data, often through mobile phone sensors, of an individual's location, physical activity and habits, to build a predictive model of human interaction behavior[112].	Now
116.	Machine vision	Machine vision is a field of artificial intelligence that uses a range of technologies to enable computers to capture and analyze images and videos and extract data from them. For example, Content Crawler[113] is an optical character recognition tool that makes non-searchable content stored in document repositories text-searchable. It can identify an image file, a PDF image, or an image attached to an email message stored in Microsoft SharePoint and convert the image into a text-searchable PDF file.	Now
117.	Swarm intelligence[114]	Swarm Intelligence (SI) is the collective behavior displayed by of natural or artificial decentralized and self-organized systems when they operate within the same environment. Typical applications might include a collection of independent sensors or (mobile) agents communicating directly or indirectly with each other to carry our data gathering, analysis and distributed problem solving.	2015
118.	Machine learning[115]	Machine learning is a field of artificial intelligence that focuses on developing tools and algorithms that enable computers to learn, adapt their behavior and make increasingly intelligent decisions over time by analyzing data, identifying patterns, drawing inferences and updating themselves in the light of new and changing inputs.	2015
119.	Deep learning software	Deep learning software goes beyond basic machine learning and mimics the patterns of brain activity associated with thinking to create tools that can learn to recognize patterns in digital representations of unstructured information such as sounds / images / text as well as data.	2016
120.	Intelligent client assistants	Avatar-like AI agents facilitating lawyer-client collaboration by operating in the client's environment and providing on-demand advice.	2016
121.	Collective intelligence tools	Collective intelligence tools are used to perform the intelligent collection and analysis of data from a variety of sensors, social networks and other sources in real time. The generated information and insights gathered by collective intelligence tools is combined into one easy-to-understand format upon which the user may wish to act, either to avoid risk or to capitalize on an opportunity[116].	2018

122.	Intelligent robots[117]	Robots of increasing sophistication are already in evidence in domains as diverse as manufacturing and elder care. Intelligent robots have the capacity to behave and perform tasks at human level. Intelligent robots are expected to appear in society by 2020. Such robots are likely to be able to understand their environment and make independent decisions, thus marking the beginning of one facet of Artificial Intelligence.	2020
123.	Computational overhang	This is the idea that AGI could develop to such an extent that futures AIs could make far more efficient and optimal use of existing computational power than current algorithms. This could lead to a massive explosion of AIs which could eventually overtake the number of humans on the planet.	2025+
124.	The Singularity	The singularity, (sometimes referred to as the technological singularity) is a term popularised by science fiction writer Vernor Vinge and futurist Ray Kurzweil. The suggestion is that through rapid and large scale advances in science and technology we could reach a time when AI has achieved 'greater-than-human intelligence'. Singulatarian visions suggest we could reach a point where we are connecting directly into a global intelligence web, sharing information with each other brain to brain and tapping into the collective knowledge of the planet. The impact of the development of such superintelligences is hard to envision as they would have far reaching implications for what it means to be human and the makeup of society.	2025 - 2045

Computing Technology and Devices

125.	Depth imaging[118]	Depth imaging is a collection of techniques which are used to produce a 2D image showing the distance to points in a scene from a specific point. The resulting image can be used to reproduce a 3D scene or screen.	Now
126.	Water-cooled processors	This data center model is based on water cooling at the chip level. It uses high performance liquid cooling to channel water at high speeds through tiny copper pipes over processors. The heat from the water can be used to heat buildings, or for other civic purposes. For example, a desalination project in Egypt is linked to a liquid-cooled datacenter. IBM's supercomputer Aquasar is based on the cooling technology and reuses the waste heat carried by the liquid. It is expected that water cooling would reduce Aquasar's energy consumption by 40% compared with an equivalent energy-hungry air-cooled system.[119]	Now
127.	Converged infrastructure[120]	Converged infrastructure unifies branch offices, data centers and public cloud systems under a common architecture. Converged infrastructure is different from most of the current IT infrastructure where public, private or hybrid clouds are provided by different organizations and are not necessarily connected. For example, Cisco and NetApp are aiming to simplify the orchestration of all of these infrastructures, connecting enterprise clouds to service providers, enterprises to branch offices, consumers to enterprises, and clouds to clouds. The FlexPod platform developed by the companies is available now but will be upgraded, so that organizations will be able to deploy and access next-generation cloud systems.	Now
128.	Embedded invisible IT[121] / Pervasive computing	Embedded invisible IT refers to a situation where computers are embedded everywhere and largely invisible e.g. in walls, tables, chairs, desks, clothing, and bodies. Also known as ubiquitous computing / microprocessing, or ambient intelligence.	2016
129.	Intuitive Computing	Intuitive applications are hardware and software embedded functionality that allow people to start discovering trends and data that were not available before. Intuitive technology could 'learn' how humans work and help combine most efficient and effective use of defined processes, applications and resources.	2016

130.	Modular computers[122]	A multiprocessing computer system where processing, memory and peripheral units can be added or removed without disrupting its operations.	2017-2018
131.	Optical computers[123]	An optical computer (also called a photonic computer) is a device that uses the photons in visible light or infrared beams, rather than electric current, to perform digital computations, and is capable of speeding up the computing process radically.	2020
132.	Next generation magnetic memories[124]	Magnetic random-access memory based on new spin transfer technology achieves higher storage density by packing multiple bits of data into each memory cell. The advantages of STT-MRAM are high read and write speed, low power consumption, great endurance, and easy integration with standard semiconductor-processing technologies[125].	2020
133.	Optical amplifier	An optical amplifier is a technology used to amplify light signals, also known as optical signals[126]. In 2011 researchers created an optical amplifier which boosts the strength of optical fiber signals, allowing a signal to travel about 4,000 kilometers (previously signals only travelled about 1,000 kilometers).The researchers who developed the technology believe that the optical amplifier will enable a better connection of cities, countries and continents, as it allows system engineers to locate amplification hubs at much longer intervals[127].	2020
134.	Supercomputers[128]	Supercomputers are large groups of computers working together to perform tasks (such as highly intense calculations or molecular modeling) that individual computers cannot do. Analysts believe that supercomputers will be able to perform complete simulations of the human brain and its nervous system by 2025. By 2030 supercomputers could reach the zetaflop scale, meaning that weather forecasts could achieve 99% accuracy.	2025
135.	Quantum computing / Quantum computers	Quantum computing is a research area focused on developing computer technology based on the principles of quantum theory. Following the laws of quantum physics, quantum computers would have enormous processing power through the ability to be in multiple states, and to perform tasks using all possible permutations simultaneously[129]. The first quantum computers are now commercially available for specialist applications. Quantum computers aimed at the business environment are expected to take a further 8-12 years to emerge.	2025[130]

136.	DNA Storage[131]	DNA storage is data being stored in DNA, the basic building block of genomics. Molecular biologists at the European Bioinformatics Institute (EBI) have improved a DNA encoding scheme to raise storage density to 2.2 petabytes (a petabyte equals 10^{15} bytes or 1000 terabytes) per gram, three times the previous achievement. At the storage density achieved, a single gram of DNA would hold 2.2 million gigabits of information, or what is usually stored in 468,000 DVDs. As proof of concept, the EBI researchers encoded an MP3 file, a digital photo, and all 154 of Shakespeare's sonnets into artificially constructed DNA.	2020
137.	Biological computers	A biological computer is a machine made from biological molecules. Like biological systems, these computers are based on large numbers of chemical reactions that occur autonomously, which means that bio computers are not linear but parallel processors.	2025
138.	Bio computers decrypting DNA-stored images[132]	These are parallel processors made from biological molecules that process information based on chemical reactions. Californian and Israeli researchers report they have created a biological computer that successfully decoded two images stored and encrypted within DNA. The numerous applications of bio computing are still to be discussed – these could range from using electricity-free systems to storing data in users' bloodstreams.	2025
139.	RFID technologies	Radio frequency identification (RFID) involves the transfer of data using radio waves from an electronic tag attached to an object for the purpose of identifying and tracking the object. A tag can be affixed to any object and used to track and manage inventory, assets and people.	Now
140.	3D spintronic microchips[133]	Spintronic chips exploit the electron's standard magnetic moment, or 'spin', whereas traditional chips use charge-based electronic technology. Unlike current microchips which pass digital information only in two dimensions, the 3D spintronic microchip allows information to move in three dimensions — from left to right, back to front, and top to bottom. 3D spintronic microchips could enable additional storage capacity and are expected to become the standard memory chip within a few years.	2018
141.	Reprogrammable chips[134]	Reprogrammable chips can be reconfigured to implement an improved design as soon as it becomes available offering the hardware equivalent to software upgrades.	2020

| 142. | Increasing storage capacity of SD cards[135] | Analysts forecast that data storage will continue to make exponential progress, with micro-SD cards surpassing the capacity of the human brain by the end of the decade. Human brain capacity is estimated to vary between 1 and 10 terabytes with a most likely value of 3 terabytes. Micro-SD cards (or equivalent devices) are expected to reach a storage capacity of 20,000 human brains by 2030. | 2020 |

Management and Analysis of Data, Information and Knowledge

143.	Big Data	Big data refers to the large and growing databases of customer and transactional information being generated through users' activities online. The scale of data collection is likely to rise exponentially due to the emerging 'internet of things'. HP has predicted that by 2020 four billion people could be online globally and 30 billion mobile phones in circulation. As a result, the global volume of data being generated and collected could rise from around 0.8 zettabytes of data in 2009 to 50 zettabytes of data per year generated by 2020 (1 zettabyte = 10^{21} bytes).[136]	Now
144.	Data mining	Data mining is the process of using advanced software analysis tools to identify trends, patterns and insights from large databases. Essentially, data mining depends on effective data collection and codification - allowing firms to turn raw data into useful information[137].	Now
145.	Audio mining	This technology enables the user to search through speech or music audio to analyze it for specific characteristics. Audio mining is typically used in speech recognition software and music analysis. When used in speech recognition technology, audio mining identifies spoken words in an audio recording and puts them in a searchable file[138].	Now
146.	Growth in video volumes[139]	Gizmodo (2012) reports that 72 hours of video are uploaded to You Tube every minute. Craig Mansfield, an engineer, has figured out that pre-screening all that video for copyright infringements would cost $37Bn per year – a sum close to Google's annual revenue. A team of 199,584 judges—or equally qualified individuals—would be required to watch and rule over the video, which in turn would cost an estimated $36,829,468,840.	Now
147.	Video mining	Video mining enables users to search through video content and analyze it for specific characteristics.	
148.	Business analytics	These are expected to find numerous applications in law firms – from supporting commodity law to the analysis of key performance metrics and improved client engagement. Increasingly sophisticated analytical tools will present deeper insights in more compelling visual formats such as 3D. Deeper insights into human cognition will also help in determining more optimal ways of presenting complex data sets and highlighting critical information such as emerging trends, anomalies and correlations.	Now

149.	Data collection technology	Data collection technology is based on software that collects, organizes and analyzes information from various sources. For example, Encase Forensic v7[140] allows investigators to acquire data from a wide variety of devices, discover potential evidence with disk level forensic analysis, and produce comprehensive reports.	Now
150.	Predictive Analytics	Predictive analytics draw on a variety of techniques from statistics, modeling, data mining, pattern recognition and artificial intelligence to predict future behaviors of people, markets or systems through an analysis of current and historical facts[141]. A range of embedded and web-based tools now use predictive analytics to help litigators in negotiating settlements. Such tools typically analyze databases containing hundreds or thousands of past cases, using pattern analysis tools, neural networks, probability theory, and behavioral patterns to predict if and when parties are likely to settle and for what amount.	Now
151.	Predictive coding[142]	Predictive coding is a learning technology. It takes information provided by people regarding specific documents, and generalizes that information to a larger group of documents, making the sorting process more efficient.[143] Predictive coding simplifies document review and reduces e-discovery costs. Whilst such tools have been around for a while, increasingly sophisticated learning and predictive analytical algorithms are expected to bring about dramatic enhancements in functionality and efficiency.	Now
152.	Knowledge Management (KM) tools	KM tools enable organizations to store, analyze, extract patterns and insights and exploit knowledge represented in a variety of forms such as text, images, video and voice. Although KM exists already, firms need to get their grips at tacit knowledge, try to codify it and put it into systems. Through advances in AI in particular, more intelligent KM systems are expected in the future	Now
153.	In-memory computing and analytics [144][145]	In-memory computing and analytics involves processing and analyzing data in the main random access memory of specialized servers instead of in complex relational databases running on typically slower disk drives. In-memory computing allows for very fast analysis of large volumes of data in nearly real-time.	Now
154.	In-memory database management systems	These systems rely on main memory for computer data storage unlike systems employing a separate disk storage mechanism.[146]	Now

155.	Virtual data centers	Virtual data centers enable users to store data on third party servers accessed via the cloud and enable businesses to manage IT infrastructure more effectively by delivering on-demand computing resources.	Now
156.	Shared databases	Firms are adopting a single shared database for key content to enable collaborative working and ease of data transfer - both within the firm and between the firm and their clients.	Now
157.	Shared knowledge bases	Shared knowledge bases enable users to search / collect, organize and share data in a joint or multiple access information repository.	Now

Security Technology

158.	Technology contradiction	Technology contradiction refers to the phenomenon of better and easier to use technologies leading to more cybercrime and increasing client demands to block / retard the use of technology.	Now
159.	Biometric identification	Biometric identification is based on capturing the unique pattern of physical features such as an iris or a voice recorded in a database for person identification. Until early 2014, Heathrow airport adopted an iris recognition system for passport and immigration control. Biometric identification would enable lawyers to avoid the issue of multiple sign-on ID's and passwords.	Now
160.	Voice/facial recognition[147]	Voice/facial recognition is based on biometrics that use advanced sensors to recognize and identify an individual through their voice, face or handprint.	Now
161.	Voice recognition / activation devices	Voice dictation has been there for a long time but using AI and voice integration to review documents and identify patters of data could make the work of lawyers much more efficient. Applications and devices offering such functionality are beginning to emerge.	Now
162.	Biometric sensors	Biometric sensors convert the physical characteristics of a user (voice, fingerprint, face) into an electric signal by measuring pressure, temperature or other kind of energies. The Vibe[148] is a far-future design concept developed as part of the Philips Design Probes program. It is an emotion-sensing necklace combining conductive ink and textile sensors. The necklace can read multiple biometric signals from the wearer and communicates them to other devices and wearers.	2018 (currently In lab)
163.	Genetic recognition technologies	These technologies would recognize and identify an individual through their unique genetic profile.	2020
164.	Body language recognition	Body language recognition (BLR) is the interpretation of gestures / non-verbal communication and behaviour by devices. A variety of research initiatives are working applications that use BLR in everything from witness statement analysis through to security verification. Devices will be able to scan and interpret the non-verbal communication of human gestures, such as facial expressions, hand movements and body language, and respond accordingly.	2015

165.	Homomorphic encryption	Homomorphic encryption refers to the development of tools that would ensure more secure cloud computing by allowing users to send encrypted data to a server in the cloud, which would process it without decrypting it and send back a still-encrypted result.	2016
166.	Anonymous e-mail identification[149]	Anonymous email identification uses text analysis and data mining techniques to uncover the author of an anonymous email. The technique works by first identifying the patterns found in emails written by the subject. Any of these patterns which are also found in the emails of other subjects are then filtered out, leaving patterns that are unique to the author of the emails being analyzed. These remaining frequent patterns constitute the suspect's 'write-print' – a distinctive identifier similar to a fingerprint. The technique could reduce the number of cybercrimes and assist in criminal identification.	2017
167.	Quantum cryptography	Quantum cryptography is based on our knowledge of physics and aims to develop completely secure cryptosystems[150] (pairs of algorithms which convert plain text to ciphertext and vice versa). Quantum cryptography can be used to distribute the secret digital keys important for protecting personal data such as bank statements, health records, and digital identity. Its security relies upon encoding each bit of the digital key upon a single photon (particle of light). If a hacker intercepts the single photons, they will unavoidably disturb their encoding in a way that can be detected[151].	2020
168.	Remote sensing security	Remote sensing security is based on terahertz, CCTV and other remote sensing technologies that offer the potential for unobtrusive detection of explosives, weapons and drugs.	Now
169.	Secret data embedded in calls	The embedding of Secret or 'silent' data of this type is not visible and intercepted by the user while a call takes place. SkypeHide[152] is a new technique that can embed secret data on a Skype call, imperceptible to callers. A user can transmit secret text, audio or video during Skype calls at a rate of almost 1 kilobit per second alongside phone calls. It could potentially be used for transmitting proprietary data.	2015
	Real-time security modeling software[153]	Secure software applications combining pattern recognition, analysis of emergent behavior, risk identification, stability modeling, and threat identification and management.	2015

Disruptive Scientific Developments

170.	Nanotechnology[154]	Nanotechnology involves the manipulation of matter at the atomic and molecular level. In ICT, nanomaterials and nanotechnology tools allow the creation of new data storage and processing methods as well as displays. Advancements in nanotechnology could allow researchers to continue the miniaturization of computer microprocessors and memory storage devices.	Now
171.	Smart Dust	Smartdust (or motes as they are sometimes known) are tiny computers, sensors, robots and other devices which typically work together in a network to perform a variety of functions from sensing and monitoring an environment to continuously recording brain activity and potentially repairing organs within the body.	2020
172.	Self-powered nano devices[155]	These nanoscale devices would be able to transmit and receive wireless signals using very little power, so that batteries would never need replacing. The chips under development are 100 times more energy efficient than most standard technologies and could be deployed for many different uses in future. For example, they could be affixed to apartment walls in cities and monitor energy consumption patterns or environmental pollutants.	**2020+**
173.	NBIC Convergence	The accelerating pace of development and convergence of advances in nanotechnology, biotechnology, information technology (especially AI) and cognitive science (NBIC) is giving rise to an era of potentially transformational and highly disruptive developments such as super-smart materials with memory, engineering of new life forms and radical enhancement of the human brain and body.	2020
174.	Civilian and commercial unmanned aircraft vehicles (UAVs) [156]	Civilian / commercial UAVs are unmanned aircraft systems that can fly autonomously or through a remote control device for the purpose of surveillance[157]. New rules in the U.S and EU are now easing the way for civilian ownership and use of UAV drones carrying sensors and cameras and even doing product distribution to homes. [158]	Now

| 175.	Driverless autonomous vehicles	A number of automobile manufacturers and new entrants are testing autonomous vehicles where the driver gives up complete control and a range of AI systems manage every aspect of the driving experience. In Europe a number of driverless public transport projects are being initiated in 2014. Google has driven several hundred thousand miles in its driverless vehicle prototypes and an increasing number of US states are passing legislation that will allow autonomous automobiles onto their roads.	Now
176.	Gigapanography[159]	''Gigapan" digital images are new panoramas approximately a gigabyte in size created with the lens zoomed in upon the detail of a larger area. A gigapan image can be created by using a handheld digital camera with a zoom lens or with the use of the GigaPan Robot. The GigaPan Robot unit is the creation of NASA and Carnegie Mellon University's robot lab.	Now
177.	Next generation battery technology	Devices offering improved power storage - giving lithium-ion batteries 30 times more power and the ability to recharge 1,000 times faster.	
178.	3D printing / Additive manufacturing	3D printing turns digital designs into three-dimensional objects by printing them layer by layer in a technique known as additive manufacturing– has been used to print objects as diverse as jawbones, jewellery and cars.	Now
179.	3D scanners	3D scanners analyse real-world objects and collect data on shape / appearance which is used to construct digital 3D models.	Now
180.	4D printing	4D printing is the creation of objects which can self-assemble and change their form over time.	2020
181.	Human augmentation	Human augmentation refers to the enhancement of natural human abilities through chemical, biological and technological means such as cognition enhancing drugs, gene therapies, physical body augmentation and electronic brain stimulation.	Now
182.	Skin- embedded screens	Blood-powered electronic interfaces embedded under the skin to mimic a tattoo, display videos or act as a phone or a computer [160]. An example is SKIN – a 'living tattoo', or form of embedded animated skin art. SKIN is a far-future design concept developed as part of Philips Design Probes program[161].	2030
183.	Substrate autonomous bodies	This is the notion that over time we could have bodies that exist in multiple forms e.g. biological, virtual and electro-mechanical forms. Transhumanist George Dvorsky suggests that *"... people will be able to form identities in numerous substrates, such as using a 'platform diverse body' (a future body that is wearable/usable in the physical/material world — but also exists in computational environments and virtual systems) to route their identity across the biosphere, cybersphere, and virtual environments."*[162]	2050+

184.	Human brain mapping	Human brain mapping aims to understand the relationship between structure and function in the brain and the physical processes that underlie human sensation, awareness, and cognition[163]. To pursue this goal, the US government has launched the heavily funded BRAIN Initiative (Brain Research through Advancing Innovative Neurotechnologies, also referred to as the Brain Activity Map Project) as a collaborative research initiative. The European Commission has awarded approximately $1.35Bn to its own Human Brain Project[164]. One of the project goals is to develop supercomputing techniques modeled on the brain.	2025
185.	Brain uploading	Brain uploading is the idea of duplicating the human mind in a non-biological substrate such as the internet or a robot. This relies on successful mapping and whole brain emulation (see 180 above).	2025+
186.	Brain transplantation	Brain transplantation is the idea of transferring either the physical brain or the content stored within it from one human to another human, or a non-biological substrate.	2025+
187.	Exocortex	An Exocortex is a theoretical artificial external information processing system that could augment a brain's biological high-level cognitive process[165]. An Exocortex refers to the various tools which are not part of the bio-brain that humans would use to augment human cognition. Blackberries, iPhones, and other essential electronic devices are sometimes described as proto-exocortices[166].	2030+
188.	Mind uploading	This is the notion of going beyond uploading just what we know e.g. the content of our memory, to uploading our higher level functions such as cognitive processes, consciousness and emotions.	2035+
189.	Memory implants	Memory implants are microchips that generate or restore memories in a human brain.	2020
190.	Hive minds	This is the idea of a group of apparently independent bodies coming together to create a collective 'consciousness', sharing knowledge and reaching consensus decisions. A range of AI research projects are exploring the concept. One idea is to see how it could be deployed to replicate human behaviour in organisations where professional and decision makers cannot be present at the same time. The notion is that their intelligent agents could act as a hive mind and then refer their collective decisions back to their human counterparts for verification.	

191.	Neural coupling	This is the idea of coupling two or more human brains. Transhumanist George Dvorsky says that *"Already today, scientists have created interfaces that allow humans to move the limb — or in this case, the tail — of another animal. At first, these technologies will be used for therapeutic purposes; they could be used to help people relearn how to use previously paralyzed limbs. More radically, it could eventually be used for recreational purposes. Humans could voluntarily couple themselves and move each other's body parts."*	2025
192.	Moral enhancement	Transhumanist George Dvorsky reports that *"Also known as virtue engineering, it's the use of drugs and wearable or implanted devices to enhance self-control, empathy, fairness, mindfulness, intelligence and spiritual experiences."*[167]	2025
193.	Artificial wombs	George Dvorsky suggests that "*This is any device, whether biological or technological, that allows humans to reproduce without using a woman's uterus, says Annalee Newitz. Sometimes called a 'uterine replicator,' she says these devices would liberate women from the biological difficulties of pregnancy, and free the very act of reproduction from traditional male-female pairings. "Artificial wombs might develop alongside social structures that support families with more than two parents, as well as gay marriage," says Newitz.*"[168]	2030
194.	iCyborg lawyers	iCyborg lawyers would have both biological and artificial parts and utilize non-invasive or invasive brain-computer interfaces.	2025
195.	Lab-on-a-chip devices	Lab-on-a-chip devices integrate multiple laboratory-type capabilities on a single chip only a few centimeters in size[169]. In 2011 *Science Daily* reported that researchers from the University of Rhode Island had invented a portable device that provides blood test results in less than 30 minutes – a big step in point-of-care diagnostics. Further miniaturization of the invention could lead to next generation lab-on-a-chip devices that can be adapted as smartphone applications[170].	2015
196.	Computational photography[171]	Computational photography enhances / extends the capabilities of digital photography using computational imaging techniques. The output is an ordinary photograph but one that could not have been taken by a traditional camera. Current examples include HDR imaging and 3D photography.	2020

197.	Photonics[172]	Photonics could be a building block for very high speed computing and communications. Photonics studies how light interacts with matter. The field consists of many sub-disciplines and applications like laser technology, display technology, optical computing, fiber optics and photonic crystals. For example, researchers are considering using light and photonic crystals to build a new generation of integrated circuits.	2017
198.	New quantum materials and devices[173]	Quantum devices seek to exploit the particle and wave like behaviour and interactions of energy and matter to deliver ultra-high speed and potentially highly secure computing and complex new materials. Quantum devices could revolutionize sensor technology long before quantum computers become available. As well as improved law enforcement, this could mean more efficient energy generation and use, better-regulated manufacturing processes, and better pollution detection.	2025
199.	Atomically Precise Manufacturing	Atomically Precise Manufacturing (APM) refers to the building of macro-scale products from the bottom-up by assembly and bonding of components at the molecular or atomic level. Experts suggest that APM would enable production with unprecedented efficiency, scope and productivity.	2035
200.	Hyperloop[174]	Hyperloop is a conceptual system that could transport passengers in pods at near-supersonic speed – the vision of billionaire entrepreneur Elon Musk. This transport concept could provide a viable alternative to short-haul travel, high-speed rail and travelling by car. It is suggested that Hyperloop could reduce the journey time between Los Angeles and San Francisco to just 30 minutes, compared to 75 minutes by plane and 5.5 hours by car. The concept is based on pods travelling through a low-pressure tube that would be suspended above the ground. Musk argues that the development would cost around $6 billion - roughly one tenth of the cost of an equivalent rail system.	
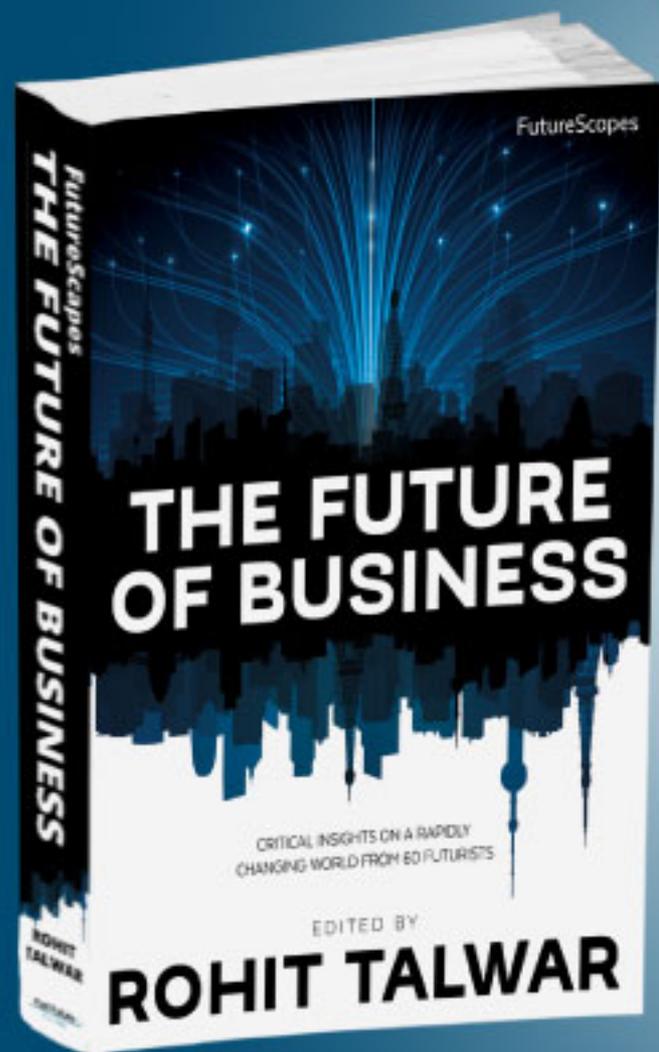
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