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Emerging trends

Over the next few years, there are expected to be a number of emerging trends in consumer and business technology that will directly and indirectly impact on the practice and execution of digital evidence. An organisation's ability to address the emerging trends will impact its ongoing effectiveness in meeting its mission. Leaders of the organisational digital evidence capability will be responsible for anticipating the emerging trends and market innovations, the impact that they will have on organisational capability and capacity and to ensure that the capability and capacity of the team are prepared. Anticipation and preparation for emerging trends in digital evidence results from a many faceted approach to leadership including, but not limited to, articulating a vision and a supporting narrative; the ongoing education and training of staff; budget and resources; and buy in from the organisation’s executive. A key to successfully meeting emerging trends is to not only look at the challenges that are posed by emerging technologies, but also to look at the opportunities that emerging technologies can provide to meet those evidence challenges.

Several technology and consulting companies invest significant resources, time and effort to anticipate emerging technologies. Some of the predicted broad trends include the following:

- sensing and motion technologies
- augmented human blurring the boundary between the physical and digital worlds
- postclassical computer and communications with quantum computing becoming a practical reality
- digital ecosystems comprising suppliers, customers, trading partners, applications, third-party data service providers and all technologies that support the ecosystem
- advanced artificial intelligence and data analytics, the science applied to the analysis of raw data [1]

Technologies to impact on digital evidence

There are many technologies in various stages of development before they are offered to market. Those trends that are at the peak of development and ready for implementation into business and consumer markets are as follows:

*Edge artificial intelligence* refers to algorithms that run on local computers or the associated embedded systems. A common Edge AI is the home smart speaker when the ‘wake’ command is locally stored on the speaker. Edge AI will replace traditional IoT configurations. In current ecosystems, sensors and devices are connected directly via a router to the Internet that provides data to a server, where algorithms then process the data to predict situations concerning the state and the environment of the device.
Low earth orbit satellite systems will enable the provision of high-speed Internet in places where it is economically unviable to lay optic fibre, such as in emerging markets or sparsely populated regions. Low earth orbit is 500–2000 km above the surface of the earth compared with traditional satellites that orbit around 36,000 km. The attraction for Internet services is the reduced latency (the time taken for data to be transmitted and received and a reply completed) from ~600 milliseconds to speeds approaching those of terrestrial services.

Autonomous driving is perhaps more commonly known as the self-driving car. Substantial research and investment is being undertaken by established motor vehicle manufacturers and technology companies. Reduced latency and improved intelligent systems will improve the viability of autonomous vehicles.

Edge analytics refers to the performance of data analysis at a noncentral point such as at a switch, a peripheral node or a connected device, as found in Internet of Things. Edge analytics configurations enable greater speeds for data processing and response.

Artificial intelligence platform as a service (PaaS) refers to the application of AI in cloud services. Established platform as a service is an environment for building, deploying and maintaining applications and comprises combinations of hardware infrastructure and software solutions. AI PaaS vendors offer pretrained models and algorithms that can solve specific tasks such as the extraction of features, prediction of outcomes and performance of complex calculations.

Biochips are logical devices, or microchips, that are designed to function in a biological environment, such as within a living organism. They can be designed to perform thousands of parallel biochemical reactions and to measure large numbers of biological indicators within an organism.

5G telecommunications is the next generation of telecommunications for mobile digital networks. The network operates on three band spectrums, in which each band spectrum will differ in speed, the ability to penetrate walls and feature extremely low latency. The benefits of 5G include significantly faster data speeds, improved latency, power efficiency, spectral efficiency, high mobility at speed and improved connection density that will support many more connected devices than current LTE systems. This will lead to improved capacity and speed of broadband; a generational improvement in the viability of autonomous vehicles in which vehicles are able to exchange information while on the road; more efficient public infrastructure; remote control of heavy machinery and improved telemedicine with remote recovery, precision surgery and remote surgery; and it will provide a major boost to IoT.

The fifth generation of mobile phone networks is now becoming a reality in many countries. 5G will bring user speeds of 10 gigabits per second (compared with the current up to 35 megabits per second), a 1000-fold increase in system capacity and 100-fold increase in connection density over current LTE and LTE-advanced networks. The advances will impact the specialisation of mobile network forensics, the cross discipline of digital forensics and cellular network analysis that seeks to ‘… investigate cellular network-facilitated crimes…’ Key technologies that accompany the introduction of 5G include Control and User Plane Separation (CUPS) permitting the deployment and use of 5G more efficient for scaling; network functional virtualisation (NFV), a technique that can virtualise an entire class of functions without the
Emerging trends

need for custom hardware for each function; network slicing that allows portions of the network to be divided for specific customer use cases; and Cellular Internet of Things (CIoT) in which IoT devices connect to the Internet via the mobile network rather than via a router. 5G will support the deployment of new devices and functions including high-speed vehicles and trains, IoT devices, commercial air to ground service and service for light aircraft and helicopters, which will be facilitated by the new and/or enhanced 5G network technologies. These new technologies (CUPS, NFV, network slicing, and CIoT) provide new opportunities for lawful interception and lawful access to location services. The NFV will cause a significant reconfiguration of law enforcement processes, and law enforcement agencies cannot assume that the network infrastructure will be regulated for forensic readiness and will have preestablished points of interception and localization. Network slicing allows network operators to create customised network partitions based on their preferred business models which can include sharing portions of the network with other operators. This allows for multititenancy of the network with multiple options for management of the network. Laws governing mobile network forensics differ between jurisdictions but, in general, require a warrant and privacy protections for safe storage and analysis of acquired evidence. With the anticipated increase in Internet of Things devices, another avenue for warrantless acquisition of mobile network evidence might be available. An IoT device can be a digital witness that can identify, collect, safeguard and communicate mobile network evidence. It might be necessary for evidence obtained from the IoT device to be correlated with evidence collected from the IoT network operator [2].

Graph analytics, also known as network analysis, is driven by social network influencer analysis which is particularly of interest to marketing managers. But it can be applied to other situations, such as detecting financial crimes including money laundering; banking, benefits and insurance fraud; crime prevention; analysis of power grids and other infrastructure; airline routes and supply chain logistics and life sciences research.

Some technologies are rising and potential implementation is in sight:

Immersive workplaces where employees can move frequently throughout the working day and choose the tools they need and the team they need at the time and place they prefer. COVID-19 has accelerated some aspects of this process and it is now closer to being ready for implementation.

Augmented reality cloud is based on augmented reality, the integration of digital information with the physical environment. Developers are able to access apps from a multitude of providers to produce apps that place digital objects in the physical world and allow for multiuser experiences, for example, Pokémon Go. AR cloud allows for the mass adoption of AR technology and could change the way in which information is stored, so that it is accessible on the move (50% of information searches are already conducted ‘on the move’) and information is available when and where it is needed. To put it another way, the AR cloud will present a 3-D copy of the world, with the possibility of eliminating the need for a personal device.

Decentralised web, which can also be referred to as ‘web 3.0’, is favoured by privacy activists and is based on peer-to-peer technology. In some respects, it is a rebellion against the big tech companies that have taken control of citizens’ data. Developers working in this space are developing decentralised apps, or ‘DApps’. The
decentralised web is seen as a replacement to, for example, Google Docs, where every key stroke is sent to Google (an advertising company). Unlike Google Docs however, decentralised web data files are stored in encrypted form on a network of computers that are unable to read the data. The encryption keys never leave the author; therefore the data are solely under the control of the author.

**Generative adversarial networks (GANs)** represents the development of machine learning that falls within the set of generative models. Generative models are algorithmic architectures that pit two neural networks against each other to produce, or generate, new synthetic content that can pass for real data. They are widely used in image generation, video generation and voice recognition. GANs can learn to mimic any data and can be taught to create images, music, speech and prose. Consequently, they can be used to generate fake media content.

**Adaptive machine learning** is a further development of traditional machine learning. Traditional machine learning has two phases: (1) the training phase in which data are collected and ingested and (2) the prediction phase in which the data are analysed to reveal insights and make predictions to aid decision-making. The adaptive approach has a single phase that monitors and learns the changes to the input and output values. For example, it can learn from events that may alter the input data behaviour, such as a market, in real time and make data-informed predictions. The adaptive learning systems can handle billions of features across vast datasets and can be applied to fraud detection, financial market trading, market effectiveness and retail effectiveness.

**DigitalOps** has led to organisations now transitioning to become digital organisations where management, business and operation processes are now data intensive as the data is integrated with, or brought as close as possible to, corporate platforms. Although DigitalOps is not necessarily a challenge from an investigative point of view, there is scope for investigations to make improved use of data to improve investigational outcomes and timeliness.

**Decentralised autonomous organisation** is an evolution of the traditional organisational structure in which the relationship between an individual and the organisation, or a politician and the citizenry, is defined by a contract. The interactions between people in decentralised autonomous organisations are defined through self-enforcing, open-source protocols. The traditional top-down structure with its layers of management and bureaucracy is absent with all behaviours defined by the code. It can be deployed in a geographically dispersed manner with coworkers located in different countries. All transactions of the company are recorded and maintained on a blockchain and are, therefore, theoretically incorruptible.

**Augmented intelligence** is a development of artificial intelligence that is designed to enhance human intelligence rather than replace it. It reflects a human-centred partnership of people and artificial intelligence that enhances cognitive performance, including learning, decision-making and new experiences. It has applications to medicine, education and creative fields where human input is intrinsic to the production.

**Flying autonomous vehicles** are self-explanatory, but some believe that these vehicles might become integrated into the transport fabric before ground-based autonomous vehicles as there are fewer obstacles (i.e., pedestrians and other vehicles) in the air than on the ground.
Transfer learning refers to a research problem in machine learning where knowledge developed while solving one problem can be stored and used to solve a different, but related, problem.

Artificial emotional intelligence is a subdivision of artificial intelligence that measures, understands, simulates and reacts to human emotions. It is also referred to as affective computing, artificial emotional intelligence, emotion recognition, emotion detection technology or even facial coding.

Light cargo delivery drones are largely self-explanatory and will account for an increasing share of deliveries for business to consumer and business to business.

Synthetic data are the production of data that are not obtained by direct measurement. It is used to address specific needs or conditions for which there is a paucity of real data. Synthetic data can be used to develop and test new fraud detection methods.

Knowledge graph is a complex concept in which a given knowledge domain is modelled by subject matter experts with the assistance of machine learning algorithms. The knowledge graph lies on top of existing databases to link all the data together. Knowledge graphs are more pervasive than is immediately apparent as they are employed by the large, well-known technology companies including Facebook, Google and Microsoft to augment search results. An example used by Google is the enhancement of Google’s artificial intelligence when answering questions posed to Google Assistant and Google Home. Knowledge graphs can combine disparate silos of data as often appears in large organisations which often results in the generation of multiple versions of knowledge and overlapping initiatives. Knowledge graphs can access and work with structured and unstructured data, a function that is often beyond the capability of other technologies. They are capable of deeper, contextualised searching to locate relevant facts and contextualised answers and provide future proofing of organisational databases for greater reusability of their data.

Personification is the attribution of human characteristics, for example, emotion, to something that is not human, such as an idea or an animal. It can lead to the belief that the nonhuman entity has the ability to act like a human.

Explainable artificial intelligence, or XAI, refers to the techniques in the application of artificial intelligence whereby the results can be understood by human experts, thereby addressing a significant shortfall of current artificial intelligence models.

To meet the digital evidence needs of organisations in the context of the abovementioned emerging trends, solutions are going to be dependent on balancing the interests of multiple parties who have a requirement for the capability, including and especially privacy concerns. Digital evidence is used in multiple forums which can be broadly described as the courtroom, the boardroom and the warroom, and yet it is becoming increasingly expensive, complex and inaccessible. The impacts of these concerns can be mitigated by improving collaboration between industry, government and academia; centralisation and coordination of research, development and administration of capabilities; mechanisms to exchange digital investigation information that align with stakeholder needs and improved availability and coordination of digital investigation knowledge and advanced capabilities [3]. Considerable concern has been expressed in public forums regarding many of the emerging technologies and in particular, government access to the emerging technologies, especially those seen to be 'intelligent'.
Some advocates propose that such technologies should be restricted, regulated or subject to strong oversight. While the ethical development, implementation and management of emerging technologies is a public benefit, any ethical framework should not stifle development in the knowledge that private companies, criminal enterprises and potential adversaries are most probably seeking to advance their own technology. An overly restrictive, ethical domestic framework may provide criminal enterprises and adversaries with a competitive advantage over domestic interests and law enforcement agencies (Fig. 17.1).

References

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