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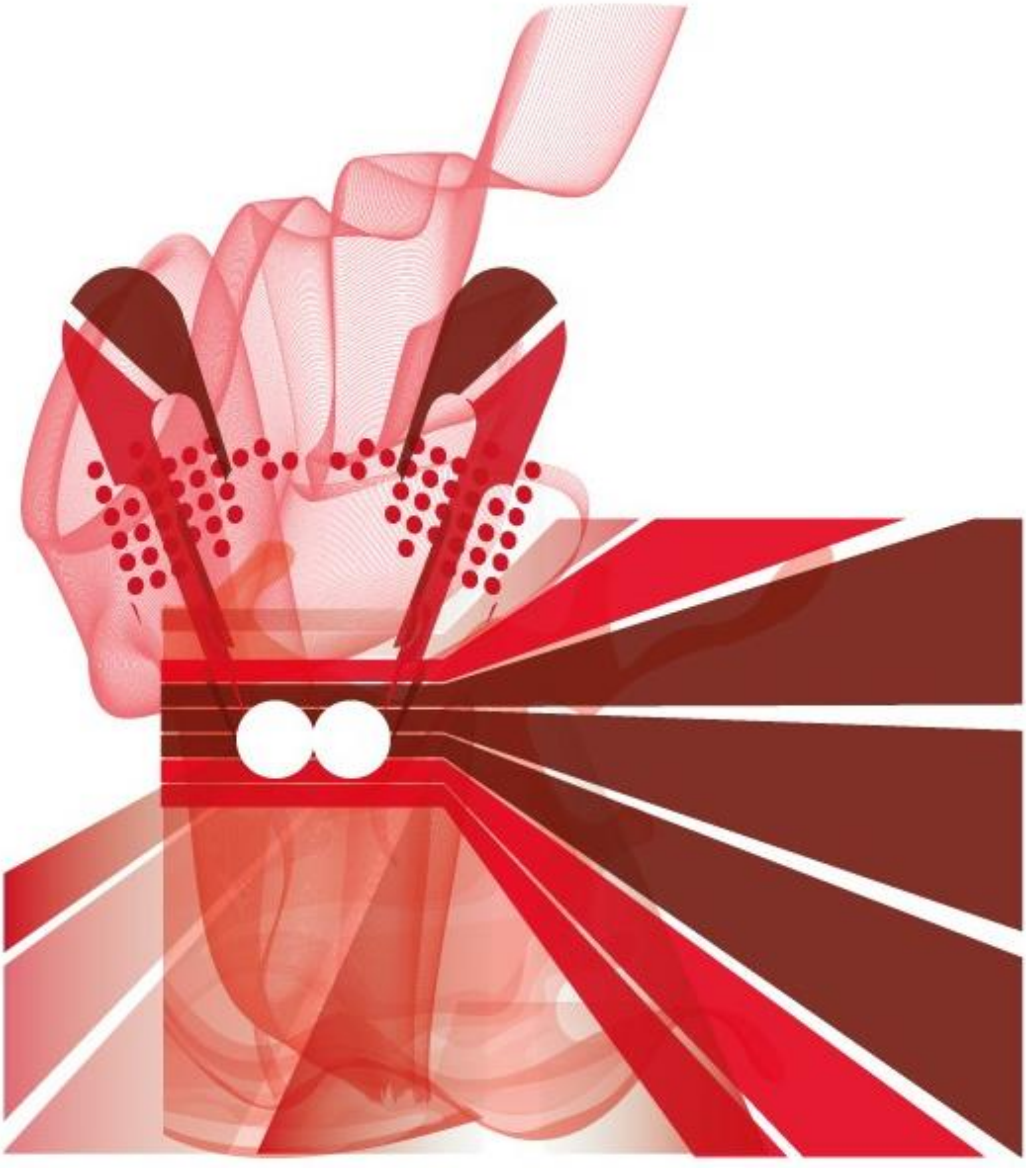

Intellectual Property Infringement and Enforcement Tech Watch Discussion Paper 2023

Prepared by the European Observatory on Infringements of Intellectual Property Rights, EUIPO, with support from the Impact of Technology Expert Group

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DISCLAIMER

The views expressed in this discussion paper do not represent any official position of the EUIPO. This discussion paper is a compilation of contributions from members of the Observatory Impact of Technology Expert Group and guest experts from the private sector, academia, the EUIPO's Digital Transformation Department (DTD) and the Observatory who participated in the various meetings and workshops of the expert group. Members of the expert group who did not attend the workshops have subsequently been given the opportunity to contribute. The views expressed in this discussion paper cannot be attributed to the expert group, nor to any single contributing expert.

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1 FOREWORD

Tech Watch encompasses looking to the future but with a firm understanding of the past and present and awareness of the impact of technology in society, on businesses and in our lives. Hopefully, this second edition of the discussion paper and possible future editions will contribute to a more comprehensive understanding of the complexity of emerging and disruptive technologies and provoke consideration of the future impact of these technologies on the infringement, protection, and enforcement of intellectual property (IP).

2 EXECUTIVE SUMMARY

The EUIPO, through the European Observatory on Infringements of Intellectual Property Rights (Observatory), develops tools and promotes best practices to enhance the protection of intellectual property (IP), which is a critical asset for companies and individuals. Emerging and disruptive technologies have, especially over the last 30 years and with accelerated speed in the last decade, become increasingly important in IP protection, as tools used both to infringe and to enforce IP.

To strengthen the Observatory's work on emerging and disruptive technologies, an Impact of Technology Expert Group was established in 2019 to:

- support the Observatory's work involving technological issues;
- identify new technologies with the potential to impact IP protection, infringement and enforcement;
- define possible use cases and carry out studies or launch initiatives to better understand these impacts;
- raise stakeholders' knowledge about technological developments with the potential to impact IP protection, infringement and enforcement.

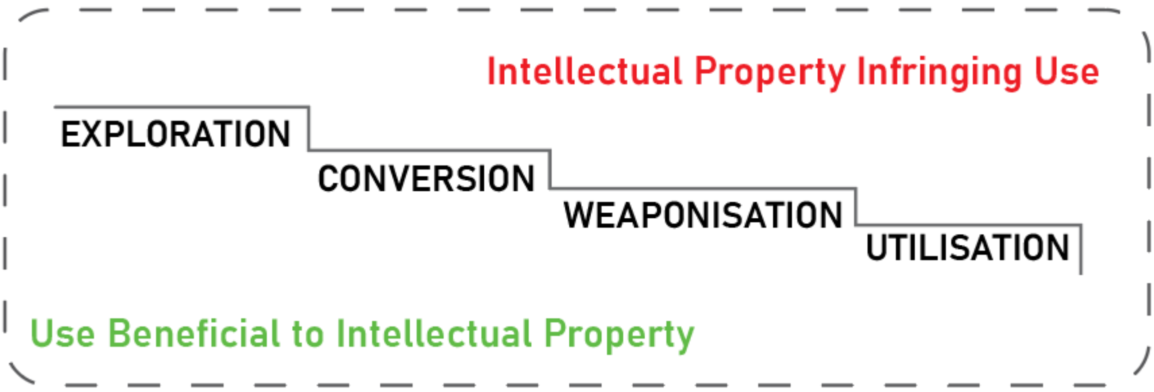
The second task has been named 'IP Infringement and Enforcement Tech Watch'. At the first meeting of the expert group in April 2019, a methodology on which to base the Tech Watch was developed, while in the expert group's first Tech Watch workshop, held in January 2020, the methodology was used to analyse six different technologies. In the second workshop, two additional technologies were analysed as well as a type of high-tech investigative tool.

During the first workshop, the methodology evolved into 'The Intellectual Property Tech Chain'. The methodology distinguishes four steps in the application of a new technology:

- exploration: exploring the technology to ascertain whether it could be applied to protect, infringe or enforce IP;
- conversion: converting the technology to enable it to achieve the identified goal;
- weaponisation: finalising the development of the application;
- monetisation: using the application to protect, infringe or enforce IP.

The methodology builds on the idea that, to understand the impact of a new technology, it is not only the technology itself that is important but also the market situation relevant to the technology, its social significance, and related legal issues. Additionally, the methodology takes into consideration that all emerging and disruptive technologies have the potential to be used in ways that are beneficial to IP but are also used as tools for IP infringement.

Figure I. Simplified version of 'The Intellectual Property Tech Chain'



At the first Tech Watch workshop held in January 2020 the expert group, together with guest experts, discussed the six technologies (Blockchain, Artificial Intelligence, Robotics, 3D Printing, Nanotech and Spatial Computing) as regards the following issues:

- key features of the technologies;
- identification of essential information resources;
- impact of the technologies on society, the economy, and world trade;
- IP protection use cases;
- threats and challenges for IP;
- investigative and enforcement opportunities.

The first edition of this discussion paper was published in September 2020 and closely reflected the discussions in the first Tech Watch workshop,

Based on the first workshop and the work preparing the discussion paper, it was decided that the quality of analysis of additional technologies would benefit from more in-depth interaction with experts outside the expert group itself, including those not inherently familiar with IP matters. This would add more insight into the technologies themselves as well as business and societal perspectives.

After a catch-up video meeting held in November 2020, the expert group decided to focus on analysing areas related to Internet of Things (IOT) and Quantum Computing.

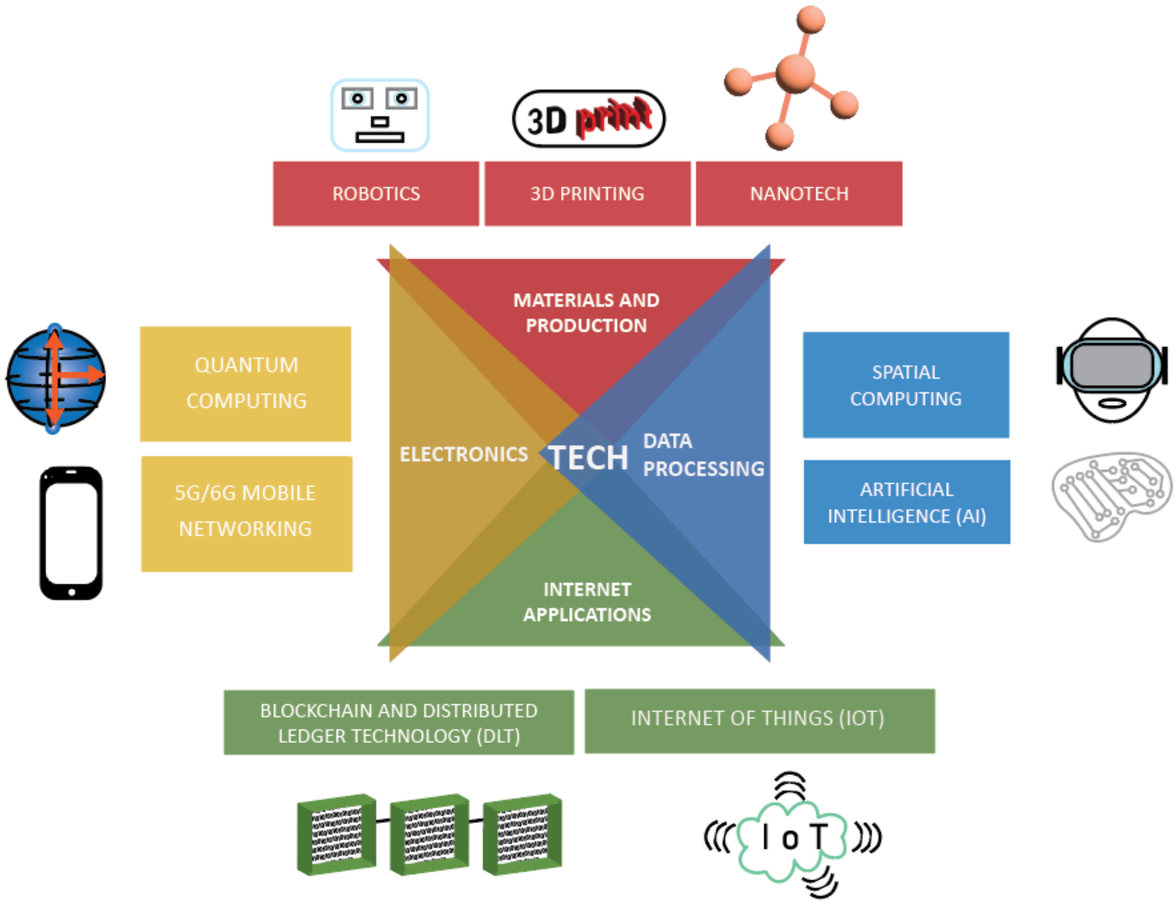
In the second Tech Watch workshop held as a video conference in May 2021 the expert group and specially invited experts discussed two technologies (Internet of Things (IOT) and 5G/6G Mobile Networking).

This was followed by the third Tech Watch workshop, held as a video conference in November 2021, at which the expert group and specially invited experts discussed the latest developments in blockchain technology (especially Non-Fungible Tokens (NFTs) and Cryptocurrency Investigative Forensic Tools).

In March 2022, the first Deep Dive Report based on the expert group's work was published. The report took a fresh and highly original look at the impact of artificial intelligence (AI), in its broadest sense, on the infringement and enforcement of copyright and designs, through two storylines featuring the production and sales of goods and the distribution of digital content.

The fourth Tech Watch workshop was hosted by the Niels Bohr Institute in Copenhagen, Denmark, over 2 days in April 2022, and focused on a single technology (**Quantum Computing**).

Figure II. Emerging technologies analysed in this discussion paper



Based on the discussions at the latest three Tech Watch workshops, it was decided to update the 2020 discussion paper.

As a consequence of the increasing focus on environmental protection, sustainable development and the need to address the challenges of climate change, this discussion paper has added a number of considerations on what impact technologies have on these issues. It also looks at how IP infringement can pose a threat to the green transition and how IP protection and enforcement can positively contribute to the green agenda.

From the discussions at the four Tech Watch workshops and other fruitful interactions with the expert group since 2019, the following 13 significant horizontal points can be identified:

1. The nine technologies are all rapidly evolving and have not yet reached their full potential, not least in relation to their impact on IP.
2. All nine technologies will, in varying degrees and forms, have a significant impact on labour, the economy and world trade. However, it seems that the most significant impact occurs when the

technologies successfully interact with each other.

3. The technologies all have essential roles to play in reaching the global sustainable development goals, such as securing good health, industrial innovation, well-functioning infrastructure, reduced inequalities, and justice. all of which are essential for the fundamental role of IP for sustainable development.
4. With the growing importance of the protection of biodiversity, countering desertification and fighting or mitigating climate change, the technologies' role must be increasingly scrutinised for their positive as well as potentially negative environmental impact.
5. Predictions about the application of the technologies range from potential significant improvements in humanity's living conditions (e.g., better-quality products and services) to major threats and dystopian visions (e.g., increased inequality, unemployment, mass surveillance or collapse of the international financial sector).
6. A key characteristic of all the technologies is the potential to automate processes, including in the production and marketing of goods and the setting-up and administration of governmental and commercial activity, almost all of which have a significant impact on IP.
7. All the technologies raise questions about the protectability of innovation and creativity related to the technologies themselves: for example, the protectability of innovations involving artificial intelligence applications; of innovations and creations made by autonomous, artificial intelligent or quantum computing-based systems; of files used as a basis for 3D printing; of the datasets that are vital to all the technologies and their application; and the increasing importance of protection of trade secrets.
8. Some of the technologies can make IP protection more effective and provide higher-quality registration, monetisation/exploitation and documentation systems.
9. All the technologies – often in combination – can be applied by IP infringers to either make future production, marketing and distribution of counterfeits more effective (e.g., cheaper production by using robots, use of local 3D printing facilities for production purposes avoiding custom checks, and more appealing presentation of products using augmented reality). However, they can also be used in new, IP-infringing ways (e.g., cybersquatting in decentralised domain name systems and copyright infringement in virtual applications) and in IP-related cyber fraud or cyberattacks (e.g., trade mark registration invoice fraud, cybersquatting, phishing attacks supported by deepfakes, or theft of trade secrets).
10. Consumers and internet users can easily be deceived by criminals misusing new and emerging technologies through a variety of scams and deceptive practices, including greenwashing and other practices with negative IP implications.
11. Most of the technologies can be used as tools for IP enforcement: for example, to protect supply chain integrity; facilitate product individualisation and identification of counterfeits; improve investigations by law enforcement; improve customs risk analysis; and make notice and takedown procedures more effective.
12. A characteristic of all the technologies is that they represent new evidential opportunities and challenges for legal systems due to their complexity and the enormous amount of generated data, but also the reliability of the information (e.g., the probabilistic nature of artificial intelligence and quantum systems, the increasing number of distinct blockchain applications, and the potential pollution and manipulation of large datasets), not least in IP infringement and IP crime cases.
13. Overall observation: all the technologies have already shown themselves to be important emerging and disruptive technologies impacting businesses, the economy, the environment, government administration and the daily lives of many people, and pose potential challenges and/or opportunities for IP.

The work of the Impact of Technology Expert Group will continue and, in the future, it will analyse more important and emerging technologies, including the metaverse, big data, open-source intelligence (OSINT), climate change mitigating technologies, nuclear analytical techniques to counter criminal infiltration into the legitimate supply chain and new developments in cybersecurity.

3 GLOSSARY AND ABBREVIATIONS

Technical terms used in this discussion paper		
Term	Abbreviation	Definition
Android		A robot or other artificial being resembling a human being.
Application programming interface	API	Procedures and functions allowing the creation of applications that can access the data or features operating system or application.
Artificial Intelligence	AI	Data processing imitating functions of the human brain.
Augmented Reality	AR	Data-processing technology that uses various devices to add virtual elements to the physical world.
Augmented Virtuality	AV	Data-processing technology that uses various devices to add substantial numbers of virtual elements to the physical world.
Automated Content Recognition	ACR	Applications of various technologies, but most often those using artificial intelligence, to identify content in an automated fashion.
Big Data		Technology connected to processing and analysing large amounts of data.
Blockchain		A method for decentralised recording of data in an immutable encrypted ledger maintained in a peer-to-peer (P2P) network.
Cryptocurrency		An encrypted data string that denotes a unit of currency.
Distributed Ledger Technology	DLT	In this paper used synonymously with the term 'blockchain'.
Domain Name System	DNS	An information system in which internet domain names are located and translated into internet protocol (IP) addresses for easy access to internet resources.
Enhanced Reality		Data-processing technology that uses various devices to virtually enhance items in the physical world.
Intellectual Property	IP	Copyright and related rights as well as industrial rights (e.g. trade marks, designs, patents, plant variety rights and geographical indications) and trade secrets.
Internet of Things	IoT	A system of interrelated computing devices provided with unique identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction.
Intellectual Property Right	IPR	Copyright and related rights as well as industrial rights (e.g. trade marks, designs, patents, plant variety rights and geographical indications).
Metaverse		An interconnected, universal and immersive virtual environment.
Mixed Reality	MR	Data-processing technology that applies different gadgets to mix virtual elements with items in the physical world.
Nanotech		Nanotechnology (nanotech) is the manipulation of matter on an atomic, molecular and supramolecular scale.
Nanotubes		The application of nanotech in the form of tubes made of carbon with a diameter measured in nanometres (a nanometre is 0.000000001 m).
Open-source intelligence	OSINT	Data collected from publicly available sources to be used in an intelligence context.
Smart Contract		Self-executing contract which instructions are stored on a Blockchain.
Quantum Computing		A field of computing based on the principles of quantum theory.
Radio-frequency identification	RFID	A form of wireless communication using electrostatic or electromagnetic coupling to identify objects.

Rio Markers		The 4 Rio markers are: • biodiversity; • desertification; • climate change mitigation (i.e. reductions in or absorption of greenhouse gas emissions); • climate change adaptation (including climate risk mitigation and vulnerability reduction).
Robotics		The field of science and engineering dealing with the creation, design, construction, monitoring, control and use of programmable and often intelligent machines.
Smart Contract		A self-executing contract, the instructions of which are stored on a Blockchain.
Spatial Computing		An umbrella concept, synonymous of extended reality, embracing different technologies and allowing immersive and engaging experiences that bring the real and the digital worlds together.
Virtual Reality	VR	Data processing technology that applies different gadgets to create a completely virtual environment.

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XXXIX	Distributed v decentralised ledgers
XL	Differences between blockchain types
XLI	Gartner hype cycle
XLII	The history of blockchain
XLIII	Wallet address

5 INTELLECUAL PROPERTY TECH WATCH

5.1 The European Observatory on Infringements of Intellectual Property Rights

001 Aim of the Observatory

The EUIPO campus in Alicante, Spain

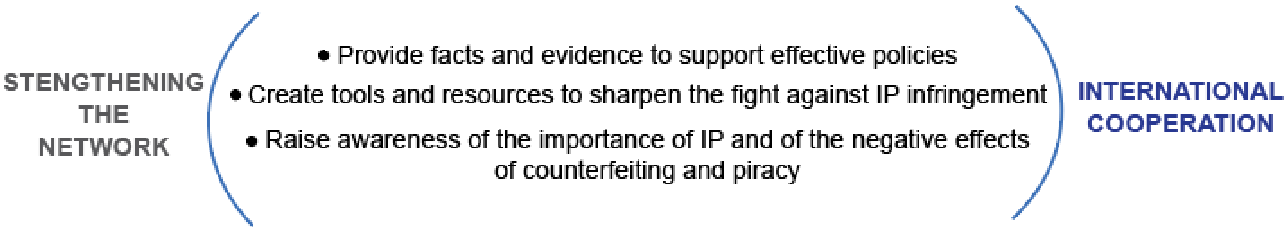
Building upon its success in managing the European Union trade marks and registered Community designs, the European Union Intellectual Property Office (EUIPO) now also covers matters relating to IP enforcement. Following a proposal by the Commission, which was backed by the European Parliament and the Council, the European Observatory on Infringements of Intellectual Property Rights (Observatory) was fully entrusted to the EUIPO on 5 June 2012. The Observatory develops tools and promotes best practices to enhance intellectual property (IP) protection, which is a critical asset for companies and individuals. The Observatory is a platform-based body that brings the public and private sectors as well as civil society and international organisations together in a dynamic network. Through this work, the Observatory monitors, aggregates and reports on trends and crucial information to assist policy makers, authorities and any other stakeholders engaged in protecting and enforcing IP rights.

002 Core activities of the Observatory

The Observatory's core activities are:

- raising public awareness;
- delivering specialised enforcement training;
- developing systems to gather, analyse, report and exchange key information on the scope and scale of and trends in counterfeiting and piracy in the EU;
- providing evidence-based data to enable EU policymakers to shape effective IP enforcement policies and to support innovation and creativity.

Figure III. The tasks of the Observatory



003 Importance of disruptive and emerging technologies for IP
Emerging and disruptive technologies have, over the last 30 years, become increasingly important in IP protection. However, they are also used as tools to infringe and enforce IP. Consequently, it was decided that the Observatory should strengthen the collection and analysis of information about these technologies and their impact on IP. One of the initiatives to enable this has been the creation of the Impact of Technology Expert Group.

5.2 The Impact of Technology Expert Group

5.2.1 Concept behind the Observatory's expert groups

004 Aim of and representation in the Observatory's expert group
The Observatory's five expert groups help to implement the Observatory's projects in focused and specialised areas. They comprise experts selected after a review of applications from those interested, based on a public communication, as well as those identified on the basis of the groups' needs. The experts represent themselves and not a particular organisation or institution. As far as possible, the expert groups are balanced in their specific expertise, geographical coverage and gender. Balance is also sought to cover both counterfeiting and piracy issues. Experts are called upon to provide expert support to the Observatory's agreed projects and activities. A particular expert group will exist only as long as its work is required; however, new expert groups can be created as the need arises, notably following proposals from stakeholders.

5.2.2 Establishment of the Impact of Technology Expert Group in 2019

005 First meeting of the expert group on 11 April 2019
The Impact of Technology Expert Group was established in February 2019 and the first meeting took place on 11 April 2019. The aim of the expert group was twofold:

- to support the work of the Observatory involving technological issues;
- to identify new technologies with the potential to impact IP protection, infringement and enforcement, define possible use cases and carry out studies or launch initiatives to better understand these impacts and raise stakeholders' knowledge about technological developments with the potential to impact IP protection, infringement and enforcement.

006 The various types of expertise represented in the expert group
The group's 25 expert members have at least some of the following characteristics:

- experience in monitoring new technologies and their impact on IP protection, infringement and enforcement;
- high-tech investigation experience (e.g. private investigations, OSINT, law enforcement, cross-border collection of evidence);
- technical expertise in:
  - alternative or enhanced realities (e.g. mixed reality, gaming, e-sport, VR, AR);
  - database technologies, advanced data collection and analytics (e.g. algorithms, API, DLT, private and public administration, machine learning, big data, cloud);
  - online payments (e.g. payment settlements, online banking, virtual currencies); and/or
  - malicious online activities (e.g. malware, phishing);
  - advanced industrial-production and tracing technologies (e.g. RFID, standardisation technologies, 3D printing, robotics, autonomous products, IOT, drones, energy

efficiency);
- green, sustainable and or climate change preventing or mitigating technologies.

5.2.3 First Tech Watch Workshop, EUIPO headquarters 30-31 January 2020

007 The workshop set-up

Snapshot I from the workshop

On 30 and 31 January 2020 the first Tech Watch workshop took place at which experts from the Impact of Technology Expert Group during four rounds discussed selected groups of technologies with guest experts from academia, the EUIPO DTD and the Observatory. This highly dynamic set-up allowed collaborative and engaging discussions, in which the members of the expert groups and experts from academia moved from one technology to another in each round, while members of the EUIPO staff remained with the technology in which they had special expertise. In each round the participants were given information on key characteristics of each technology and were challenged with provocative talking points.

008 The selected technologies

The workshop was organised around four groups of technologies with some examples given on the application of robotics, 3D printing, nanotech, artificial intelligence (AI), augmented reality, blockchain and distributed ledger technology (DLT). The technologies were discussed from the perspectives of their impact on society, the economy, world trade, protection of IP, infringement of IP, enforcement of IP and investigation of IP crime,

009 Preparation of the first edition of the Discussion Paper

The notes from the meeting were shared with the members of the Impact of Technology Expert Group, including those who could not attend the event and those from academia and the EUIPO. The experts then provided comments on the draft, resulting in this final version of the discussion paper. The intention is to update the discussion paper following each workshop of the Impact of Technology Expert Group. At future workshops, additional emerging technologies will be analysed and, occasionally, those analysed previously will be revisited to ensure the paper maintains its relevance. To limit the document's exponential growth, all entries will be kept succinct, to the point and not overburdened with detail. To ensure the paper does not become outdated, it will avoid references to specific products or services and keep descriptions on a general level. References to reading materials will also focus on sources of a more permanent nature with descriptions that do not quickly outdate.

Snapshot II from the workshop

0010 The first edition of the discussion paper.

The first edition of the Intellectual Property Infringement and Enforcement Tech Watch Discussion Paper 2020 was published on the EUIPO website in September 2020, it has been downloaded from the EUIPO website 4523 times.

0011 Adding more expertise from outside the expert group

Based on the first workshop and the work on preparing the discussion paper, it was decided that the quality of analysis of additional technologies would benefit from more in-depth interaction with experts outside the expert group itself, including those not inherently familiar with IP matters. This would add more insight into the technologies themselves as well as business and societal perspectives.

5.2.4 Virtual meeting and workshops in 2020-2021

0012 Virtual meeting, 12 November 2020

The meeting involved experts and discussed the group's future, including the technologies to be discussed, the organisation of the group's work, the further development of the Tech Watch methodology and future updates to the discussion paper.

0013 Second Tech Watch Workshop, Virtual meeting, 5 May 2021

In this meeting participants were introduced to Digital Mobile Networking (GSM-6G) and the internet of things (IoT) technologies. They discussed their impact on intellectual property related enforcement, investigation and legal systems. The discussion was organised in three groups, focussing on: 'Consumer Goods and Digital Content'; 'Services and Public Infrastructure' and 'Production; and Impact on IP Related Enforcement'.

0014 Third Tech Watch Workshop, Virtual meeting, 18 November 2021

During this meeting the expert group discussed blockchain trends, crypto forensics and non-fungible tokens (NFTs). There was also a presentation on the EUIPO's IP Register on Blockchain project as well as new developments in blockchain law. The meeting concluded with an introduction to the Intellectual Property Crime Investigation Handbook project that the EUIPO began in 2022.

5.2.5 First Deep Dive Report published March 2022

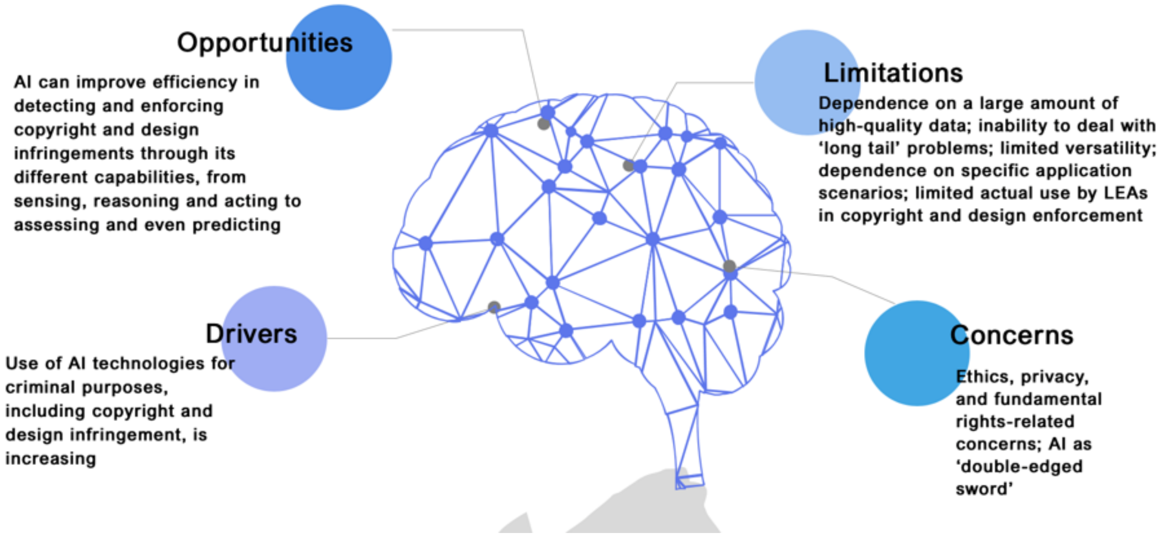
0015 First full-scale application of the expert group methodology

The Deep Dive Study on the Impact of Artificial Intelligence on the Infringement and Enforcement of Copyright and Designs was published on the EUIPO's website in March 2022. It has been downloaded from the website 1 983 times. The report applied the unique expert group (EG) method of analysing the impact of new technologies and their applications in different stages of development on IP, bearing in mind that use of a particular technology can facilitate both the infringement and enforcement of IP. This method was applied to artificial intelligence (AI), using two detailed storylines on the infringement and enforcement of copyright and designs in the production and marketing of physical goods and the sharing of digital content.

0016 Main findings of the Deep Dive Report

The main findings of the report can be summarised in relation to opportunities, drivers, limitations and concerns, as shown in this graphic from the report.

Figure IV. AI and copyright and designs infringement and enforcement



5.2.6 Fourth Tech Watch Workshop, the Niels Bohr Institute, 22-23 April 2022

0017 Setting of the Fifth Workshop

The Niels Bohr Institute in Copenhagen is part of Copenhagen University. The institute was founded in the 1920s and has been at the forefront of quantum technology ever since. The legendary physicist Niels Bohr worked and lived in the building that is still the core of the institute.

Participants of the Fourth Tech Watch Workshop at the Niels Bohr Institute

Workshop at the Niels Bohr Institute

0018 Concept of the discussions

The workshop's main theme was the analysis of the impact of quantum computing, but time was also allocated to discuss other topics relevant to the expert group. For the first time, the group engaged in discussions with leading researchers in a specific technological area and was able to apply the information about the state and potential application of quantum computing to the field of protection, infringement and enforcement of IP. The chapter in this discussion paper on quantum computing is based on the findings from this on-site workshop.

5.2.7 Future work of the Impact of Technology Expert Group

0019 Adding more technologies

The expert group will continue to work with Tech Watch and the following technologies and high tech investigative tools are expected to be discussed:

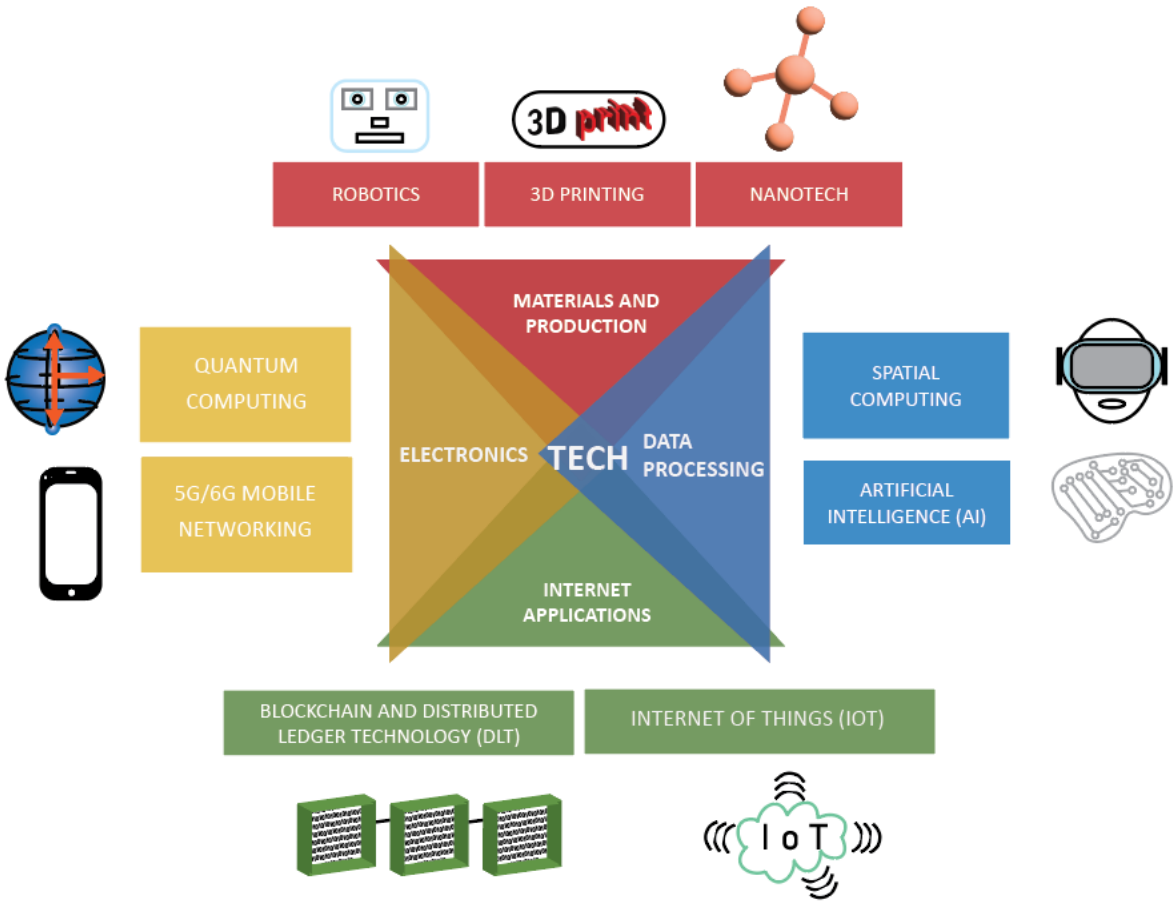
- the Metaverse;
- big data;
- open source intelligence (OSINT);
- climate change mitigating technologies;
- nuclear analytical techniques to counter criminal infiltration into the legitimate supply chain;
- new developments in cybersecurity.

5.3 Typology of Key Emerging Technologies

0020 A simplified typology of technologies

Before the first workshop of the Impact of Technology Expert Group, a typology of technologies was developed for practical reasons, to enable a simple and easily understandable overview of specific technologies with major relevance to IP protection, infringement and enforcement. The simplified typology distinguishes between 'materials and production technologies', 'electronics', 'data-processing technologies' and 'internet applications', although the technologies cannot always be clearly separated. By contrast, most of the physical technologies depend on data processing; data processing relies on electronics; and the internet is usually essential for all technologies. For example, there is often an AI element in robotics; important data-processing applications will include both AI and blockchain technologies, and 3D printing will depend on the use of electronically processable files. Therefore, the separation between subcategories of the main types of technologies are merely indicative.

Figure V. Emerging technologies analysed in this discussion paper



0021 The technologies in focus

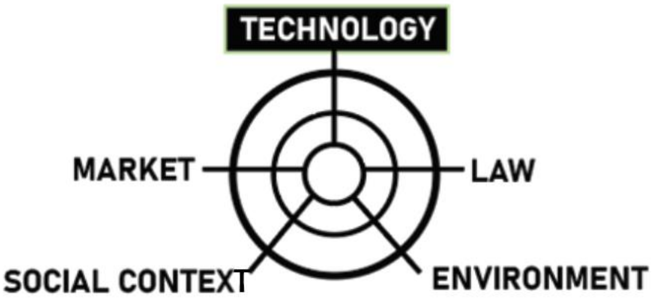
The technologies in focus were selected due to their significant impact on IP infringement and application in IP protection and enforcement. Questions of the patentability of new innovations, policy making, and purely legal issues were not considered when selecting the technologies.

5.4 Tech Watch Methodology

5.4.1 The Lawrence Lessig Code theory

0022 The code theory's relevance for the expert group

Figure VI. Adaptation of the Code theory



At the first meeting of the expert group, Lawrence Lessig's theory presented in 'Code and Other Laws of Cyberspace' (Basic Books, 1999) and updated in 'Code Version 2' (Basic Books, 2006) was introduced and has subsequently served as a loose basic idea behind the group's work. The code theory (also often known as 'the pathetic dot theory') helps people understand internet regulation and describes how human online activity is regulated by law, social norms, and the market mechanism, but most importantly the technical infrastructure of the internet (the eponymous 'code'). The theory has been applied by the expert group in the sense that all technological impact on IP should be considered from these four angles: (1) the market (2) the law (3) social context, and (4) the technology itself. Due to the growing independent relevance of environmental concerns, the model has now incorporated (5) the environment as a factor to be considered alongside the first four.

5.4.2 The relationship between IP and emerging technologies

0023 Metaphors

In addition to the code theory, two metaphors have played a vital role in the development of the expert group's Tech Watch methodology.

0024 The 'yin and yang' metaphor

The 'yin and yang' metaphor indicates that the application of a technology in infringing, protecting or enforcing IP involves, to some extent, some of the same elements. It also suggests that there can be weaknesses in each application of the technologies that can be exploited by the other side.

Figure VII. The 'yin and yang' metaphor

0025 The 'double-edged sword' metaphor

The double-edged sword metaphor indicates that most – if not all – emerging technologies can be a threat as well as an opportunity for IP protection and enforcement.

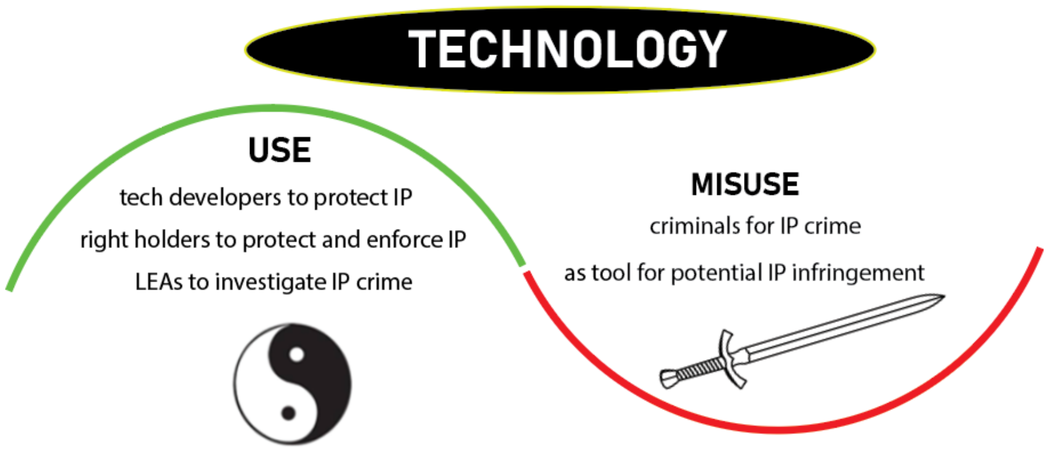
Figure VIII. The double-edged sword metaphor

0026 Five areas of interest between IP and new emerging technologies

Combining the Lawrence Lessig code theory with the 'yin and yang' metaphor and the 'double-edged sword' metaphor, the expert group was able to suggest early on that the relationship between IP and a new emerging technology would have at least five areas of interest:

1. the need for companies developing new solutions based on an emerging technology to protect their IP and avoid infringing the IP of others;
2. how other IP rights holders can use solutions based on the emerging technology in their own efforts to protect and enforce their IP;
3. how the emerging technology can be applied by governments in measures made available for the protection of IP (e.g. registration systems for trade marks and patents);
4. how IP infringers can apply new technologies to infringe the IP of others;
5. how law enforcement agencies, prosecution services and other governmental agencies can apply new technologies to investigate and prosecute IP crime and carry out other acts of IP enforcement.

Figure IX. Areas of interest for IP regarding emerging technologies



5.4.3 *Sustainability focus*

0027 Environmental impact

A product's design can substantially determine its total environmental impact throughout its lifecycle. Products need to be as durable, reliable, reusable, upgradable, reparable, maintainable, refurbishable, and recyclable as possible, and as energy- and resource-efficient. Beyond their environmental impact, products need to support general sustainability goals by facilitating communication, supply chain management, and continuous differentiation and innovation. As many experts have identified, designs are only one of the creations protected under IP through both design rights and copyright. However, in creating designs, a lot of technology protected by patents and software protected by copyright and trade secrets comes into play; the same is true in marketing trade marks, involving many more technologies with strong IP components. Therefore, the second edition of this discussion paper aims to add the environmental/sustainability dimension to the 'code theory', cornerstone of the expert group's working methodology.

0028 Rio markers

In 1998, the Development Assistance Committee (DAC) of the Organisation for Economic Co-operation and Development (OECD) created the Rio markers system, consisting of policy markers to monitor and statistically report on development finance flows targeting the themes of the Rio Conventions. There are four markers:

- biodiversity;
- desertification;
- climate change mitigation (i.e. reductions in or absorption of greenhouse gas emissions);
- climate change adaptation (including climate risk mitigation and vulnerability reduction).

0029 Greenhouse emissions

The EU, as a key player in United Nations (UN) climate change talks, has signed the Paris agreement and, in 2015, committed to cutting greenhouse emissions in the EU by at least 40 % below 1990 levels by 2030. In 2021, the target was changed to at least 55 % reduction by 2030 and climate neutrality by 2050. This goal of zero net emissions is enshrined in the climate law.

0030 Analysing environmental impact

This edition of the discussion paper addresses the environmental impact of the analysed technologies, as well as the environmental aspects of infringement and enforcement of IP in relation to these technologies. Therefore, in this new edition of the discussion paper the symbols in the following figure will be used.

Figure X. **Analysing environmental impact**

when a potentially **positive** environmental impact of a technology is identified

when a potentially **negative** environmental impact of a technology is identified

0031 17 United Nations (UN) sustainable development goals

Environmental concerns are of course only one aspect of the general need for a sustainable economy. This discussion paper will also try generally to consider the 17 United Nations sustainable development goals, especially those relating to health, industrial innovation, well-functioning infrastructure, reduced inequalities and justice. The discussion paper is built on the general concept that a sustainable society can only be achieved through extensive and effective use of the IP system.

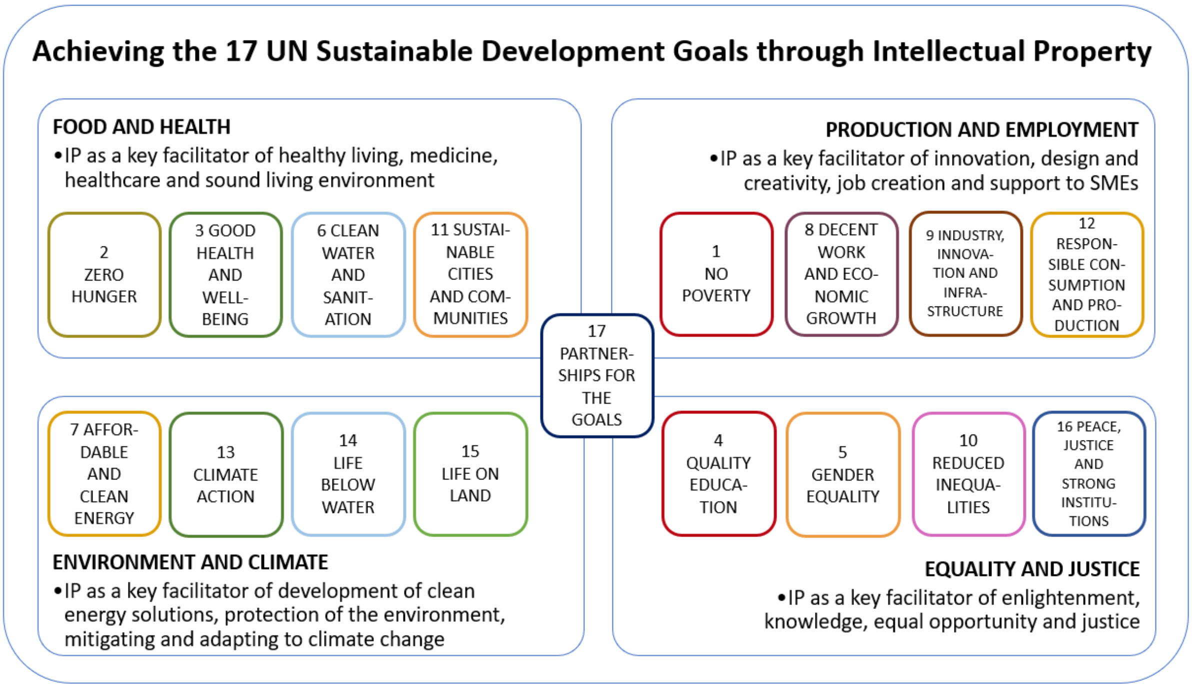
0032 IP as a tool to achieve the sustainable development goals concerning production and employment

The sustainable developments goals concerning (1) no poverty, (8) decent work and economic growth, (9) having good industry, innovation and infrastructure and (12) responsible consumption and production, naturally relies on IP as a key facilitator of innovation, design, creativity, job creation and support to SMEs.

0033 IP as a tool to achieve the sustainable development goals concerning food and health

The sustainable developments goals concerning (2) zero hunger, (3) good health and well-being, (6) clean water and sanitation and (11) sustainable cities and communities, cannot be achieved without strong IP To facilitate healthy living, pharmaceutical progress, effective healthcare and a sound living environment.

Figure XI. The 17 sustainable development goals



0034 IP as a tool to achieve the sustainable development goals concerning environment and climate

To achieve sustainable developments goals concerning (7) affordable and clean energy, (12) climate action, (14) life below water and (15) life on lands, IP is a strong facilitator for the development of clean energy solutions, technological measures to protect the environment and to mitigate and adapt to climate change. The discussion paper will provide several examples of how emerging technologies can provide much needed solutions to important environmental and climate change related concerns.

0035 IP as a tool to achieve the sustainable development goals concerning equality and justice

Last but not least, IP is a key facilitator of enlightenment and knowledge that is necessary to achieve sustainable developments goals concerning (4) quality education and (5) gender equality. Furthermore, fighting organised IP crime and related poly-criminality generating very substantive illicit income is key in (10) reducing inequalities and facilitating (16) peace, justice and strong institutions.

0036 Working together to achieve the sustainable development goals

The IP system has successfully built strong partnerships within its internal stakeholders but has also reached out to many other areas of society to facilitate collaboration to provide sustainable solutions not least in highly technical areas. These partnerships and collaborative efforts involve governments, law enforcement, the judiciary, the private sector including SMEs, academia and, not least, consumers, and will increasingly be necessary for long-term sustainable global economic development that especially takes the environmental and climate change challenges into account. At the same time new threats like greenwashing will have to be effectively countered.

5.4.4 Greenwashing, technology, and IP

0037 Greenwashing

Greenwashing is a term used to describe different marketing tools that confuse or deceive consumers into believing a product is more environmentally sustainable or climate-friendly than it is. Often this happens by overemphasising technological aspects that ensure a higher level of sustainability of the goods or services in question. Greenwashing ranges from potentially a little confusing to decidedly illegal marketing practices, some of which, in the most serious instances, can be considered criminal offences.

0038 Nine transgressions of greenwashing

Here are nine examples of greenwashing with increasingly serious effects:

1. Rebranded green: a non-green good or service is rebranded as green without any solid technological, environmental, or economic basis.
2. Vague or irrelevant green: using vague descriptions like ‘natural’ or ‘wild’ to create an impression of sustainability when marketing a good or service without any solid basis, or providing irrelevant information (e.g., a good or service is marketed as green because it does not use prohibited substances or is not processed).
3. Uncertified green: a good or service is marketed as green without a green certification.
4. Selected green: one green technological element in a good or service is overemphasised while the good or service cannot be considered green or other elements are clearly not green.
5. Exaggerated green: using terminology when marketing a good or service that exaggerates the use of a green technology or business practice.
6. Untrue comparative green: a good or service is wrongly being hailed as greener than a competitor.
7. Non-existent green: a good or service is marketed as using green technology, but the claim is untrue.
8. Imaginarily certified green: a good or service is marketed as utilising green technology or environmentally correct practices in conjunction with a symbol that seems like a green certificate but is not a green certificate.
9. Counterfeit green: a good or service misuses a trade mark of a green good or service provider or claims a green certification mark without rights.

Figure XII. Nine transgressions of greenwashing

0039 Legislative measures

There are a number of existing and new legislative measures against greenwashing, including various consumer protection laws and laws against misleading advertising of the essential characteristic of the good or service, often with the possibility of heavy fines. In the case of counterfeit green, the sanctions can be up to several years' imprisonment. The transgressions mentioned above are therefore not only relevant for consumers, when searching for sustainable products, but also for companies and individuals, to avoid greenwashing accusations that could lead to expensive fines or, in the most serious instances, imprisonment.

5.4.5 Law enforcement priorities

0040 EMPACT priorities

The European Multidisciplinary Platform Against Criminal Threats (EMPACT) tackles the most important threats posed by organised and serious international crime affecting the EU. EMPACT strengthens intelligence, strategic and operational cooperation between national authorities, EU institutions and bodies and international partners. EMPACT runs in 4-year cycles focusing on common EU crime priorities. IP crime is one of the priorities for the 2022 to 2025 cycle alongside other related priorities such as:

- cyberattacks;
- online fraud schemes;
- criminal finances, money laundering and asset recovery;
- organised property crime;
- environmental crime.

0041 Law enforcement IP crime priorities

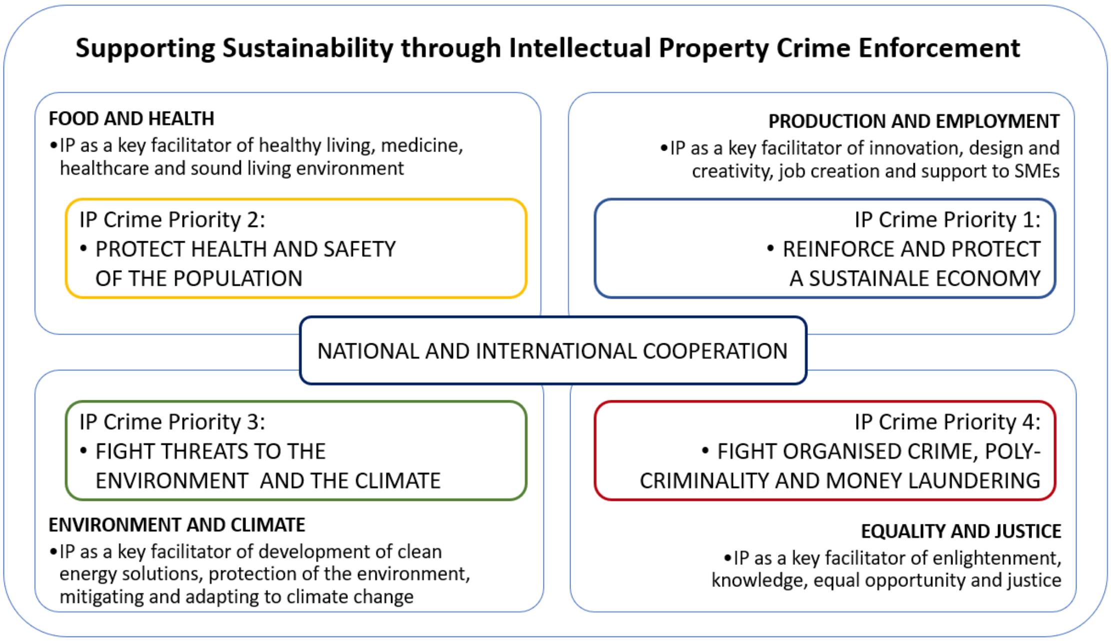
The EUIPO has actively supported the EMPACT priorities and engages extensively to share good investigative and prosecutorial practices as well as knowledge building and networking. Through this work, the EUIPO, together with members of the expert group and other experts in the field, has identified the following IP enforcement priorities that are most relevant to the interplay with emerging and disruptive technologies:

- reinforce and protect a sustainable economy;
- protect the health and safety of the population;
- fight threats to the environment and the climate;
- fight organised crime, poly-criminality, and money laundering.

0042 Cooperation

The four identified key priorities for IP crime enforcement naturally follow the sustainable development goals discussed above. However, to achieve results in enforcement against IP crime threats, multidisciplinary cooperation at national and international levels is necessary. This cooperation involves the public and private sectors, as well as academia, and needs the support of policy makers and the general population to be fully successful.

Figure XIII. Supporting sustainability through IP crime enforcement



0043 WIPO development agenda (2007) recommendation 45

The 2007 WIPO development agenda's 45th recommendation introduced a broad approach to IP enforcement (including criminal enforcement), used to promote technological innovation in the interest of our society. Subsequently, many international projects have since aimed to enhance sustainability in IP protection and enforcement.

5.4.6 Impact of Technology Expert Group's Tech Watch Methodology

0044 The four step Tech Watch methodology

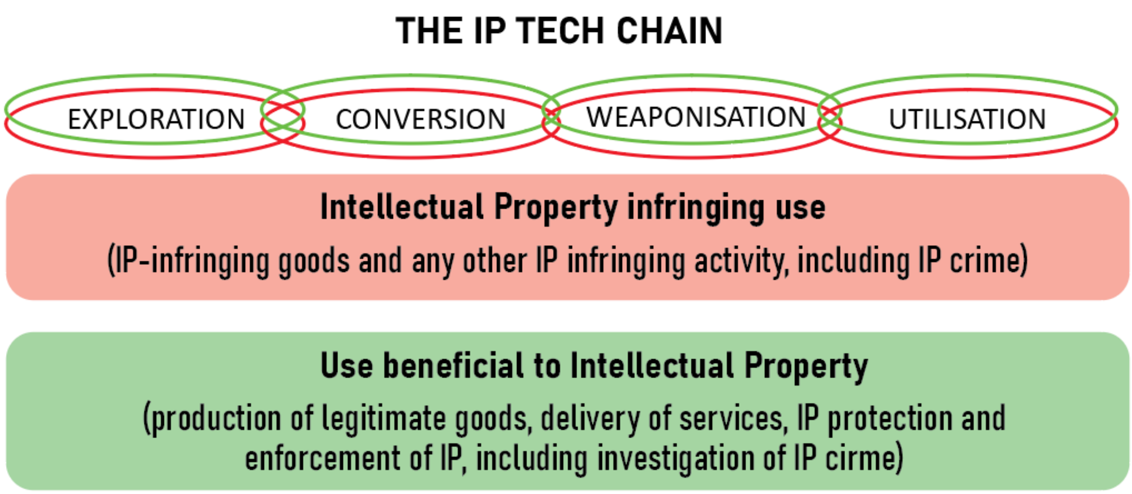
The Impact of Technology Expert Group has developed and refined an original Tech Watch methodology. The methodology provides a way to analyse the development of any application of a new technology to infringe, protect or enforce IP. The methodology divides the development of any application into four steps:

- **exploration**: exploring the technology to ascertain whether it could be applied to infringe, protect or enforce IP;
- **conversion**: converting the technology to enable it to achieve the identified goal;
- **weaponisation**: finalising the application's development;
- **utilisation**: using the application to infringe, protect or enforce IP.

0045 'The Intellectual Property Tech Chain'

The Intellectual Property Tech Chain distinguishes between applications of new technologies with the aim of infringing IP and those applied in a way that is beneficial to IP. This methodology has proved itself more suited to analysing the technologies discussed in the workshop, which is clearly reflected in this discussion paper.

Figure XIV. Tech watch methodology



0046 Full implementation of the methodology

The Intellectual Property Tech Chain has proved increasingly helpful in analysing technologies that have reached different levels of development. The methodology was fully implemented and utilised in the Deep Dive Report on Artificial Intelligence (AI), in which it helped to compare the use of AI applications now and in the foreseeable future with regard to the infringement and enforcement of copyright and designs. Another example of the model's continued high relevance is the analysis of quantum computing, which, at the time of the fifth Tech Watch workshop, was still mostly in an early experimental phase, provoking many considerations and discussions around the impact of IP in general and infringement and enforcement in particular.

6 MATERIALS AND PRODUCTION TECHNOLOGIES

6.1 Robotics

In a properly automated and educated world, then, machines may prove to be the true humanizing influence. It may be that machines will do the work that makes life possible and that human beings will do all the other things that make life pleasant and worthwhile.

Asimov, Isaac, Robot Visions, Byron Preiss Visual Publications, Inc., 1990

6.1.1 The technology in a nutshell

0047 Robotics – an ever-evolving technology

A number of experts suggested that the characteristics of science and engineering dealing with robotics are the creation, design, construction, monitoring, control and use of programmable and often intelligent machines. Although a number of experts suggested that robotic technology has not yet reached its full potential, the technology is evolving rapidly and successfully and is undoubtedly revolutionising may aspects of our lives and work. Medicine, architecture, transport, education, engineering, archaeology, aeronautics and energy, are just some of the areas that already extensively benefit from innovation within this technological field.

0048 Relation between robotics, 3D printing and Nanotech

Robotic technology, 3D printing and nanotech are, according to a number of experts, closely related and will be even more interdependent in the future. 3D printers could be used to print nanorobots; nanotech could be applied to mark files for 3D printing; and 3D printing could be used to make nanomaterials or to employ them as filaments. However, these exponential advances are changing the world faster than ever and represent a significant challenge for a society used to linear development. The three technologies can provide significant benefits in the field of sustainability and the circular economy. Currently, various types of plastic are essential for 3D printing as well as nanotech, in which they are used as conductors. Nevertheless, as these technologies develop, the use of environmentally friendly materials such as plant-based filaments (soy, seaweed, eucalyptus, algae, bamboo, recycled paper, etc.), biodegradable filaments and recycled building materials could considerably reduce waste and minimise the environmental impact. 3D printing would also contribute to the reduction of waste and pollution, as there would be no need for locally or home-printed products to be packed or transported.

6.1.2 Information resources

0049 Suggested reading

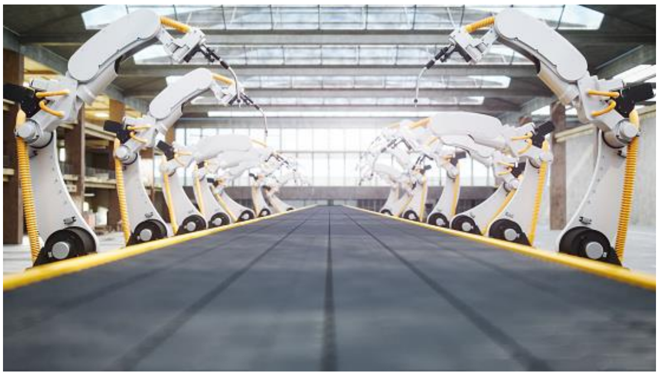
The experts suggested the following general sources of more information:

+ Keisner C. A, Raffo J. and Wunsch-Vincent S., *Breakthrough Technologies – Robotics, Innovation and Intellectual Property*, Economic Research Working Paper No. 30, WIPO, 2015;

+ Keisner C. A., Raffo J. and Wunsch-Vincent S., *Breakthrough Technologies – Robotics and IP*, WIPO magazine, December 2016;

6.1.3 Impact on society, the economy, world trade and the environment

0050 Robotics effect on many aspects of human life



Interior of a Modern Automated Factory with Robotic Arms and Conveyor Belt

It was suggested during the discussion that robotics technology already influences many aspects of both the workplace and home environment. Furthermore, it has the potential to positively transform lives and work practices, raise efficiency and safety levels and provide enhanced levels of service. It was emphasised by some experts that the development of robotic technology has drastically changed the labour market and could lead to social polarisation. According to a number of experts, these changes could potentially disturb the social and economic balance on a national and international levels in terms of unemployment, crime, education and world trade, these effects are currently especially visible in developing countries. Nevertheless, these changes also affect society on an individual level.

0051 Effects on labour

Technological dependence and the transfer of physical and mental tasks to machines could result in a significant loss of knowledge and skills. Practical experience obtained through apprenticeships could be lost; this, consequently, would diminish the quality of work and products. Some experts noted that the use of robots could create new, high-paying jobs that require skilled workers. Although it is true that robots are replacing low-skilled workers and automating the tasks that they perform, robots and automation require jobs that focus workers on higher-value work. However, robotics could lead to sustained periods with a large percentage of people not working. A rise in unemployment would lead to a lack of consumer spending, which could, in turn, put companies at risk. As robots take over low-skilled jobs, concerns arise as to what to do with lower-skilled workers who are at risk of unemployment due to automation. One possible solution is for companies to invest in training to enable the retention of these workers in new sectors of activity, or government social schemes.

Figure XV. History of robotics

1940'
- The first industrial robot is developed in the form of a small crane
- The word 'Robotics' is first used in the Three Laws of Robotics

1950'
- The first electronic autonomous robots, Elmer and Elsie, are created
- An automatically operated programmable robotic arm is invented and patented

1960'
- Unimate - the first industrial robot - is sold
- The first palletising robot - a machine that automatically stacks cases of goods onto a pallet - is introduced

1970'
- The Programmable Universal Manipulation arm is invented

1980'
- A robot with functional stereo vision to navigate and determine distances automatically is invented

1990'
- The first packaging robot is developed

2000'
- Opportunity and Spirit robots are sent to explore the surface of Mars
- Mass produced robotic vacuum cleaners are introduced

2010'
- Introduction of collaborative robots designed to work side by side with human workers
- Robonaut2 sent by NASA to the International Space Station - it is designed and built to provide assistance to astronauts in orbit
- Handle - an automaton with 'physical' skills and abilities - is able to run and adapt to varied and steep terrains

2020'
- Presentation of humanoid robot 'Optimus'

0052 Robotics – a democratic technology?

According to some experts, a growing number of people have access to the technologies that enable the creation of new products without the need for a vast educational background or experience. The democratisation of technology will undoubtedly lead to more rapid developments and innovation within the industry; however, it also raises issues regarding the liability and quality of the products made by amateur developers. These elements have a big impact on innovation, versatility and creativity, but also give rise to a number of questions over how to effectively protect and enforce IP.

0053 Various key sectors use of robotics

Robotics are widely used in manufacturing, assembly and packing, transport, earth and space exploration, surgery, weaponry, laboratory research and the mass production of consumer and industrial goods. They are also used for jobs that are considered too dirty, dangerous or dull for humans. In these various industries and sectors, robotics already underpins employment. According to some experts, the proper use of robotics increases the productivity of industry and leads to:

- enhanced product quality;
- higher product output;
- reduction of production costs;

Close-up of Robotic Arm Holding a Tomato

- growth in labour productivity;
- shift from manual jobs to jobs requiring critical thinking;
- an increase in gross domestic product (GDP);
- positive environmental and climate effects.

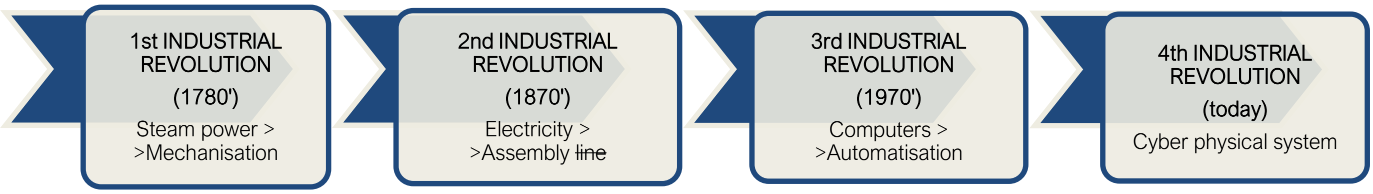
0054 Effect on world trade

Some experts addressed the issue of robotics' impact on world trade. It was suggested that this technology has been one of the drivers that has enabled global-scale manufacturing, and that therefore globalisation has become successful under the economic, technological, political, social and cultural influences of robotics on a worldwide scale. The pace of goods production has ramped up to satisfy the increasing demand for commercial products.

0055 Green robotics

The evident progress of recent years has made it possible to create 'green' robots, made of recycled and biodegradable materials and powered by renewable energy sources. These robots are tasked with collecting the information necessary to protect the animal and plant species that populate the area subject to the robot's analysis. As pointed out by several experts, this creates new greenwashing threats if environmental claims are misleading or deceptive.

Figure XVI. Industrial Revolutions



6.1.4 IP Protection Use Cases

0056 A few suggested use cases

Some experts suggested a number of use cases for robotic technology as regards IP protection, including the following:

- Protection of end-products for differentiation (robots themselves).
- Protection of robotics platforms, both proprietary (competitive) software and hardware developments.
- Protecting the final products as the result of the robot's work. In future, robots are likely to produce new solutions to problems and in so doing create intangible outputs that could, at least in theory, be perceived as IP.

0057 Robots as inspiration for creative works

Some experts indicated that robots (and androids) have been a source of immense inspiration for authors, musicians, filmmakers and videogame producers, and that these creative works have inspired scientists and industrialists to develop and use robotics and other new technologies.

Figure XVII. Examples of robots and androids in culture

+ Frankenstein, novel by Mary Shelley. UK: Lackington, Hughes, Harding, Mavor, & Jones, 1818;
+ Metropolis, motion picture directed by Fritz Lang. Germany: Universum Film A.G., 1927;
+ I, Robot, novel by Isaac Asimov, USA: Gnome Press, 1950;
+ Do Androids Dream of Electric Sheep?, novel by Philip K. Dick. USA: Doubleday, 1968;
+ Westworld, motion picture, directed by Michael Crichton. USA: Metro-Goldwyn-Mayer Studios, 1973;
+ We are the Robots, song performed by Kraftwerk. Germany: Kling Klang (EMI), 1978;
+ Hey! Rise of the Robots, song performed by The Stranglers. UK: United Artists, 1978;
+ Blade Runner, motion picture directed by Ridley Scott. USA: Warner Bros, 1982;
+ Terminator, motion picture directed by James Cameron. USA: Orion Pictures, 1984;
+ Transformers, cartoon series. USA: First-run Syndication, 1984;
+ RoboCop, motion picture directed by Paul Verhoeven. USA: Orion Pictures, 1987;
+ Robot Visions, collection of short stories by Isaac Asimov. USA: Byron Preiss Visual Publications, 1990;
+ Ghost in the Shell, anime directed by Mamoru Oshii. UK-Japan: Kodansha, Bandai Visual and Manga Entertainment, Production I.G., 1995;
+ Paranoid Android, song performed by Radiohead. UK: Parlophone Capitol, 1997
+ Matrix, motion picture directed by the Wachowski Brothers. USA: 1999;
+ Steel Battalion, video game. Japan: Capcom, 2002;
+ Battlestar Galactica, television series. USA: Sci-Fi Network, 2004;
+ Robots (The Humans Are Dead), song performed by Flight of the Conchord. USA: Sub Pop, 2008;
+ Bioshock, USA: 2K Games, 2008;
+ Wall-E, animated motion picture directed by Andrew Stanton. USA: Pixar Animation Studios, 2008;
+ A.I. Artificial Intelligence, motion picture directed by Steven Spielberg. USA: Warner Bros., Dreamworks, Amblin Entertainment, 2011;
+ Westworld, television series. USA: HBO, 2016;
+ Crier's War, novel by Nina Varela. USA: Quill Tree Books, 2019.

0058 Specific copyright protection issues

Some experts emphasised that the issue of copyright protection is relevant to robotics in several respects. Copyright protection is especially an issue when software code has been 'reduced to writing' and is believed to be unique and original. In practice, robotics companies typically use copyright enforcement to prevent others from copying or simply accessing their computer code. Another example of how copyright protection could be used for robotics, although not common in the industry, is for a unique aesthetic design, such as a design pattern on a robot. Some experts emphasised that it is generally accepted in most countries that circumventing an electronic barrier in order to gain access to copyrightable computer code is a violation. This is particularly important for the robotics industry because most robotics companies employ electronic barriers to restrict access to their robots' computer code.

0059 Autonomous created works and innovations

Some experts introduced the issue that robots can already, and increasingly in the future, produce new solutions to problems and, in so doing, create intangible outputs that could – at least in theory – be perceived as IP. This could raise interesting questions over the boundaries of the current IP system, especially the definition of author or inventor as a physical person. Do objects, software code or other assets created autonomously by a robot qualify for IP protection? If so, how? Moreover, who would own these IP rights? The producer? The user of the robot? The robot itself? Autonomous robot creation, and the question of who owns the IP rights to creations by robots, will surely be a matter of much future discussion. These questions also arise in regard to other technologies, such as AI.

Automatic robot mechanical arm is working in temporary storage in a distribution warehouse

6.1.5 Threats and challenges for IP

0060 Counterfeiting perspective

From a counterfeiting perspective, some experts suggested that robotics allows the easy replication of items and, therefore, facilitates the illegal production of goods. There is no doubt that robots facilitate infringement by making product reproduction faster, more widely available and more easily accessible to regular consumers. However, these types of infringement are conceptually not very different from those currently known. Therefore, for the time being, these cases can be examined by applying existing law and enforcement measures. Trade in counterfeit goods is damaging to the environment, as counterfeit goods are usually of low quality, are transported over long distances and will usually be destroyed if detected by the authorities. People may also be in danger, since safety measures applied by legitimate companies to protect workers might not be adopted in the manufacturing process of counterfeit products.

0061 Trade secret issues

The technological complexity of robotics systems means, according to some experts, that trade secrets are often the first option for companies seeking to protect their innovations. The experts identified a number of reasons for this:

- few people have the expertise to reverse engineer these complex systems;
- highly expensive robots are very difficult to get hold of, making reverse engineering practically impossible or at least not economically feasible.

0062 Trade secret theft

In relation to trade secrets, a number of experts stated that companies developing robotic solutions will be cutting-edge and will retain large amounts of valuable knowledge that others may wish to steal. Trade secret theft can happen through various methods, including theft by insiders or outside hacking attacks. Ransomware attacks are also common against such companies. Cybersecurity breaches and cyberattacks can have severe negative consequences for the individual company's competitiveness, profitability and ability to continue developing new products and services. The ripple effects on society are negative economic and social consequences and, potentially, damage to the environment, which urgently requires the development of sustainable technological solutions.

0063 Effect of employee mobility in the robotics sector

A humanoid woman looking to the right

According to some of the experts, employee mobility is high in the robotics sector, so many companies apply restrictive covenants when employees move to competitors. Uncertainties surrounding the patentability of software in different jurisdictions could further tilt the balance in favour of trade secrets. Next to patents, industrial designs that protect a robot's appearance – its shape and form – also play an important role in improving the marketability of products and helping firms achieve the returns on their R&D investments.

6.1.6 *Investigative and enforcement opportunities*

0064 Law enforcement use of robotics
According to some experts, robotics can be used by law enforcement in combination with AI, through the use of drones and IR cameras to identify illicit products.

0065 Customs use of robotics
This technology, as noted by a number of the experts, can also be used by customs authorities in the form of many small or nanorobots that inspect the goods in a container and identify products for inspection. One of the biggest issues customs officers face on a daily basis is the quantity of imported parcels that need to be checked. This time-consuming and costly process could in the future be carried out by small robots or drones. These devices should be able to fly inside a container and be equipped with AI and cameras/scanners that would detect counterfeit goods. These improvements would result in shorter response times and a higher number of checked containers; this would consequently resolve limited storage space issues, make the destruction of goods less environmentally harmful and make distribution of the workforce more effective. The robots could be equipped with other types of sensors, such as thermo- and odour sensors, similar to those used to determine air quality, and trained to recognise signals that the goods in question are original products. The enhanced effectiveness of customs controls will have beneficial consequences for the economy, employment, health and safety and the environment.

6.2 3D Printing

The multitude of benefits that 3D printing can bring to the world should of course be weighed against its perils. Some commentators have written about how the technology could be used to undermine governments, while others fear that it may bring about the end of capitalism and incite revolutions across the globe.

Council, Aaron, with Petch, Michael, 3D Printing the Rise of the 3rd Industrial Revolution, gyges3d.com, 2014.

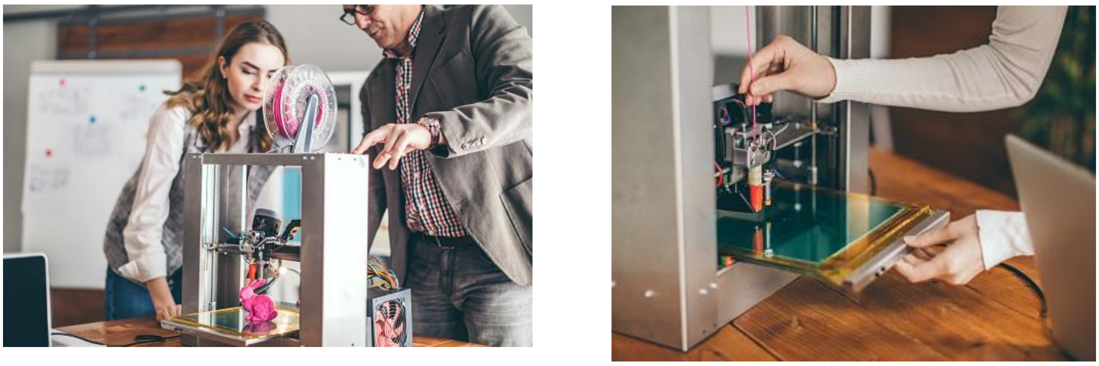
6.2.1 The technology in a nutshell

0066 3D printing – an emerging technology

Although a number of experts were of the view that 3D technology has not yet reached its full potential, the technology is evolving rapidly and successfully and is undoubtedly revolutionising every aspect of our lives and work. Medicine, architecture, transport, education, engineering, archaeology and aeronautics, are just some areas that benefit from innovation within this technological field. A key advantage of 3D printing is the ability to produce very complex shapes or geometries.

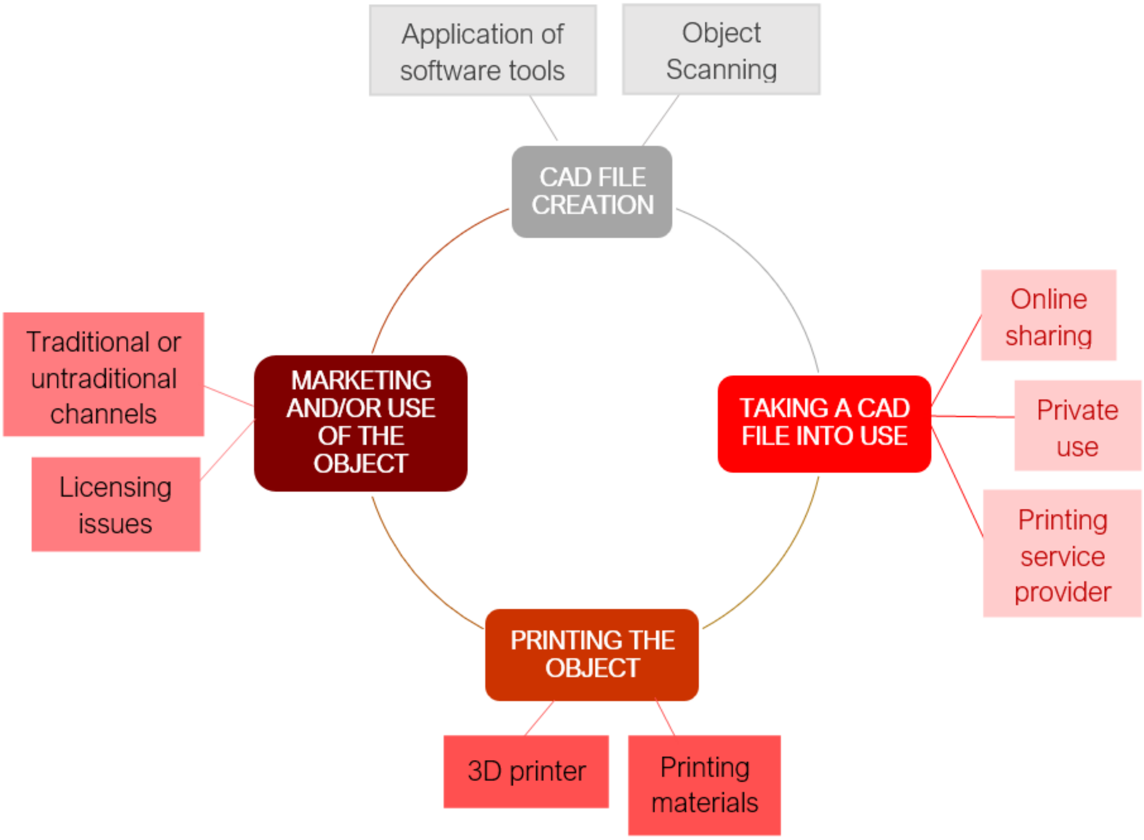
0067 The 3D printing process

Some experts explained that the 3D printing process builds a three-dimensional object from a computer-aided design (CAD) model, usually by successively adding material layer by layer (i.e. additive manufacturing). The term '3D printing' originally referred to a layer-by-layer process that deposits a binder material onto a powder bed using a printer. Recently, the term has encompassed a wider variety of additive-manufacturing techniques and processes, such as electron-beam additive manufacturing and selective laser melting. Earlier 3D printing techniques were considered suitable only to produce functional or aesthetic prototypes. More recently, due to their enhanced production precision, repeatability and material range, 3D printing processes have been considered viable as a true industrial-production technology.



The 3D printing process

Figure XVIII. The IP Implications of the development of industrial 3D printing



6.2.2 *Information resources*

0068 Suggested reading

The experts suggested the following general sources of more information:

+ *Do criminals dream of electric sheep?*, EUROPOL, 2019;
+ Bechtold, S., *3D printing and the intellectual property system*, Economic Research Working Paper No. 28, WIPO, 2015;
+ Mendis, D., Lemley, M., and Rimmer, M., *3D Printing and Beyond*: Intellectual Property and Regulation, Elgar, 2019;
+ *3D Printing Gives Hackers Entirely New Ways to Wreak Havoc*, Harvard Business Review 2017;
+ Fruehauf, J., Hartle, F., Al-Khalifa, F., 3D Printing: *The Future Crime of the Present*, 2016;
+ Mendis, D., Nordemann, J. B., Ballardini, R. M., Brorsen, H., Calatrava Moreno, M. d. C., Robson, J. and Dickens, P., *EC Study on The Intellectual Property Implications of the Development of Industrial 3D Printing*, European Commission, 2020.

6.2.3 Impact on society, the economy, world trade and the environment

0069 3D printing – a tool for positive change

Some experts emphasised that 3D printing could have positive environmental effects:

- no carbon footprint due to product transportation, since they could be produced at the place of distribution;
- reduction of waste due to less packaging and distribution;
- reduction of pollution and CO_2 emissions due to less transportation of goods;
- on-demand production and less need to hold goods in stock;
- weight reduction through cost-effective geometric optimisation of parts.

0070 Sustainability by way of 3D printing

3D printing technology offers more sustainable production methods capable of reducing material waste and, consequently, production waste. This enables widespread production that reduces the carbon footprint associated with transportation. It achieves its sustainability objectives thanks to an efficient system that allows production only when and where necessary.

0071 Changing to more sustainable business models

Some experts suggested that, in the field of digital manufacturing and 3D printing, many companies are in a phase of changing their business models, and many are evaluating new and more sustainable supply chain models. 3D printing and its more flexible nature favour a circular economy. The lifecycle of products can be extended through the on-demand spare parts that 3D printing enables, or the innovative use of the more ecologically friendly and recycled materials that new moulded fibre technology offers instead of disposables.

Figure XIX. The history of 3D printing

1950' Invention of photopolymer (a polymer that changes its properties when exposed to light)

1960' Experimentation with creating solid objects from photopolymers using a laser

1970' First patents granted in the area of computer aided additive manufacturing of 3D printed objects

1980' Apparatus for fabricating an industrial part using a single laser beam
First commercial 3D printing solution using stereolithography

1990' Numerous technological developments

2000' 3D printing standards developed

2010' Mass commercialisation of 3D printing solutions
The emergence of 3D printed guns
A 10 metre long 3D printed bridge is inaugurated

2020' Launch of new polymer powder 3D printing technology based on high speed sintering process

0072 Effect on production and distribution of goods

Some experts stated that one of the main effects of 3D printing is the ability to produce, in a standardised and serialised way, customised products based on demand (i.e. with less waste). Serialisation and customisation may seem to be opposing concepts, but 3D printing actually combines them. In other words, a 3D printing production line can now produce 'series' of unique items instead of identical goods. In the field of 3D printing, three main business models can be identified: (1) trading, lease or exploitation of 3D printers, (2) trading of CAD files, and (3) trading of printed products.

0073 Effect on labour

Some experts noted that the further development of 3D printing may have a dramatic effect on the labour market as the production of goods becomes more decentralised. The democratisation of the technology will undoubtedly lead to more rapid development and innovation within the industry. However, it also raises a series of issues regarding the liability for and quality of the products made by amateur developers.

0074 Supply chain issues

In terms of distribution, 3D printing can address supply shortages and reduce the need for packaging and transport. 3D printing could therefore result in less global trading of goods; however, there will still be the need for trade in the raw materials and components used in 3D printers. There could also be an effect on tax revenue and solutions will have to be sought to compensate for the loss on tax incomes, since 3D printing files can travel through cyberspace with no restriction of movement and accordingly no customs' control.

6.2.4 IP protection use cases

0075 IP and 3D printing – a multidimensional issue

Some experts suggested that the protection of IP in 3D printing technology is a multidimensional issue affecting virtually every area of IP law (including copyright, patent law and design law), since the printing process has various elements that can be protected in varying degrees:

- the 3D printing machines;
- the materials;
- the CAD file formats;
- the CAD files themselves;
- the printed products.

0076 Digital rights management (DRM) and traceability

Many industrial companies using 3D printing in the production process are collaborating with various organisations to find feasible solutions for the protection of 3D printers. One innovation recently implemented by the manufacturers of 3D printers is the use of a DRM system within the printers. In this regard, 3D printing technology would follow the steps taken by the music, book and film industries as a means of preventing unauthorised copying or use. Many companies are also looking into establishing traceability solutions for printers to ensure integrity at every step of the process.

0077 Control of CAD files

Recognition tools such as fingerprinting, hashing or watermarking could be used for tracking CAD files, which can also be encrypted and reinforced with a licencing system. This would determine the number of copies that can be printed from a particular model, as well as the terms and conditions of its commercial use. The permission to print a certain 3D model may also be restricted by the use of serial numbers. In this way, a particular file could only be printed on a machine with a particular serial number. Following this methodology, each file would contain an embedded identifier that is impossible to eliminate or alter. A number of experts were of the view that the file tracking system is a beneficial addition to the protection given by the registration of the design, since if the model is distributed online illegally, the owner can trace the source and use this as grounds to file a claim.

0078 Legal challenges

Some experts noted that, in most cases, existing IP laws could be applied to the new technologies. Nevertheless, some amendments, or maybe even a new type of IPR, might be needed in the case of the creation or modification of living organisms using nanotech or 3D printing. However, IPR protection of these technologies will be ineffective without adequate reinforcement, which could be achieved by implementing watermarks or certificates. Since the issue of standardisation raises similar challenges for standards organisations and IP organisations, cooperation between these institutions would be very valuable. The unique characteristics of the 3D printing process raise questions that courts will inevitably need to address in the future, for instance, in terms of authorship/ownership: who owns an object conceived by one individual, digitally modelled by another and printed by a third? As for ethics: is there a need to establish a new type of IPR to regulate 3D printing with biomaterials, such as living tissue?

0079 Consumer-related issues

Assuming that 3D printing evolves into a widespread consumer technology, consumers may become creators of designs and products. Consequently, they will interact with IP not just as end-users but, above all, as owners of IP rights. This will require more awareness-raising campaigns to instruct them on owning and managing IPR. The democratisation of 3D printing technology raises questions regarding the safety and ownership of the final product in the event of unauthorised modifications to CAD files. In the event of injury, material damage or an IP-related dispute caused by a substandard product, does liability lie with the owner of the 3D printer who made the product, with the designer who created the file, with the provider of the printing material, or with the maker of the 3D printer? Some experts suggested that the principles of this system coincide largely with the principles applied to 'do it yourself' guidebooks and products. One of the possible regulatory solutions would be the implementation of a licencing agreement containing the terms and conditions of use that would regulate the materials, the resolution and consequently, the quality of the final product.

6.2.5 Threats and challenges for IP

0080 3D printing and counterfeiting

From a counterfeiting perspective, 3D technology allows the easy replication of items and, therefore, facilitates the illegal production of goods. As 3D printing evolves and the quality of the materials increases, printed products may become almost identical to mass-manufactured versions. In this regard, 3D printing could lead to increased IP infringement, as it would be more difficult to detect whether the products are original or counterfeit. The risk would increase further with the dissemination of 3D printers able to print with gold, silver and other high-value materials. However, these types of infringement are conceptually not very different from those currently known. Therefore, for the time being, these cases can be examined by applying existing law and enforcement measures. However, despite the wide range of possibilities that 3D printing technology offers to counterfeiters, the current situation is not as worrying as it first appears. A number of experts indicated that IP infringers generally look for fast and cheap solutions. 3D printing will undoubtedly advance and improve, but for the time being it is still too slow and too expensive for large-scale counterfeiting. While 3D printing generally has a lot of potential environmental benefits, the private production of 3D printed counterfeits could have negative environmental consequences. The threat of 3D printing related greenwashing should also be considered.

6.2.6 Investigative and enforcement opportunities

0081 Use of 3D printing as a tool for enforcement of IP

Some experts subscribed to the view that 3D printing hardly offers any benefits for enforcement and is seen rather as a threat. This is because 3D printing frees the travel of 'know-how' through cyberspace and, therefore, there can be no restrictions on the movement of the final physical goods.

0082 Relevance for customs control

Customs scanning processes could be improved by implementing 3D and penetration scanners adapted to large-scale objects or by applying nanotech. However, customs checks could focus on inspecting, detecting and controlling the distribution of the primary and popular materials used for 3D printing (e.g. plastic pellets). This is expected, nevertheless, to decrease as the world adopts a circular economy paradigm in which materials are recycled and locally sourced.

0083 Determining originality of 3D objects using nanochips

Some experts indicated that 'nanocodes' could be integrated into CAD files and used to track 3D-printed objects. Originality could then easily be determined in checks carried out by the authorities.

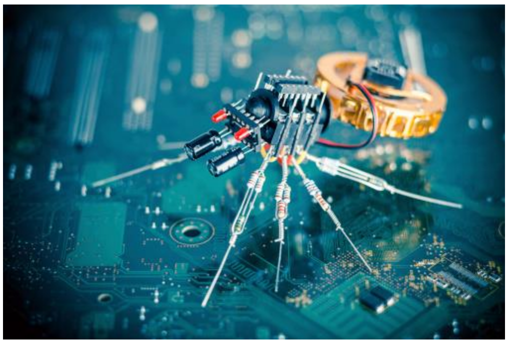
6.3 Nanotech

Many, many rules had begun to bend at the hand of nanotechnology, gene therapy, robotics, artificial intelligence. This produced a lot of good, and a lot of bad. This trade-off has always plagued us. When you make waves, you produce peaks and troughs.

Spire, Matt, Caligatha, Deadprism, 2015.

6.3.1 The technology in a nutshell

0084 The nanotech science



Electronic Spider Working on a Motherboard

Nanotechnology (nanotech) is the manipulation of matter on an atomic, molecular and supramolecular scale. One of the first applications of the technology aimed to precisely manipulate atoms and molecules in order to fabricate larger products. Currently, nanotech refers to a whole area of scientific and industrial research that deals with the special properties of matter below a given size. Nanotech includes fields of science such as surface science, organic chemistry, molecular biology, semiconductor physics, energy storage, microfabrication and molecular engineering. Applications of the technology range from extensions of conventional device physics to completely new approaches based upon molecular self-assembly, from developing new materials with dimensions on the nanoscale to direct control of matter on the atomic scale. Future applications of nanotech will be developed to create revolutionary new materials and devices.

0085 Nanotech – a powerful emerging technology

Although a number of experts indicated that nanotech has not yet reached its full potential, the technology is evolving rapidly and successfully and could undoubtedly revolutionise many aspects of our lives and work. Medicine, energy, architecture, transport, education, engineering, archaeology and aeronautics are just some areas that will benefit from innovation in this and other technological fields, including robotics and 3D printing.

0086 Carbon nanotubes

One important application of nanotech is, according to some experts, carbon nanotubes, which are tubes made of carbon with a diameter measured in nanometres (a nanometre is 0.000000001 m). Nanotubes already have a wide range of uses, and look set to become crucial to several industries, such as electronics, strengthened materials, medicine and diagnostics. Carbon nanotubes could become a major traded commodity with the potential to replace some conventional raw materials.

6.3.2 Information resources

0087 Suggested reading

The experts suggested the following general sources of more information:

- Karim Md, *Nanotechnology Law and Policy: An Introduction*, 2023;
- Nanotechnology, EU Science Hub, European Commission;
- Ouellette, L. L., *Economic growth and breakthrough innovations: a case study of nanotechnology*, Economic Research Working Paper No. 29, 2015, WIPO.

Figure XX. The history of nanotech

1960' First concepts around modern nanotechnology are presented

1970' The term "nano-technology" is coined

The first Molecular Electronic device is patented

1980' Scanning tunnelling micorscop is developed

Discovery of the first fullerene (C60)

1990' Carbon nanoparticles invented

2000' A new class of carbon nanomaterials (carbon dots) is discovered

2010' Several DNA-like robotic nanoscale assembly devices are created

2020' Development of novel electrochemical sensor modified with multi-walled carbon nanotubes for the real-time detection of COVID-19

6.3.3 Impact on society, the economy, world trade and the environment

0088 Impact of nanotech

Graphene nano material processing in graphene processing factory

According to some experts, nanotech raises many of the same issues as any other new emerging technology, including concerns about the toxicity and environmental impact of nanomaterials, and their potential effects on global economics, as well as speculation about various doomsday scenarios (e.g. in respect to nano weapons and bioweaponry). If nanotech is going to revolutionise manufacturing, health care, energy supply, communications, and defence, then it will, as a number of experts emphasised, also transform the labour market, the medical profession, the transportation sector and sustainable energy infrastructure. All of these developments could lead to significant social disruption.

0089 Green nanotech

Nanotechnologies focused on sustainability are those dedicated to the environment, involving specific industrial processes such as the decontamination of contaminated soils and production waters (nanoremediation), the reduction of new pollution by improving the current situation of toxic substances (including nanowaste), and the creation of new sensors for the production of environmental pollutants (intelligent sensors). Nanotechnologies will help provide drinking water through new filtering techniques and the ability to purify water. The materials produced thanks to nanotechnologies can contribute to a more efficient exploitation of resources. They are lighter, resistant materials, the production of which involves a lower use of energy. It was noted that misleading or deceptive marketing can pose a threat of greenwashing.

6.3.4 *IP protection use cases*

0090 Potential issues concerning IP protection

The experts identify some potential issues concerning nanotech and IP protection:

- protection of manufacturing processes;
- protection of nanotech products;
- protection of nanodevices, nanomaterials and nanotools;
- protection of nanobiotechnology used to modify human or other living beings' genes.

6.3.5 *Threats and challenges for IP*

0091 Effect on counterfeiting

The commercialisation of nanotech-based products has been relatively modest, due to its complexity and costliness. Nevertheless, current research activities demonstrate extraordinary potential, which raises a question as to whether the infringement of nanomaterials IPs will increase when this technology becomes widely applied and economically profitable.

6.3.6 *Investigative and enforcement opportunities*

0092 Intelligent materials

Nanomaterials such as fibres or threads can be formed into 'intelligent materials' that can be used to create new products with proof of authenticity embedded. As the production of these nanomaterials can only be produced by certain companies, it would be complicated for forgers to create similar fake products. These 'intelligent materials' may also change their physical shape when viewed to contain invisible information about the product, which forgers cannot alter or even detect.

0093 Nanotech and robotics in combination

Some experts expressed the view that nanotech and robotics in combination could have a positive impact on investigative and enforcement procedures once they reach their full potential. Further investigations in the application of these technologies are therefore welcome.

0094 Customs application of Nanotech

Some experts suggested that customs' scanning processes could be improved by applying nanotech. Special intelligent nanomaterials holding embedded information about the authenticity of the product would act as a type of embedded radio-frequency identification (RFID) sensor and transmit the coded data when being scanned and could serve as an effective recognition method.

0095 Counterfeiting resistant products

Colourful Abstract Data Flowing Chromatic Holographic Dynamic Waves

Unlike watermarks or holograms, which can be counterfeited, nanomaterials are significantly more challenging and, above all, more expensive to counterfeit. The impossibility of removing them, unlike chips and SIM cards, makes them ideal components for labelling. These materials would be able to emit a signal and could serve as tracking devices. Assuming that counterfeiters would not make the effort to embed nanomaterials in the counterfeit products, some experts indicated that such goods would be easily recognised by their lack of these elements. This system would not only be beneficial for customs, but also for consumers, as a universal app could be developed to scan goods and verify whether they are original. Another possible solution that nanotech enables is the DNA spray. The spray is based on an invisible liquid embedded with a unique code and microdots that glow under UV light and can be easily traced. As nanotech becomes more widely available and cheaper, anti-counterfeiting may face challenges, as seen with other technologies such as holograms.

7 ELECTRONICS

7.1 Quantum Computing

It's a quantum physics concept where everything that happen, is happening, in an infinite number of parallel universes.

Semple, Maria, Where'd You Go, Bernadette, Little, Brown and Company; 2012.

7.1.1 The technology in a nutshell

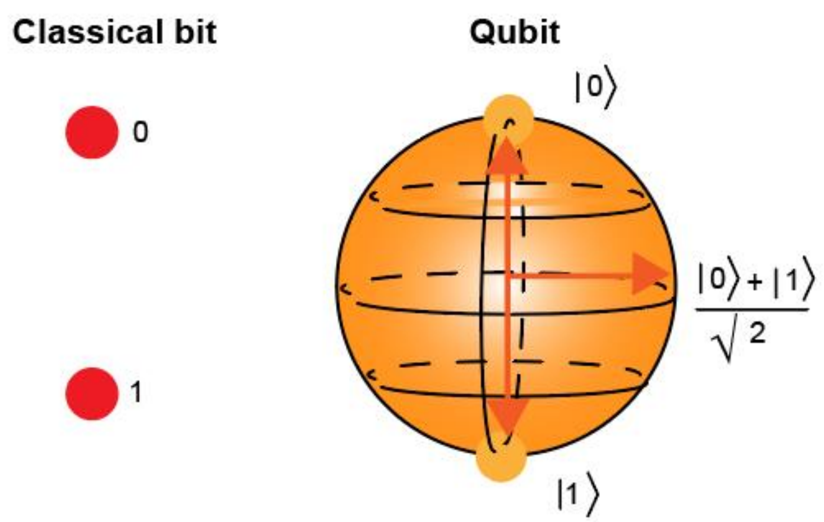
0096 Main applications of quantum physics

Three main technologies have emerged from the quantum technology sphere: quantum metrology and sensing, with applications such as the atomic clock, MIR imaging and quantum sensors; quantum communication networks, which have enabled the invention of quantum satellites and quantum (and post-quantum) cryptography; and quantum computing.

0097 Quantum computers

Quantum computing is, according to a number of experts, a technology based on processors called quantum computers, which exploit the laws of physics and quantum mechanics, especially the principles of entanglement and superposition. Quantum computers are new types of devices that allow information to be represented and manipulated not through the classic bits – 0 and 1 – but through the qubit, the basic component of these special calculators and has the peculiarity of operating as both a 0 and 1 at the same time in multiple variations. Theoretically, this allows very fast processing and the ability to perform a multitude of calculations simultaneously.

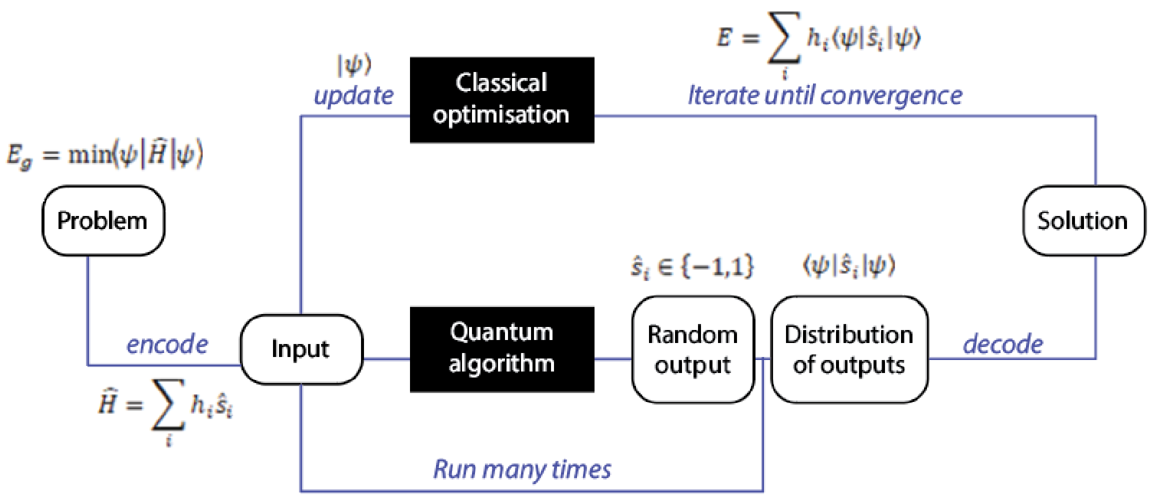
Figure XXI. A Qubit



0098 Generations of quantum chips

The first generation of quantum chip technology led to the invention of the transistor. The second generation of quantum technology produced inventions such as the ultra-precise atomic clock in navigation systems and the quantum key in cryptographic techniques. Another key invention in the field of quantum cryptography was post-quantum cryptography, a less invasive technique that does not require the installation of new hardware in the communication device. Other developments were the universal quantum computer, a programmable device based on error correction, and quantum sensors, with applications in the navigation and military sectors. In addition, this generation of technology had applications in medical imaging, earthquake and tsunami warning systems, gravitational sensors, the detection of underground water, and secure quantum communication.

Figure XXII. Variational quantum Eigelsolver (VQE)



0099 Quantum computers will not replace traditional computers

The above figure shows a practical example of the use of a quantum computer. A problem that could be solved using a quantum computer is identified. A traditional computer will input the data needed to be processed in the quantum computer that, in several rounds, will be asked to do the calculation using a quantum algorithm. When a sufficiently high number of calculations leads to the same result, the output is interpreted by a traditional computer, and the result can be used to optimise data collection and algorithms for future calculations. Quantum computers – certainly for the foreseeable future – will mostly perform calculations to solve mathematical problems or calculations about natural phenomena that are quantum in nature (e.g. biochemical problems). Quantum computers are not yet suitable for calculation of social or economic problems. Consumers are likely to have to wait at least a century, if not longer, to have quantum computers at home. However, one can expect a broad use of them in data centres, providing access to quantum services. Currently, however, it is difficult to indicate any practical use of this technology.

Figure XXIII. The history of quantum computing

1980'	First conference on the Physics of Computation is held, where a basic model for a quantum computer is proposed
1990'	Shor's algorithm is presented - it allows a quantum computer to factor intergers much faster than the classical algorithm
	Theory of quantum error-correcting is introduced
2000'	First experimental demonstration of a quantum algorithm
	First real-world execution of Shor's algorithm
	First working pure NMR - nuclear magnetic resonance - quantum computer is demonstrated
2010'	First commercial quantum computer is produced
2020'	The U.S. National Institute of Standards and Technology initiates a process to standardise quantum-resistant public-key cryptographic algorithms

7.1.2 Information resources

00100 Suggested reading

The experts suggested the following general sources of more information:

+ Grumbling, E.; Horowitz, M., *Quantum Computing: Progress and Prospects, National Academies of Sciences, Engineering, and Medicine*, 2019.
+ Hidray J. D., *Quantum Computing: An Applied Approach*, Springer Cham, 2nd ed., 2021.
+ Hughes, C., Isaacson, J.; Perry, A.; Sun, R. F.; Turner, J.; *Quantum Computing for the Quantum Curious*, Springer, 2021.
+ Wong, T., *Introduction to Classical and Quantum Computing*, Rooted Grove, 2022;
+ Zhao, Y., *Quantum Computing and Communications*; IntechOpen, 2022;

7.1.3 Impact on society, the economy, world trade and the environment

00101 Processing of enormous data sets

Quantum computing allows the storage, processing and manipulation of huge and exponentially rising amounts of data using less power than a traditional computer. It does this by applying a completely new approach from that used in traditional computing developed over the last 70 years. Quantum computing is constantly evolving and transforming and aims to provide faster processing solutions in the future to problems that are currently unsolvable or that only supercomputers can solve. Some members of the expert group determined that quantum technologies would not replace but complement classical technologies. Both types would together produce more efficient solutions to problems such as the Haber-Bosch process, by combining a quantum algorithm with a production line powered by classical computing.

00102 Expensive technology

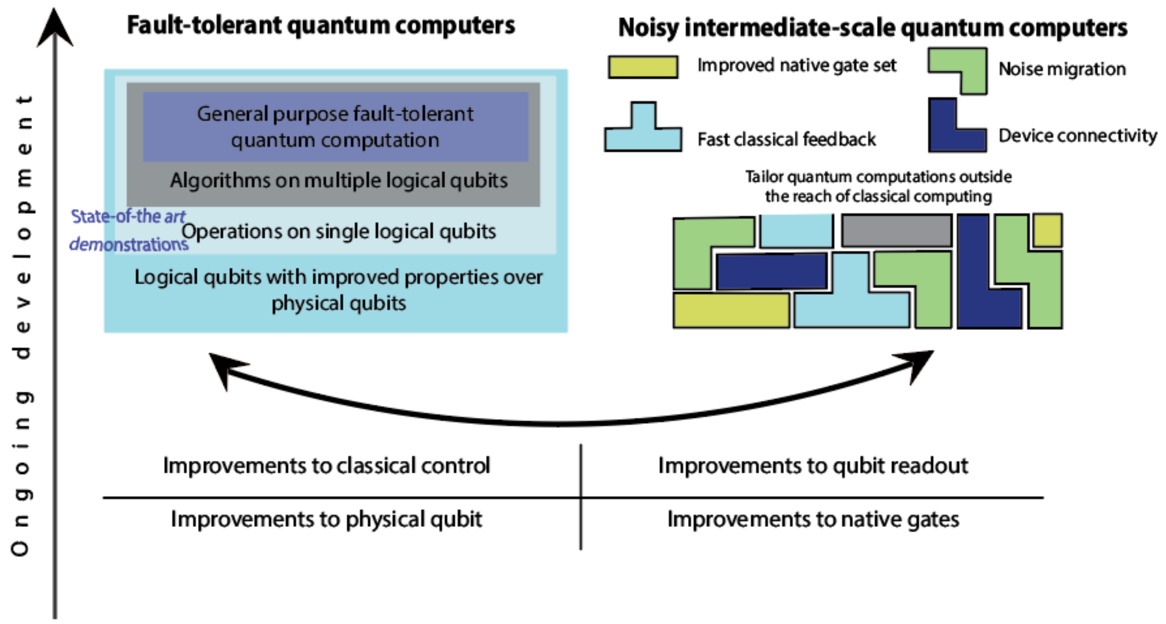
Some members of the expert group emphasised that quantum computing is a very expensive technology, inducing a sort of protectionism that should be mitigated. Otherwise, the data is at risk of being at the mercy of powerful corporations.

00103 Data protection issues

Regarding the General Data Protection Regulation (GDPR), quantum computing presents a legal challenge due to its impact on public-key cryptography and symmetric cryptography, which serve as a base for many data protection regulations. Quantum cryptography could even pose a risk retrospectively to past data, which, according to regulations such as the GDPR, are legally required to be protected.

Although the possibility of quantum technology cracking that encryption exists, the most effective protection lies in understanding the data and acting accordingly.

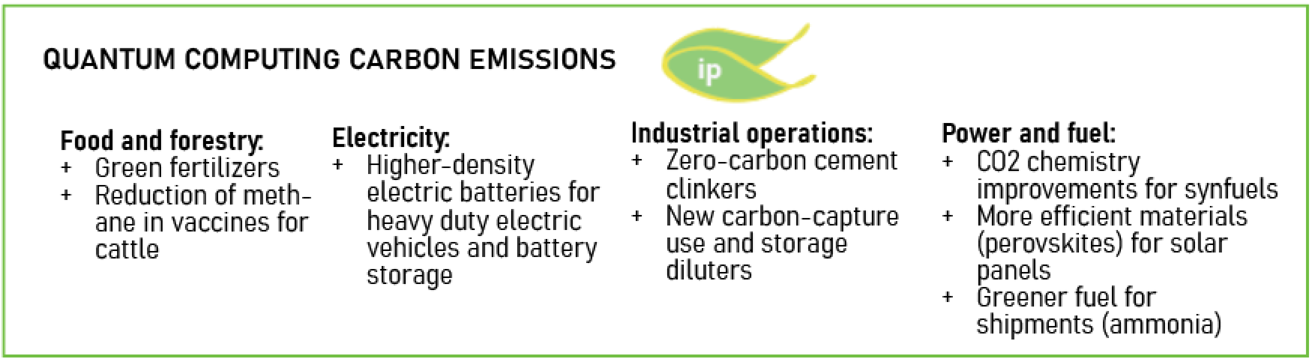
Figure XXIV. Future development of quantum computing



00104 Environmental benefits

Some experts mentioned that some of the most promising use cases for quantum computing lie in the development of products and processes that can reduce the energy consumption of important industrial processes, such as those involving fertilisers. Even more sophisticated machines could cause a significant reduction in air pollution, becoming a useful tool in the fight against global warming.

Figure XXV. Positive environmental impact of quantum computing



00105 Environmental hazards

However, to operate, a quantum processor needs to stay at a temperature of at least 15 millikelvin (-273°C); maintaining such a cold environment requires enormous supplies of energy. This is expected to grow proportionally to the work performed by the processors.

7.1.4 IP protection use cases

00106 Europe´s position in the quantum race

According to some experts, Europe is at the forefront of quantum computing research, while China and the USA lead the way in terms of innovation monetisation and the number of patent applications published. The long-term consequences of European companies not working in quantum computing may include loss of competitiveness as well as serious security concerns.

00107 Patentability issues

Regarding the patentability of quantum computing inventions, according to some of the experts, a number of requirements must be met. Firstly, researchers should avoid publishing any study prior to the filing of the patent application. Secondly, to avoid being disqualified by the third paragraph of Article 52 of the European Patent Convention, the researcher should indicate the technical name of the invention obtained from a computer of their own. Thirdly, the applicant must comply with the clarity requirement, according to Article 84 of the European Patent Convention, with a sufficiency of disclosure (i.e. they must disclose the invention in a way that allows an expert to replicate it, with some missing parts), taking into account that no additional information can be added to the filing once it is presented.

00108 Quantum principles-based teleportation and parallel universes in culture

Quantum physics principles like superposition and entanglement have been a key driver behind a lot of science fiction literature, films, TV series and video games. Subjects inspired by quantum physics often revolve around teleportation and parallel universes.

Figure XXVI. Examples of teleportation and parallel universes in culture

+ Alice in Wonderland, novel by Lewis Carroll. UK: Macmillan, 1865;
+ The Man in the High Castle, novel by Philip K. Dick. US: Putnam, 1962;
+ Dune, novel series by Frank Herbert. US: Chilton Books, 1965;
+ Planet of the Apes, motion picture, directed by Franklin J. Schaffner. USA: APJAC Productions, 1968;
+ 'Pretzel Logic', song performed by Steely Dan. US: ABC, 1974.
+ Time Bandits, motion picture, directed by Terry Gilliam. UK: Handmade Films, 1981;
+ Dark Tower, novel series by Stephen King. USA: Grant, 1982;
+ The Terminator, motion picture, directed by James Cameron. USA: Orion Pictures, 1984;
+ Silent Running (On Dangerous Grounds), song performed by Mike + The Mechanics. US: Atlantic, 1985;
+ The Fly, motion picture, directed by David Cronenberg. US: Brooksfilms, 1986;
+ Weaveworld, novel by Clive Barker. UK: Collins, 1987;
+ Lost in Time, video game. France: Coktel, 1993;
+ Ratchet & Clank: A Crack in Time, video game. USA: Insomniac Games, 2009;

- Spiderman: Edge of Time, video game. Canada: Beenox, 2011;
- Interstellar, motion picture, directed by Christopher Nolan. US: Paramount Pictures, 2014;
- The Man in the High Castle, television series, USA: Amazon Prime Video, 2015;
- Dark, television series. Germany: Netflix, 2017;
- Avengers: Endgame, motion picture, directed by Anthony Russo. US: Marvel Studios, 2019;
- Dune, motion picture, directed by Denis Villeneuve. US: Warner Bros. Pictures, 2021.

7.1.5 Threats and challenges for IP

00109 Encryption related threats

During the workshop at the Niels Bohr Institute, some members of the expert group expressed concern about the negative implications of the popularisation of the technology, as it could give criminals the ability to crack the encryption of credit card transactions in a short period. In reply, researchers from the Niels Bohr Institute informed the members of the expert group of the recent establishment of 'quantum-proof encryption', a powerful security tool to protect the system from wrongdoers. In addition, the speaker reflected on the danger of weaponising quantum technologies on a governmental scale.

00110 Reverse engineering

One of the issues raised by the members of the expert group was that reverse engineering has two applications for traditional IP. Firstly, it offers the possibility of replicating patented models through quantum computing, which is a weakness of the system. Secondly, the fact that patent examiners can use quantum computing to verify that an invention is efficient is a strong point.

00111 Patent protection

Lab in the Niels Bohr Institute

Furthermore, researchers in this field state that filing for patent protection is complex since research teams are global, there is a constant exchange of ideas due to new workings methods, and inventions are published too soon. In addition, since quantum technology-related inventions are literally 'in flux', this may hinder the patent filing process, which relies on the description of inventions, processes and workflows as static processes and cannot be constantly changing. However, a positive aspect of this technology for patent filing is that hardware and software combinations are very robust and could make the patent application process easier.

7.1.6 Investigative and enforcement opportunities

00112 Limitations of the technology

Some experts drew attention to the limitations of the technology concerning finding the right formulation of the problem, taking into account the specific conditions that could be difficult to. They also pointed out some potential cases in which quantum computing could be helpful: processing and filtering technology to help match content and human recognition, as well as for digital rights management (DRM); the use of qubits to mark banknotes, which could be applied to the fight against counterfeiting; and closing the gap between offline and online. Moreover, quantum computing could improve the user experience by enabling better planning, use of decentralised networks and distribution of content. It could also open the door to quantum enforcement services. Another development enabled by quantum computing is teletransportation, in which an original work of art is sent/teleported somewhere else while the original is destroyed. This could solve the current dichotomy related to the uniqueness of works using NFTs.

00113 Protection of data

Physical protection of data takes longer than the time needed for the development of quantum computing (cryptography). Post-quantum cryptography could solve that, but this is not guaranteed since someone could come up with an algorithm to infringe this. Quantum key distribution could be a solution for this, but it is costly.

00114 Quantum policing

Quantum computing could enable improvements in predictive policing and crime-scene and risk analysis. However, it also brings some deficiencies, as risk analysis could be predicted by criminals. To enhance the depth of analysis, quantum computing could be an important tool, but the human element is still paramount.

00115 Fighting cybercrime

In addition to this, some expert group members discussed whether quantum computing could be used to track personal behaviours, and commented on the difficulties of fighting cybercrime due to its flexibility and adaptability and the need for public funding for quantum computing cybersecurity.

7.2 5G/6G Mobile Networking

But I think there are obvious structural changes in the economy. This technological revolution is a revolution; there isn't any doubt about it. The speed of communication, the speed of information transfer, the cheapness of communication, the ease of moving things around the world are a difference in kind as well as degree. It's that kind of structural change.

Quote from Paul Volcker, former Chairman of the Board of Governors, Federal Reserve System, 1979-87, in an interview with PBS (https://www.pbs.org/fmc/interviews/volcker.htm), 2000.

7.2.1 The technology in a nutshell

00116 Second generation (2G) networks

2G refers to the second generation of mobile networks based on GSM (Global System for Mobile Communications). 2G capabilities were achieved by allowing multiple users on a single channel via multiplexing. Key features of 2G included: the use of a digital signal instead of an analogue signal (1G); services such as SMS (Short Message Service) and MSM (Multimedia Messaging Service); better quality voice calls; the use of encryption techniques to improve confidentiality; and picture messaging. However, users experienced spam attacks and the interception of communications through fraudulent base stations.

Figure XXVII. The History of 2G-5G Technologies

1990' 2G introduces digital voice and SMS services

2000' 3G introduces video calling and mobile internet

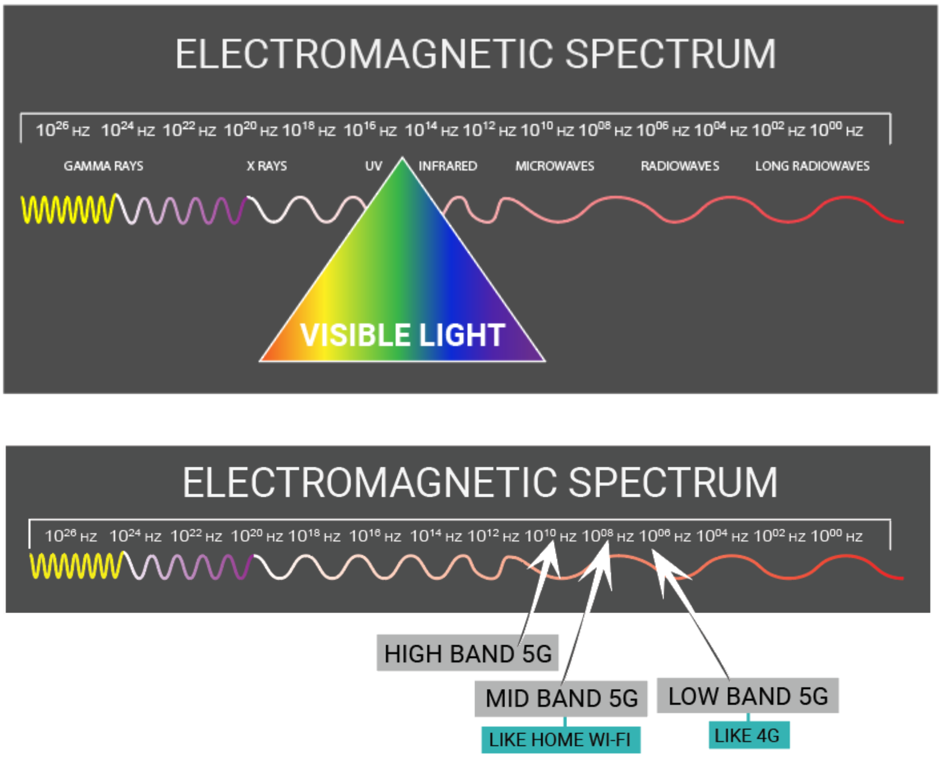
2010' 4G introduces support for large ranges of frequencies and HD video

2020' 5G introduces higher frequencies and shorter wavelengths, as well as applications beyond person-to-person communication

00117 Third generation (3G) networks

3G combined aspects of the 2G network with new technologies and protocols to deliver a significantly faster data rate. Key features included: increased bandwidth; the transmission/reception of large email messages; multimedia functionalities; mobile internet access; video downloading; and video calling. The inclusion of multimedia and internet access enabled the first malware attacks and privacy violation via GPS location.

Figure XXVIII. The electromagnetic spectrum



00118 Fourth generation (4G) networks

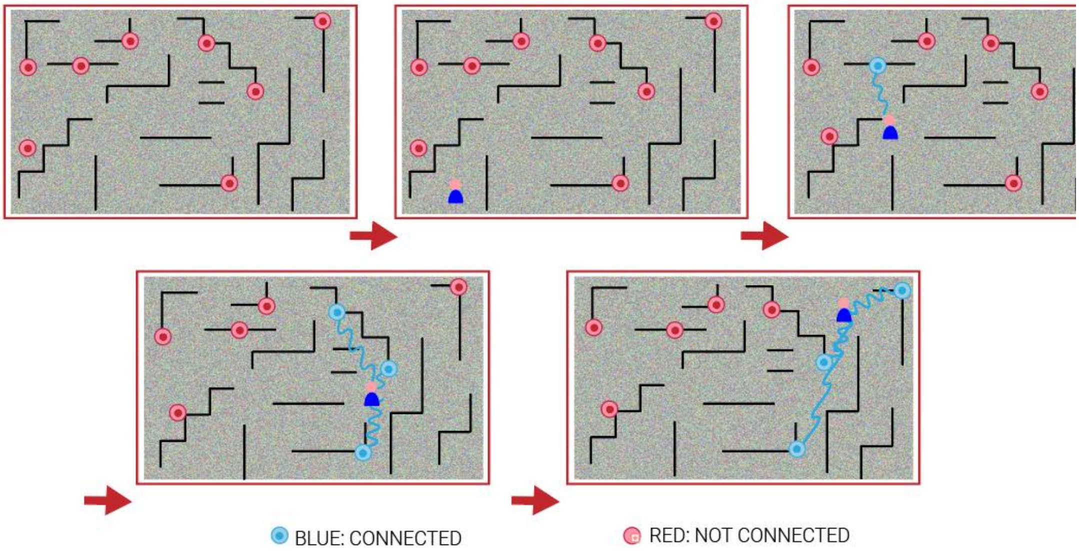
4G differs from 3G mainly in the data rate. 4G LTE (Long Term Evolution) includes a major improvement over 3G speeds but it is not 4G. Instead, it is one step on the path to full 4G standards. Key features of 4G LTE include:

- support for interactive multimedia, voice and video;
- high-speed, high-capacity and secure internet connection;
- global and scalable mobile networks;
- high-definition mobile TV support.

00119 Fifth generation (5G) networks

5G differs from 4G in its peak capacity, low latency and bandwidth size. 5G can be built in different ways using multiple bands of the wavelength spectrum: low-, mid- and high-bands. High-band millimetre-wave frequencies have greater bandwidth, allowing more data to be carried in dense urban areas, but they require cell sites to be closer together and have limited penetration inside buildings. Mid-band balances speed and range, providing broader coverage than high-band, and is less impacted by buildings. Finally, low-band travels further than other bands and can pass through more obstacles, providing better coverage and a stronger signal both indoors and outdoors.

Figure XXIX. Connectivity of 5G network



00120 Sixth Generation (6G) networks

6G will be the successor to 5G and will be able to use higher frequencies than 5G, providing higher capacity and much lower latency.

7.2.2 Information resources

00121 Suggested reading

The experts suggested the following general sources of more information:

+ "5G Observatoy", European 5G Observatory, European Commission, 2022;
+ "Do criminals dream of electric sheep?", EUROPOL, 2019;
+ Dahlman, E., Parkvall, S., Skold, J., 5G NR: The Next Generation Wireless Access Technology - 1st edition, Academic Press ELSEVIER, 2018;
+ '6G – Connecting a cyber – physical world', Ericsson White Paper, 2022;
+ 'Ericsson Antenna System', Ericsson, 2021;
+ 'Ericsson Mobility Report', Ericsson 2022;
+ Kumar, S., Evolution of Mobile Wireless Technology from 0G to 5G, International Journal of Computer Science and Information Technologies Vol. 6 (3), 2015; 'Introduction to the 5G technologies and their risks in terms of privacy', Agencia española protección datos, 2022;
+ Kranz, G., What is 6G? Overview of 6G networks & technology, TechTarget, 2022.

7.2.3 *Impact on society, the economy, world trade and the environment*

00122 The future of the digital economy

5G is predicted to be one of the most critical building blocks of the digital economy in the coming years. The technology will enable faster data connections and lower latency and will be able to handle the increasing number of connected electronic devices. Therefore, innovative businesses are expected to take advantage of the technology and develop various new products and electronic solutions.

Figure XXX. Speed comparison GSM – 6G

Generation	2G		3G		4G		5G	6G*
Technology	GPRS	EDGE	3G Basic	HSPA +	LTE Cat.4	LTE-Advanced Cat. 16	5G	6G
Maximum Download Speed	0,1 Mb	0,3 Mb	0,3 Mb	21 Mb	150 Mb	979 Mb	1,000-10,000 Mb	1,000,000 Mb

00123 Simplification of terms and conditions

Some experts pointed out that the simplification of terms and conditions will be key in the future. Furthermore, they indicated that users are not necessarily aware of contradictions among different sets of terms of service, even if they understand them. For instance, if a downloaded app uses a part of the user's bandwidth (and the user agrees to this in the terms and conditions), this is in conflict with the Internet Service Provider's (ISP) terms and conditions, which indicate that home bandwidth cannot be used for commercial purposes. The user can consent, but the two agreements cancel each other out.

7.2.4 *IP protection use cases*

00124 Registration and representation of touch, scent or smell as a trade mark

It was emphasised by some experts that, although in the EU it is possible to protect a scent or a taste as a trade mark, it has never been possible to make a format that is clearly definable so that it can be protected, because there is no technology that can represent such trade marks. However, in a cyber-physical continuum, it could be possible to define these kinds of experiences so precisely that they can be registered.

7.2.5 *Threats and challenges for IP*

00125 Faster IP crime

While 5G mobile networking in itself does not pose a threat to IP, the enhanced speed and capacity of 5G technology will, according to some experts, make it easier to commit traditional IP crimes carried out online (e.g. downloading of copyright-protected content). Moreover, according to some experts, the ability to initiate large-scale cyberattacks to steal trade secrets could also exploit 5G technology.

00126 Industrial espionage

Some experts explained that in certain countries 5G infrastructure can be compromised by the producers themselves and added that industrial espionage would become a severe problem for law enforcement.

7.2.6 Investigative and enforcement opportunities

00127 Device to device communication

Some experts noted that device-to-device (D2D) communication systems are enabled by 5G technology and indicated that the ability of 'things' to exchange information and communicate directly with each other, without going through the network of a telecom operator, may pose a serious traceability issue for law enforcement authorities. Moreover, some experts raised the question of the maximum distance that still allows two objects to communicate, indicating that embedding monitoring or surveillance tools in the operating system of connected devices – rather than on the networks of telecom operators – might be the only way to investigate or control communications for enforcement purposes.

00128 Greater agility of criminals in not having to act legally

Criminals can act in a much more agile fashion than law enforcement and governments, since they are not constrained by law. Furthermore, companies that practice surveillance capitalism are so advanced that they can also act in a more agile manner than law enforcement and governments, and are always one step ahead.

8 DATA PROCESSING

8.1 Artificial Intelligence (AI)

David is 11 years old. He weighs 60 pounds. He is 4 feet, 6 inches tall. He has brown hair. His love is real. But he is not.
Journey To A World Where Robots Dream And Desire.
This Is Not A Game.
This summer, discover the next step in evolution.
Do not speak the seven-word activation code unless you mean it.

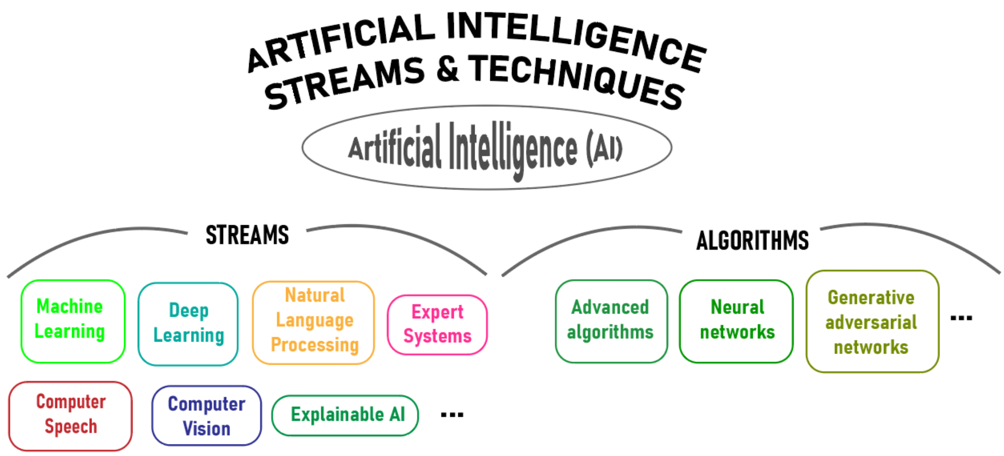
Tagline from A.I. Artificial Intelligence, motion picture directed by Steven Spielberg, Warner Bros, Dreamworks, Amblin Entertainment, 2011.

8.1.1 The technology in a nutshell

00129 Artificial intelligence – a multitude of different technologies
In most cases, the fundamental AI models (e.g., artificial neural networks, Bayes networks, hidden Markov models and support vector machines) represent a mathematical description of how the input data is going to be processed and what kind of input is expected from the model for given performance evaluation criteria. Therefore, artificial intelligence (AI) systems are primarily advanced learning systems. By applying AI, a machine can learn to perform a task previously performed by a human with limited or no human intervention. AI encompasses a wide range of very diverse techniques, including:

- advanced statistics-based machine learning algorithms and multi-task learning algorithms;
- deep learning often executed in a multiple layer neural network (a computer framework imitating the human brain);
- prediction models to support decision making and other kinds of probabilistic reasoning that combines deductive logic with probability theory.

Figure XXXI. Artificial intelligence (AI) streams and techniques



00130 Key features
A number of experts pointed out the key features of these technologies: efficiency; promptness in new developments; usefulness; product cost reduction; user-friendliness; good investment opportunities; employment transformation; general improvement in quality of life; and major improvements in fields such as mobility, media, security, health and education.

00131 Applications of artificial intelligence
Artificial intelligence can be used as a part of an almost endless range of exploratory data analysis (aiming to understand what data represents):

- computer vision (including automated content review and characterisation);
- big data analysis (including automated consumer recommendations);
- creation of virtual worlds (together with augmented or virtual reality technologies), music composition, style imitation or content restoration;
- automated content recognition (ACR): audio, video, semantics, text, picture and speech recognition;
- improvements to robot functioning (together with robotics technology).

8.1.2 Information resources

00132 Suggested reading
The experts suggested the following general sources of more information:

+ *Do criminals dream of electric sheep? How technology shapes the future of crime and law enforcement*, EUROPOL, 2019;
+ Lim, M., *History of AI winters*, Actuaries Digital, 2018;
+ Greenfield, A., *Radical Technologies: The Design of Everyday Life*, Verso Books, 2017;
+ WIPO Technology Trends 2019 – Artificial Intelligence, WIPO 2019;
+ *The Malicious Use of Artificial Intelligence: Forecasting, Prevention, and Mitigation*, University of Oxford, 2018;
+ Kempas, T., *A note on artificial intelligence and intellectual property in Sweden and the EU*, Vinge, 2020;
+ *Facing reality? Law enforcement and the challenge of deepfakes*, EUROPOL, 2022;
+ *Towards Responsible AI Innovation, Second Interpol-Unicri Report on Artificial Intelligence for Law Enforcement*, Interpol - Unicri, 2020;
+ *Study on the impact of artificial intelligence on the infringement and enforcement of Copyright and designs, Economic performance of IPR indicators, Impact of Technology Deep Dive Report I*, EUIPO, 2022.

8.1.3 Impact on society, the economy, world trade and the environment

00133 Impact in general
AI will have a major impact on society, the economy and world trade. These new technologies will modify societies in matters of safe transport, mobility, security, health, media content recognition, the quality of the services offered and, last but not least, employment.

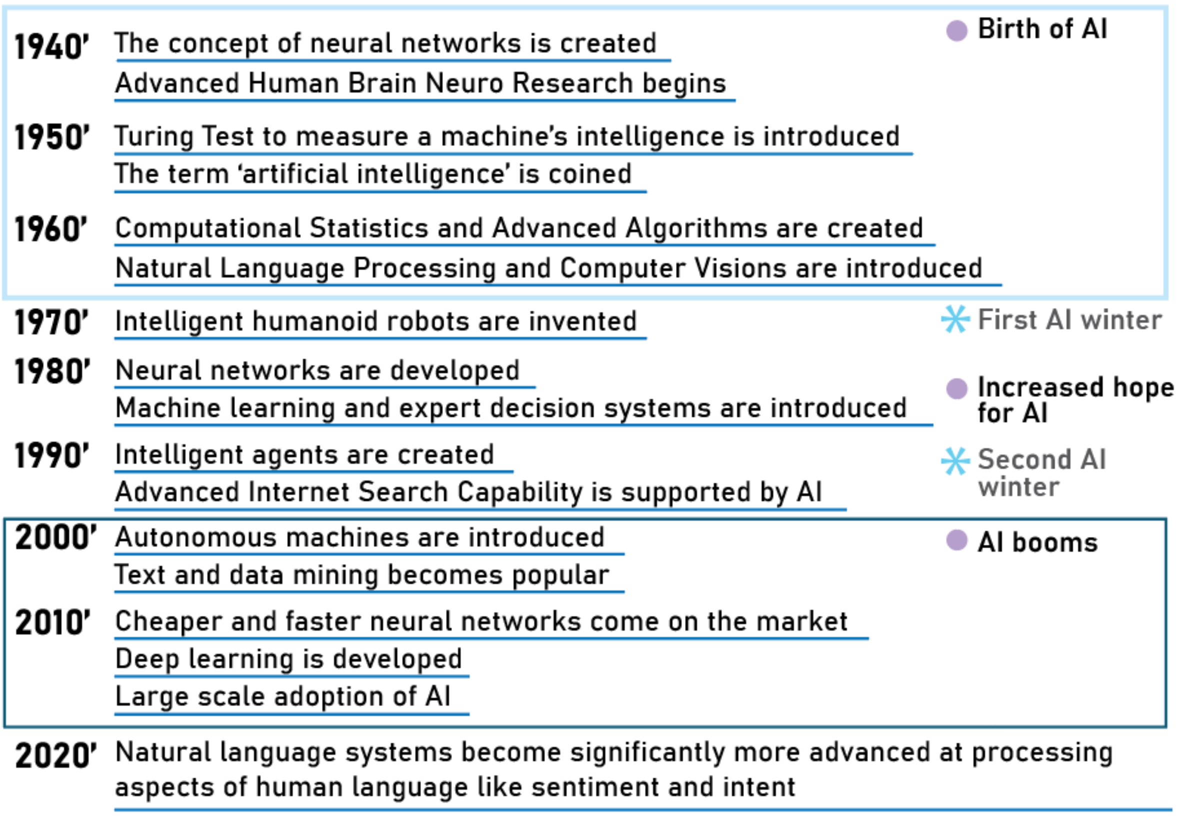
00134 AI's impact on the economy and world trade
In terms of the economy, some experts believed that humanity is likely to witness the exploitation of ever-

cheaper resources for training AI, increased competitiveness and productiveness of traditional enterprises applying AI, and the development of completely new business models. Concerning world trade, overall production capacity might increase due to AI-driven, completely automated production and less wasteful systems, leading to more affordable, customised products that can be delivered faster.

00135 AI's impact on employment

Some experts emphasised that many people currently accept low-paid jobs involving offline and online tasks. These jobs are unchallenging and consist of simple, repetitive duties and assignments. Due to AI, many of these jobs will disappear, transforming the workplace. However, there will be a high demand for people to create and provide training of AI solutions. Some of the experts pointed out that many AI predictive statistics applications rely on data input, which requires extensive manual labour for preparation, in contrast to the idea that AI can make sense of disorganised data.

Figure XXXII. The history of AI



00136 AI related legislation in the future

Some experts believed that changes in legislation are likely to be required concerning the use of data in AI solutions. The fundamental rights of human beings will, however, have to be respected in any use of these technologies. AI also raises issues of legal responsibility and consequences in the event of accidents caused by AI-driven decisions. Experts suggested that international legislative initiatives will be needed. Either way, privacy and fundamental rights protection is essential. Therefore, some experts were of the view that an updated legal environment that addresses AI challenges in various fields is needed, taking into account the rapid development of AI technology. In regard to the use of AI results as evidence in court, some experts mentioned that the Daubert standards (a rule of evidence regarding the admissibility of expert witness testimony applied in US federal law) could be used to establish the reliability of the evidence in courts to avoid erroneous decisions. Some experts raised the issue of the liability of the providers of AI solutions and suggested this might require regulation.

00137 Access to data – a big challenge for AI

Some experts emphasised that a major issue for the implementation of AI is ensuring that smaller businesses have fair access to data controlled by bigger companies. AI only works in a controlled environment, and its effectiveness relies more on access to relevant data than having the best algorithms.

00138 Positive and negative impacts of AI

AI is undoubtedly a powerful tool for the development of environmentally sustainable products and services. The technology's ability to analyse large datasets is vital in finding long-term climate change solutions to highly complex problems. However, some experts also highlighted that progress in AI can be seen as a convenient example of the double-edged sword metaphor. This is presented in the EUIPO's study on the impact of artificial intelligence on the infringement and enforcement of copyright and designs. However, whether a given impact of the technologies is considered positive or negative will often be subjective and depends on the perception of the experts that develop them and the technology's manufacturers. The evolution of AI technology will take some time. Therefore, some experts considered that humanity must prepare for the consequences, both positive and negative; this includes looking closely at the fundamental rights aspects of AI, ethical perspectives on AI, and social responsibility in the use of AI. The most plausible usage of AI in the current state of the art is as so-called decision support and recommendation systems.

8.1.4 *IP protection use cases*

00139 New challenges for IP protection

Some experts held that two issues were of special interest to IP protection: creation and transformation. It is complicated to distinguish between something considered to be original or new and something that has already been created or made. It is, according to some experts, difficult to establish what originality or transformation mean in the context of AI. A machine might be able to create something *à la manière de* or *à la façon de*. The fact that a machine is able to easily create 'new' content based on existing content poses a threat. Many experts also pointed out that it has yet to be determined if and how AI-generated inventions and completely original works should be protected under patent and copyright law. While copyright is based on the lifetime of the author as a human being and not as a machine, and the European Patent Convention states that an inventor designated in the patent application has to be a human being, the question about the possibility of a machine owning the rights of these creations has arisen in several occasions. A machine never dies, but who owns these rights? If databases of copyrighted works are used to train the AI, what are the implications for these original works? For the time being in the EU and the US the case law and most IP experts have not recognised machines as the authors/owners of these rights.

00140 Use of AI in examining trade mark applications

According to some experts, AI-based applications can help both the application and the examination processes a great deal, reducing the overall time of trade mark registration and leading to fewer oppositions. There are already tools using image search technology that help users ascertain whether their logo could be in conflict with existing trade marks. Natural language processing (NLP) is being used to find the best match for their goods and services, leading to a more precise classification of goods and services and avoiding possible deficiencies. It is also used to assist examiners in drafting their decisions. Using AI tools, users could know whether their trade marks may be in conflict with existing trade marks, taking into account the visual, aural and conceptual similarities. All this could help users file their trade mark quickly and correctly, avoiding deficiencies in the examination process. AI tools would also help examiners make quicker and better decisions, allowing them to focus on more complicated tasks and drop routine, simple tasks. Machine-learning techniques can help detect defective work, maintain consistency, and support examiners on their learning path. In addition, machine translation will address the cost and time required for the manual translation of trade mark details

00141 Patentability of input data for training AI models
Some experts raised the question of the patentability of the input data used for the training of AI models and the issue of whether these examples should be filed together with the model. If this is the case, the question of whether the data should be considered part of the patent protection must be addressed. Some experts pointed out that the issue that should be addressed is the definition of raw data in the context of AI, and whether disclosure requirements for the data in the patent application should be put in place to allow the patenting of a certain object. Currently, no case-law addresses this matter. Some experts referred to the risks of imposing too high a threshold in terms of transparency or relating the technical effect achieved by the machine learning system to the specific data it is trained on. Moreover, although making a connection between the claimed invention and the data is possible, it is very rare in practice. This highlights the nature of the data instead (i.e. the variables that are needed to train the system).

8.1.5 Threats and challenges for IP

00142 New challenges for IP enforcement
A number of experts stated that IP faces new challenges due to the rapid development of AI, primarily as regards the protection of IP rights and understanding to what extent certain actions result in IP infringement. For instance, AI can be used to remove watermarks used to protect digital content. AI can also be used in risk analysis aimed at optimising infringement, because infringers can monitor enforcement efforts and figure out how to counter them for illegal purposes. Another problematic use of AI would be in 'smart imitations', which means calculating the grey areas where an applicant can produce an infringing design or use a business identifier while avoiding liability. Lastly, if enforcement is increasingly run by AI, infringers can calculate the response to their activities by themselves applying AI. IP infringers will potentially be able to defeat automated content recognition (ACR) systems, for example, with slight alterations of content calculated by competing AI or by a generative adversarial network (GAN).

00143 Bypassing automated functions
Some experts noted that the more automation is developed in IP, the more prone it will be to attack through adversarial machine learning, since infringers might be able to determine the means to bypass automatic checks with the help of powerful AI tools. The greatest challenge for these technologies lies in balancing the veracity of the recognised content, the data resources to enforce these systems, and the strength to account for variations in content.

00144 Flooding the IP system with original works or designs
Some experts stated that AI could be used to generate large numbers of designs and original literary, musical or artistic works. Such designs and works could flood IP systems, making it difficult to ascertain what should be protected and what is a future infringement.

00145 AI – a bigger opportunity than threat
It was the view of a number of experts that AI will provide more new means of protecting and enforcing IP than it will create opportunities for infringers. AI can be applied for a good cause, and it will more use in the protection of IP than in carrying out criminal attacks. Moreover, AI can be efficient in improving IP protection, so the investment is worthwhile. However, threatening IP may still – in many cases – be easier manually or wilfully (with a clear and direct intent) rather than through the development of sophisticated AI tools that require significant time, resources and investment. However, this may change as AI becomes cheaper and easier to use.

00146 Deep fakes

Deep learning is a kind of machine learning where a computer analyses datasets to look for patterns with the help of neural networks. Deepfake technology uses the power of deep learning technology to generate audio and audiovisual content. Experts estimate that as much as 90 % of online content may be synthetically generated by 2026. There are special marketplaces on which users or potential buyers can post requests for deepfake videos. Their impact on privacy and personal security will doubtless result in new categories of crime that will have to be policed. Moreover, since photographs and videos are important as evidence, there is a challenge when these materials can be generated artificially.

00147 Main findings concerning infringement of copyright and design in the Deep Dive Report

AI can perform a number of different functions, ranging from sensing, reasoning and acting to assessing and even predicting. AI can identify and prioritise risks, instantly spot malware on a network, guide incident responses, and detect intrusions before they occur. Some of the most common uses of machine learning in the enforcement of copyright and design include: analysing large amounts of information to detect threats; identifying social engineering bots; scanning images to detect false pages or illicit content; improving ACR tools; and providing insights to find infringement patterns. Natural language processing can analyse and block cyberattacks like phishing, identify the behaviour of fraudsters, and create correlation analysis to promptly identify copyright and design infringements. Computer speech and computer vision can also be employed in this field. Some of their uses include pattern recognition to predict future infringements, detecting the marketing of infringing goods, and detecting and analysing fraudulent logos or other images. Expert systems can be used by law enforcement to decide which strategy is more adequate to protect a system from specific vulnerabilities, including those linked to copyright and design infringement. Customs and law enforcement authorities should continuously monitor the new technology landscape to ensure their preparedness to use new tools that may help to identify, limit and investigate IP violations. Explainable AI, although it does not solve all possible issues, could be used by law enforcement authorities to increase the use of innovative tools – including AI – for analysis and prediction, while at the same time helping to achieve the prerequisites of fairness, accountability and transparency. The use of AI in law enforcement and the judiciary should in any case always be subject to strong safeguards and human oversight, through built-in human control.

8.1.6 *Investigative and enforcement opportunities*

00148 AI – an opportunity for IP enforcement

Some experts stated that there are investigative and enforcement-related opportunities in AI. In fact, investigation and implementation of this technology is a continuous process. For some companies, the technology is already being applied in IP enforcement. Either way, the algorithms and applications will undoubtedly improve over time (e.g. by adding keywords and images for AI and machine learning). Nevertheless, these technologies must be refined in order to reach major milestones in the field under discussion.

00149 Detecting potential infringements

AI-based tools are used to identify similar trade marks, designs and patents. These AI tools can also be applied to check an existing copyright. This application of the technology allows rapid corroboration of whether a new IP rights claim conflicts with an existing right. GANs could be used to find paths and calculate distances between two designs to establish the ‘closeness’ of an infringing design to an earlier one. Another possibility is the detection of audiovisual piracy. The AI tool monitors devices’ ID numbers and detects anomalies (e.g. a device switching on and off regularly) in the TV data stream that are characteristic of piracy networks.

00150 Applying machine learning in e-commerce

Some experts discussed the practical application of machine learning. Online marketplaces have already adopted machine learning to fight counterfeiting. They extract features from the text description of the product and intervene with ACR implementations. If this technology becomes too effective in the marketplace, IP infringement moves somewhere else: for example, social media. Breakthroughs in e-commerce are therefore an iterative process.

00151 Customs risk analysis

Some experts mentioned that AI can be applied in customs risk analysis. AI's efficiency is remarkable, since it is able to process or verify unusually large amounts of data in a relatively short period. An AI agent is therefore capable of analysing and tracing similarities – such as specific characteristics within millions of individual shipments – to identify or even predict the occurrence of IP infringement.

00152 Detecting cybersquatting

Some experts mentioned that AI can find patterns in the creation or details of suspicious domain names and support initiatives to stop the activities of these domains if these suspicions are verified.

00153 AI combined with blockchain technology

Some experts held that different types of risk analysis could benefit from a combination of AI and blockchain technology. As DLTs become established, an increasing amount of information is stored in them. At the same time, the immutability feature of blockchains make them ideal for investigations. However, since blockchains are repositories of large volumes of data, it is likely to require AI and machine learning algorithms to assist in the data-mining tasks: for example, in risk analysis and the detection of suspicious trends or patterns. On the other hand, blockchains could be used to address the transparency and explanatory challenges that AI faces. In other words, dedicated DLTs can be used to capture an AI's decisions and state transitions when arriving at a particular decision. Several experts concluded that AI could establish patterns and generate reports describing this process.

00154 AI as a mirror of human knowledge

Some experts emphasised that AI technology is like a mirror of human knowledge and capability. While AI is neutral by definition, it is still trained by humans, and humans can be biased. Some experts expressed this as 'machines learn from data based on human behaviour, so bias should be removed from the data before it is given to machines for training'. Therefore, AI is often limited by the knowledge and vision of those in control of its application. Humans cannot completely rely on machines, although they can enhance speed and effectiveness. Nonetheless, it is all subject to risk tolerance. What levels of risk in AI applications are acceptable? Some experts gave the example of ACR malfunctions. These generally occur because a human did not programme the AI properly. AI can make mistakes that humans have not considered. One of the main challenges for IP is developing a technology that is not biased.

8.2 Spatial Computing

I do think that a significant portion of the population of developed countries, and eventually all countries, will have AR experiences every day, almost like eating three meals a day. It will become that much a part of you.

Leswing, Kif, 'Apple CEO Tim Cook thinks augmented reality will be as important as eating three meals a day', Business Insider, 3 October 2016, https://www.businessinsider.com/apple-ceo-tim-cook-explains-augmented-reality-2016-10?IR=T, accessed 6 May 2020.

8.2.1 The technology in a nutshell

00155 Spatial computing

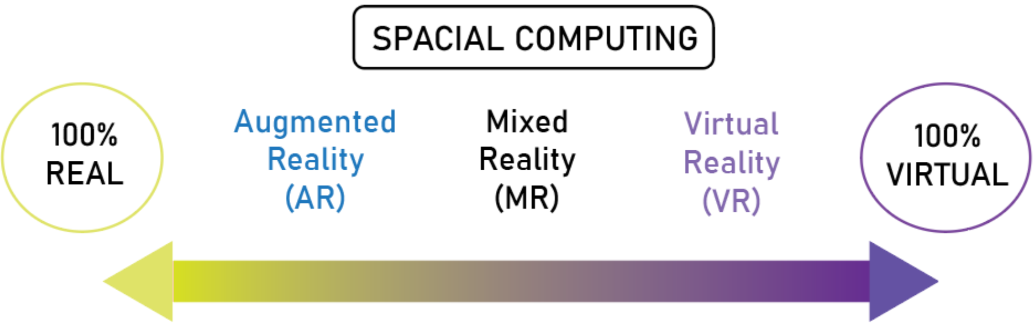
Spatial computing is an umbrella concept synonymous with 'extended reality'. It encompasses various technologies allowing immersive and engaging experiences, bringing the real and the digital worlds together: augmented, mixed and virtual reality.

- Augmented reality (AR): the merging of 3D graphics with the real world and spatial registration in the real environment. It always takes place in physical space (e.g. Pokemon GO).
- Mixed reality (MR): a fully synthetic or fully virtual view, being a completely constructed reality (e.g. virtual museums).
- Virtual reality (VR): realities that are mixed, in a state of transition.

00156 Extremes of spatial computing

Spatial computing has two extremes: a fully real environment (i.e. the real world) and a fully virtual environment (i.e. VR). Everything in between is described as MR. Types of MR include AR, which is mostly a real environment augmented with some virtual parts, and 'Augmented virtuality' (AV), which may be completely immersive or partially immersive, or may involve some elements of reality.

Figure XXXIII. Spatial computing



00157 Spatial computing is soon a part of ordinary life for everyone

Several experts held that the incorporation of spatial computing into the daily life of most human beings is only a matter of time. In this context, it is important to differentiate between VR and AR: the former implies a fully immersive experience in the virtual environment, while the latter combines real and virtual objects in a physical space, creating a mixed reality. On the basis of this differentiation, AR can have a wide range of beneficial applications in education, communication, investigation, prosecution, sports, healthcare, marketing and entertainment, among others. However, just like any other technology, AR can also be used with criminal intent, which raises new challenges for judges, authorities and policymakers.

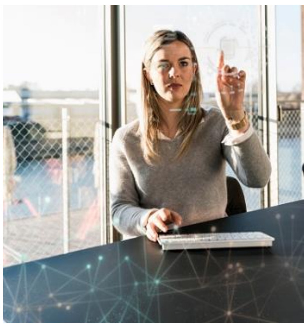
00158 Simulation of reality

The following aspects of reality can be simulated in a virtual environment or translated from the physical to the digital to align both environments: audio, motion, haptics, taste/flavour and smell. One should also consider the following potential dimensions of AR, MR and VR: the number of environments and of users, the level of immersion and of virtuality, and the degree of interaction.

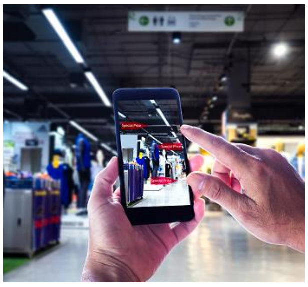
00159 Devices necessary for spatial computing

One of the main characteristics of spatial computing nowadays is that it requires a device for it to be perceived: for example, mobile phones, projectors, or wearable items such as VR glasses and headphones. In the future, the devices may be reduced to contact lenses or even to neural links that allow direct brain interactions, accompanied by sensors that enhance other the senses.

Combines real and virtual
objects in a real environment
(graphics and audio)



Runs interactively
and in real time
(explicit v implicit interaction)



Registers (aligns) real
and virtual
(in 3D space)

00160 Metaverse

The Impact of Technology Expert Group has not yet had the chance to analyse the impact of the metaverse but it will be the next development that will be analysed and in 2023 work on a deep dive report on the metaverse and related subjects will begin.

8.2.2 Information resources

00161 Suggested reading

The experts suggested the following general sources of more information:

- Greenfield, A., *Radical Technologies: The Design of Everyday Life*, Verso Books, 2017;
- Barfield, W., and Blitz, M.J., *Research Handbook on the Law of Virtual and Augmented Reality*, Elgar, 2018;
- Speicher M, Hall B. D., Nebeling M., *What is Mixed Reality?*, 2019.

8.2.3 Impact on society, the economy, world trade and the environment

00162 Different strategies in applying spatial computing

Some experts mentioned that certain sectors already apply spatial computing as a proactive measure: for instance, to have a competitive advantage or to completely revolutionise an industry. Others use reactively, such as in criminal investigations. Nevertheless, the content of this technology is currently not very varied, due to the huge effort required for its creation and to the small number of companies producing it. However, spatial computing is here to stay and will evolve as value shifts from physical products to virtual items. This could trigger a shift in all levels of the economy, powered by the emergence and implementation of 5G technology. Some experts suggested that currently there is not enough bandwidth to enable the smooth functioning of spatial computing, but 5G could be the trigger that speeds up AR development and enables higher-quality and better rendered spatial computing.

Figure XXXIV. The history of spatial computing

1970'	First head-mounted augmented reality display is created
	An artificial reality lab is established
1990'	Augmented reality is first used for entertainment
2000'	The term 'spatial computing' is coined
	Augmented reality is first used for navigation
	First spatial computing game is launched
	Spatial computing apps for smartphones are introduced
2010'	A pair of augmented reality glasses that users can wear for immersive experiences is created
	Pokémon Go is launched
	Spatial computing applications are introduced for use in the retail sector
2020'	First time wearable augmented reality contact lens

00163 Spatial computing – the technology that can tie the other emerging technologies together

In the current environment, and with the fast evolution of technology, spatial computing will, according to some experts, change the way humans think, behave and live. Some experts suggested that spatial computing is not yet mature, but that it could be the technology that ties all the other emerging and disruptive technologies together. Robotics, 3D printing, nanotech, AI, blockchain technology, etc. could work together with AR to create completely new ways for humans to live.

00164 Changes in human interaction

It was the view of some experts that spatial computing will change our way of interacting with others, and not only in the field of entertainment. The metaverse is a clear example of this and the topic of the metaverse will be addressed by the expert group in 2023. Nevertheless, some experts noted that this poses considerable threats to users, who may be overly absorbed in the artificiality. Furthermore, this could lead to the confusion of virtual and real elements and even result in physical harm.

00165 Gaming

Gaming was one of the first industries to embrace spatial computing: the technology's increasing accuracy eventually has the capacity to immerse the player in an almost perfectly rendered environment. This has been the starting point for the metaverse and its various potential applications, such as live interviews, virtual clubbing, or live virtual conferences. Gaming has a broad and growing audience, with some games even inducing an addiction in players. Some experts introduced the term 'neurocognitive capitalism', meaning the creation of a psychological dependency on artificial worlds through patterns that cause the secretion of dopamine, often with the help of AI

00166 Cyber-addiction

Some experts suggested that this would be especially relevant in environments where ownership can be monetised. Some experts mentioned that, in the coming era of AR and with the improvement of its realistic rendering, addiction levels may increase, with a subsequent impact on money flows. Additionally, cases of theft of digital items that hold a strong emotional (and economic) value to the players have already been registered, some of them ending up in court. Some experts disagreed on the issue of the possible addictive effect on players and stated that it is not possible to control players with games. Instead, players take games and do unexpected things with them. The game belongs to the player, not the other way around. In addition, some users of spatial computing solutions have already experienced injuries while playing on the street by bumping into objects or tripping over obstacles.

00167 Virtual events

Holograms are already used in concerts as background decoration or to digitally represent musicians. The next step may be that consumers can attend concerts from home, a trend that could expand into other entertainment and cultural industries. Many people might prefer to attend events from home if the quality and intensity of the overall experience is the same as attending in person. This could, according to some experts, lead to the disruption of whole industries, which would impact both the economy (transportation, travel and catering, etc.) and the environment.

00168 Virtual shopping

Person Interacting with Augmented Reality

As some experts pointed out, virtual marketplaces and shops are already a reality. Spatial computing can be used as a powerful tool to facilitate legitimate sales (e.g. mirrors in physical shops that allow clients to visualise how each item of clothing would fit without needing to put the garment on). According to some experts, virtual marketplaces and shops are a rising force, to the point that some brands have opened stores in some of the most popular virtual worlds. This was in response to consumer demand and to fight the IP infringers who were fulfilling the market needs. The use of spatial computing in virtual marketplaces and shops points towards a reduction in apparel samples and inventory, avoiding unnecessary waste. It could also lead to higher-quality clothing and apparel designs. A number of fashion designers are even starting to prepare entirely virtual collections with corresponding virtual fashion shows. Moreover, the sale of 'skins' (i.e. virtual garments) and accessories for avatars is on the rise.

00169 Use of avatars

Spatial computing may allow the user to create avatars (virtual representations of a person) to embody themselves in a social or work environment. This could result in abandoning the need for a physical presence at social or work events. Some individuals (though not all) may feel isolated as a result. Some experts commented that this shift in lifestyle towards seclusion could affect employment, causing the disappearance of some jobs, but also an increased need for specific roles, such as programmers and IT experts.

00170 Threat of mass surveillance

Some experts felt that one of the more evident threats of spatial computing is permanent mass surveillance. In a situation where practically every person possesses a mobile phone and, in the future, also devices capable of registering and rendering the surrounding environment, the collection of data becomes more valuable than ever. This poses a number of risks in terms of the use of the information collected, which could be sold to third parties, and also in terms of the protection of personal data and privacy. Some spatial computing games that rely on geolocation systems have been used to identify new paths and improve mapping tools, which could entail legal issues if the games are used by children. Spatial computing is already used to provide information on users' daily actions (e.g. in relation to transportation and goods for sale in shops).

00171 Positive societal impact of spatial computing

Several experts felt that spatial computing will have a mainly positive impact on society, creating new opportunities for businesses, education and the health sector. Even the environment will benefit from a more customised user experience that reduces the physical impact of goods and their consequent carbon footprint. Some experts emphasised that an economy based around digital assets could evolve in the years to come, changing perspectives on ownership. A wide range of original products will be created, inducing new shopping habits and giving rise to innovative services and forms of marketing that will expand the virtual industry and resonate all over the world.

8.2.4 IP protection use cases

00172 Spatial computing to enhance IP protection

Some experts mentioned that spatial computing applications will influence the protection of patents, trade marks, designs, copyright, etc. AR can be used as an effective visualisation tool to reproduce items in 3D form, helping rights holders and rights examiners to appreciate the nuances of marks, designs and innovations and make better decisions during the registration, verification and examination processes. Some experts believed that the number of applications for holograms, 3D shapes and new forms of trade marks and designs may increase with the rise of pioneering spatial computing applications, although the recent reform of the trade mark law has not yet been accompanied by the expected registration response rate. In addition, new types of goods and services are being created, entailing the potential revision of the classification lists (i.e. Nice and Locarno) for the respective registration of trade marks and designs.

8.2.5 Threats and challenges for IP

00173 Crime between reality and virtuality

Currently there is a considerable and growing amount of global crime online, although human beings exist offline. Spatial computing could merge both worlds and provide an opportunity for criminals to create a whole new criminal system at the 'back end' of the technology. The sense of morality and respect for legal rules could, according to some experts, become more fluid. Therefore, spatial computing has great potential to shape the way we interact with the world, but this potential could also be used in unexpected, unlawful ways. Several experts were of the view that the known possible uses of the technology do not pose any major issues that currently require new legislation concerning criminal liability.

00174 Augmented IP infringements

The virtual space is growing and must be continuously explored as it opens the door to new applications that can pose threats to IP. An example of these are 'augmented' products, which enhance lower-quality physical products. Some experts suggested that the illicit improvement of a product through spatial computing could be unfair and misleading to the consumer, even if it did not always constitute a direct infringement of IP. As so much of what makes spatial computing compelling is its ability to display creative text and images in new ways, the potential for copyright issues is obvious.

00175 Low quality products appearing as high-quality products

A low-quality product in a living room can appear to be a high-quality expensive product via spatial computing. With copyrights, since the author is the only one who can transform (or improve) the work, the degree of improvement is irrelevant: if the author has not given their authorisation, it is an infringement. Therefore, the risk or threat for IP is to develop digital tools to detect this kind of infringement, which may go undetected by the human eye. In the field of patents, any improvement that needs to be made using a previously patented product or procedure must have the authorisation of the previous owner; if not, it is an infringement, regardless of the level of improvement. The increase in the production and distribution of counterfeits in this way could have serious negative environmental consequences and could also be considered examples of deceptive greenwashing.

00176 Pirated applications

Currently, spatial computing applications are quite expensive to develop, especially those made for entertainment purposes. Just like applications or games made for smartphones, AR applications may be pirated and distributed illegally for free (including on alternative spatial computing app stores), which could harm the developers and makers of these programmes. The spatial computing market is still experimental and has not yet adopted or implemented specific DRM systems or anti-piracy protections (unlike video games, for instance). This lack of anticipation could be a problem, as it is always more difficult to fight against piracy afterwards (rather than taking preventative measures before piracy spreads, which is preferable).

00177 IP infringements in virtual marketplaces

As some experts pointed out, virtual marketplaces are already a reality. While spatial computing can facilitate legitimate sales, it can also complicate the task of protecting IP: copyright-protected works, trade marks and designs can easily be manipulated in spatial computing-enhanced environments. Some experts emphasised the potential threat from temporary pop-up marketplaces employing spatial computing. These marketplaces could complicate enforcement and pose evidential challenges. The use of AR in virtual marketplaces may encourage infringement, as it is very simple to copy a product or offer it through AR for use in other marketplaces, such as those for gaming or sports. Everything can be manipulated by spatial computing – even patented products – but some experts pointed out that trade marks, designs and copyrights will be most affected by possible copies using AR. Another risk is that AR may be used to make consumers believe that they are buying something online that then turns out to be a fraud. The speed at which digital platforms or purchase profiles can be opened and closed increases this risk.

00178 Deep fakes

Some experts mentioned the rise of deepfakes and emphasised that spatial computing could be used to recreate an artist's behaviour, moves and voice. This could be misused for copyright infringement but also to discredit the artist, thereby reducing their popularity and causing economic losses. The creation of a certification stamp for legitimate content may become a necessity in these scenarios, and digital deposit systems could also prove useful.

00179 'Augmented' deceptive marketing

Another threat already existing in the digital world is the replacement of legitimate content by infringing content. For instance, cases have already been registered where the advertising in a film has been modified or changed. Moreover, when scanning a code, the device could be redirected to an infringing webpage, since a link can be easily hacked. With spatial computing, the possibilities of infringers making use of personal data increase exponentially. In the future, personalised (and possibly infringing) advertisements may be embedded into entertainment products. Due to the lack of control and checks in the virtual world, it is quite likely that IP will be violated.

8.2.6 Investigative and enforcement opportunities

00180 Visualisation tools

According to some experts, spatial computing allows an original and a suspected fake product or part of a product to be compared or even merged, facilitating the task of spotting differences and detecting unfair competition. In addition, spatial computing could serve as a pre-diagnostic tool for brands and companies before launching a product. It could also have applications for law enforcement authorities (LEAs), especially customs. Spatial computing could also be valuable in the event of a dispute. It could be used as a visualisation tool for legal assessment in a courtroom, an instrument that would allow it to specify an accurate percentage of similarity, for which the current procedure consists of comparing the design registered with the infringing product. This technology would increase the probability of establishing whether there is an infringement by providing the opportunity to enlarge objects, since the scope of protection is not related to size, but to the general view of the product. Imagine a lorry in the courtroom: with spatial computing this would be possible. Space would no longer be a barrier to presenting bulky objects as evidence during a trial: the prosecutor could show any object, regardless of its size, shape or weight, before the court. This means that spatial computing could also be used to display large sculptures and

00181 Crime scene documentation

Hand Holding Tablet Using AR Application to Check Relevant Information about the Spaces Around a Customer in Tokyo

Imagine documenting a crime scene during an investigation that could later be presented in a courtroom via spatial computing. The technology would recreate a space to leave notes, tag objects or mark areas of interest – actions that could be visible only to the selected person or audience, allowing the presentation of confidential information. Furthermore, the augmented reality representation could be sent to an investigator who cannot access the original crime scene, enabling them to study it from a distance. This system also allows virtual tours in some of the world's greatest museums and heritage sites. However, the creation of augmented and VR worlds is very costly and labour-intensive, factors that may delay the development of these technologies and that in some cases are already decisive for the quality of the outcome. In addition, it is essential to protect the content, which is also liable to piracy.

00182 Police training

Another field in which spatial computing could play a relevant role in the protection of IP would be as a training tool in police academies. The students could practice in an enhanced reality crime scene and move around it searching for clues. This is in addition to the previously mentioned applications of AR in the training of enforcement authorities. AR, which enhances the visual sense, could be complemented by haptic interfaces, allowing humans to interact with the computer by creating tactile experiences and simulating differences in touch.

00183 Customs application of spatial computing

Spatial computing could be used to support customs operations. For instance, 3D image displays of products could be available via databases used by customs; with the appropriate equipment, customs authorities could use spatial computing to evaluate goods and plan seizures. However, for this system to be effective, rights holders should be responsible for creating the images, uploading them to the databases and maintaining them – a challenge in itself. In addition, facial recognition and car registration data could be used by law enforcement authorities as an overlay to obtain instant information, always respecting data privacy regulations.

00184 E-enforcement

The idea of e-enforcement may be realised in the future to respond to infringing applications of new technologies. IP infringement, such as IPTV piracy, could be fought more easily with the establishment of an online system meaning that experts would not have to be on location to act. As real experts in these matters are rather scarce, the elimination of the need to travel would make them more accessible. This is especially relevant in the case of infringement operations whose networks, servers, streaming services, etc. are located in different geographical areas; according to some experts, these operations could be subject to more efficient notice and takedown procedures. Moreover, spatial computing can enhance the visualisation of content where there is a physical lack of facilities: for instance, by projecting images onto a large number of 'screens' when there is not enough equipment or space to contain them, allowing investigations to be better monitored or suspected links to be displayed.

9 INTERNET APPLICATIONS

9.1 Internet of Things (IoT)

'The Internet of Things is about empowering computers... so they can see, hear and smell the world for themselves'.

The term 'Internet of things' was coined by Kevin Ashton during a 1999 presentation about using RFID tags in the supply chain.

9.1.1 The technology in a nutshell

00185 Internet of Things definition

The Internet of Things describes the network of physical objects 'things' connected to the internet that are embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems, including

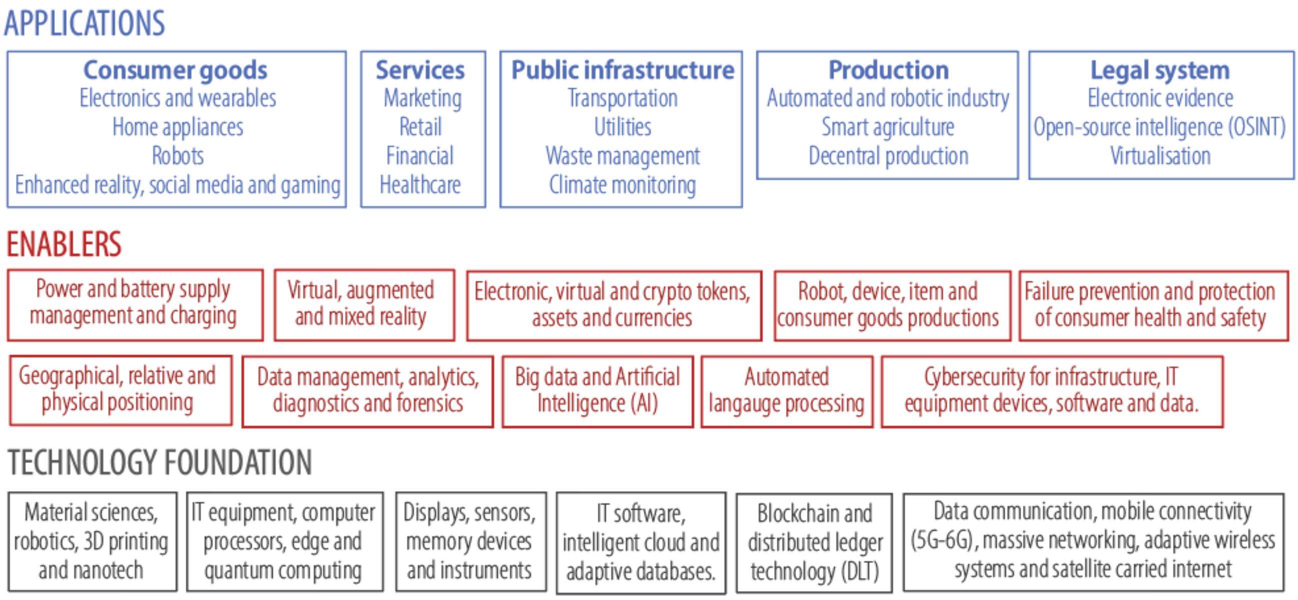
- smart consumer goods and wearables;
- home appliances and robots;
- intelligent marketing, retail and payment services;
- automated and robotic industries;
- electronic evidence and open source intelligence;
- automated healthcare, diagnosis and treatments;
- autonomous vehicle navigation;
- smart public infrastructure;
- climate monitoring and smart agriculture.

Figure XXXV. IoT applications

00186 Internet of Things' architecture

Although several experts indicated that there is no single universally agreed-upon IoT architecture, the most accepted is a three-layer architecture consisting of the perception, the network and the application layer. The first layer is where sensors and connected devices gather information about the environment; the second layer transmits and processes the data collected by the previous layer; and the third layer delivers specific applications to the user.

Figure XXXVI. Foundational technologies behind IoT applications



9.1.2 Information resources

00187 Suggested reading

The experts suggested the following general sources of more information:

- Fleisch E., *What is the Internet of Things?: An Economic Perspective*, 2010
- Rose, K., Eldridge, S., Chapin, L., *The internet of Things: an overview, Internet Society*, 2015;
- Pardes A., *The WIRED Guide to the Internet of Things*, WIRED, 2020;
- Velosa A., Kutnick D., Lheureux B., Williams R., *Hype Cycle for the Internet of Things*, Gartner, 2020;
- *Internet of Things (IoT). What is IoT?*, Sciforce, 2018;
- *Internet of Things: IoT Day Special Edition*, LexInnova;

9.1.3 Impact on society, the economy, world trade and the environment

00188 Legal and privacy issues

Some experts held that two main issues were of special legal interest:

- data management (how and where to store it, when to use it and when not);
- the security of people (how and in what circumstances authorities can use the data).

00189 Legal diversity

Some experts indicated that different jurisdictions stipulate different data restrictions and law. Therefore, a set of harmonisation principles and legal directives should be established, taking into account companies' perspectives, consumer protection, and government needs. Some experts pointed out that the lack of globally accepted general principles would lead to an increase in data and privacy issues.

00190 Security issues related to the data collected

It was pointed out during the discussion that some apps allow criminals to identify behavioural patterns and the location of their users. Moreover, data collection via sensors can be risky, since not all sensors support encryption. Some experts subscribed to the view that security issues related to the data collected by wearables, for instance, access rights, processing and storing of the data, should be looked into.

00191 Permission chain and IoT devices

Some experts raised the concern about the permission chains in relation to the use of IoT devices. It was pointed out that average users forget what they have agreed to and do not pay much attention to the permissions and their updates, partly due to data overload. Therefore, it was suggested that a better system should be put in place since users are fallible, which leads to holes in the chain.

00192 The need for standardisation

A number of experts pointed out that, usually, the technology is developed first, and the relevant standards are developed later, which causes a number of issues. As regards IoT malware and default passwords, some experts were of the view that new password and identification standards should be put in place to avoid assigning a password per device per user and hence limit the exposure of IoT devices. Moreover, it was noted that some countries are trying to work on the standardisation of IoT devices. For example, the proposal of the UK government is to issue technology companies with a logo that indicates that these organisations meet the industry requirements in protecting personal information. The question of who would establish security standards for IoT was raised, and some experts indicated that standards established by private companies cannot be trusted. Therefore, rules and guidelines should be established exclusively by standards bodies and governments. Furthermore, it was indicated that the information related to personal data should be stated in the first sections of the terms and conditions agreements.

00193 Centralisation versus decentralisation of data

Some experts emphasised that the discussion regarding the centralisation versus decentralisation of data collection is very relevant and necessary. Some experts explained that the dynamic nature of IoT and the geographic distribution of sensors could help prevent the monopolisation of data. This provides an opportunity to empower and reward the individual collectors of data and hence prevent the centralisation of the latter. It was pointed out that blockchain could be leveraged to help decentralise data collection and give credit to the people that collect the data.

00194 Undefined format for storing data

Some experts were of the view that the legislation does not define in what format the telecommunications companies have to store the data, which is counterproductive since the data is not reliable and it leads to evidential issues. Furthermore, it was indicated that the new AI regulation proposal would stipulate that law enforcement and public authorities can oblige AI providers to provide certain information about the formats of data. In this context, it was suggested that the term transparency is too broad and that the key concept is auditability of the whole transformation pipeline from the first layers of acquisition to the AI layer. Some experts explained that the issue of trust and responsibilities is closely related to the notion of transparency and traceability of the data. Data is often transformed in the pipeline and shared in many ways which makes it hard to trace and to impute responsibility.

00195 Cybersecurity concerns

The experts discussed IoT technology and indicated that currently there are some obvious cybersecurity concerns related to IoT consumer devices and home appliances. Additionally, it was raised the question as to whether AI could be used to update the security of these devices after the purchase.

00196 The use of AI to invade user's home

Some experts introduced the term 'travelling AI ghost' to refer to criminals that can programme AI to invade user's home through IoT devices and can easily move to another household if they are discovered by law enforcement authorities.

00197 IoT orphan devices
It was noted by some experts that IoT orphan devices, i.e., devices connected to the internet, placed somewhere in the house and forgotten by the users could store high volumes of personal and behavioural data and provide opportunities for collection and extraction of data.

00198 Environmental consequences
IoT devices has the potential of having a number of beneficial environmental consequences as well as have a positive impact on human health and safety:

- IoT devices can turn-on and turn-off and recharge when sustainable electricity is available;
- IoT devices can reduce accidents involving cars and other items.

Figure XXXVII. History of IoT

1980'	A vending machine is connected to the internet to check remotely for cold drinks
1990'	The first toaster controlled via the Internet is demonstrated
	The term 'Internet of Things' is used for the first time
2000'	The first smart refrigerator is announced
	Testing of self-driving cars starts
2010'	IoT products are commercialised as the speed of mobile networking increases
2020'	The number of IoT connections has passed the number of non-IoT connections

9.1.4 IP protection use cases

00199 IoT independent body
Some experts pointed out that making IoT more secure for users could be achieved by a programme similar to the password manager tool that would notify users about the number of times they reused certain email addresses and passwords in their IoT devices. It was emphasised that this type of guidance provided by an IoT independent body, which would notify users about the password-related risks and inform them about the entities that can access their data, might qualify for a new type of IP. It was also indicated that, in the future, due to the advances made in 5G and 6G technology, the use of 'IoT in motion' would increase significantly.

00200 Protection of collected data
In Europe, collections of data can be protected by *sui generis* rights that protect the investment (financial, material and/or human) in the production or collection of data. Some experts addressed the issue of the protection of functional and simulated data. In the virtual or augmented world, data is not only an element that is being sent but is also being created. The IoT, according to some experts, plays an important role in the transformation of the data that is being converted, manipulated and augmented in a number of ways. Furthermore, information is being constantly added to the data, which presents a problem for IP protection of such data, since in principle it falls outside of the scope of the *sui generis* database protection. The data may not be original as such, but can be created, which, according to some experts leads to gaps in the current protection system.

00201 Ownership of face recognition images provided by IoT devices

The question of the ownership of face recognition from images provided by IoT cameras used to train AI machines was raised during the discussion. Some experts pointed out that *sui generis* database protection could be applicable to face recognition images under very particular constraints. However, in the case of patent protection, this is not currently applicable.

00202 Counterproductive effect of overprotecting

The importance of ensuring an orderly progression between an open source playing field, standardisation, and IP protection was identified by some experts, and it was pointed out that overprotecting would have a counterproductive effect, therefore, the aim should be protecting only objects that meet a specific technical purpose. The system should be designed as a pyramid with open source at the bottom followed by standardisation and certain monopolies and exclusive rights at the top, for instance, patent protection.

9.1.5 Threats and challenges for IP

00203 Malware-infected IoT devices

IoT devices allow for the proliferation of attack vectors. Insecure IoT devices may become an easier target for criminals aiming to distribute attacks, infiltrate or infect networks. There is also a growing number of cases involving malware infected IoT devices, which exploit software vulnerabilities or weak authentication settings. The vulnerability of IoT devices may be exploited by criminals seeking to collect personal data, compromise user credentials or even spy on people or organisations.

00204 Exposure of IoT devices

The diversity of types of endpoints in IoT increases the exposure of IoT devices to attacks. Therefore, creating an operating system for the ‘things’, which will most likely come from the private sector, would be an opportunity to reduce the risk and enhance the security of IoT devices.

00205 Potential monopolisation related to IoT devices

Some experts raised the issue of monopolisation in the field of IoT where it could happen that one or a few players hold most of the data and are the only ones who can develop new products in a certain area. This situation was compared by the experts to the advent of the internet and the use of search engines where it was thought that it would lead to creativity in this area, but today in Europe only one or very few search engines monopolise the market.

9.1.6 Investigative and enforcement opportunities

00206 Investigations and quality of evidence related to IoT devices

Some experts mentioned that internet of things (IoT) devices will collect large amounts of data that will be very valuable for future criminal investigations. These experts also emphasised that due to the vastly increasing number of devices being connected to the internet, these devices will generate and collect ever growing amounts of data, including data that can serve as contextual evidence related to all sorts of IP crimes. However, obtaining and validating the evidential value of data generated or collected by IoT devices is complex. One challenge is the unbroken chain of custody that is vital in guaranteeing evidence integrity and continuity in the court system. Many of the experts stressed that it is necessary to document where, when and who accessed the electronic evidence at each stage of an investigation. It was mentioned that it is vital that law enforcement, the judiciary, the private sector and academia collaborate in sharing experiences, building methodologies and creating tools to ensure high quality evidential results. The expert group has decided to explore this topic more in upcoming workshops together with the topic of big data.

9.2 Blockchain and Distributed Ledger Technology (DLT)

What is needed is an electronic payment system based on cryptographic proof instead of trust, allowing any two willing parties to transact directly with each other without the need for a trusted third party.

Transactions that are computationally impractical to reverse would protect sellers from fraud, and routine escrow mechanisms could easily be implemented to protect buyers.

Nakamoto, Satoshi, Bitcoin white paper: A Peer-to-Peer Electronic Cash System, 31 October 2008, https://bitcoin.org/bitcoin.pdf, last accessed 6 May 2020.

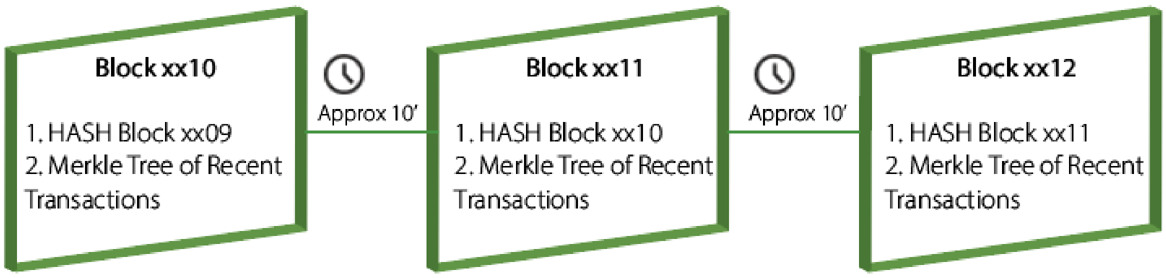
9.2.1 *The technology in a nutshell*

00207 Blockchain definition

Some experts proposed the adoption of the commonly accepted definition of a blockchain as a method for the decentralised recording of data in an immutable encrypted ledger maintained in a peer-to-peer (P2P) network. Transactions in a blockchain network can be conducted without the authentication of a central authority, while still being trustworthy. A blockchain is considered to be a type of Distributed Ledger Technology (DLT). Strictly speaking, DLTs do not need to be cryptographic in nature, although the most popular instantiations of DLTs are delivered as blockchain technologies due to the particular characteristics the latter offer, as presented below. Variations include:

- cryptocurrencies and assets;
- smart contracts;
- autonomous organisations;
- databases;
- NFTs (non-fungible tokens).

Figure XXXVIII. Functioning of the Bitcoin Blockchain



00208 Blockchain key characteristics

According to some experts, blockchain technology has the following key characteristics:

- Decentralisation. In conventional centralised transaction systems, each transaction needs to be validated through the central trusted entity. In contrast, a transaction in the blockchain network can be conducted between any two peers (P2P) without authentication by a central entity.
- Immutability. Since transactions are stored in different nodes in the distributed network and validated through distributed consensus, it is almost impossible to tamper with the blockchain. Each broadcasted block and its transaction are validated by all the nodes before being recorded. Any falsification can be easily detected. However, this presents a challenge when repairing an error or changing the data.
- Efficiency. It takes time to propagate transactions and blocks on a global public blockchain network. As a result, transaction throughput is limited, and latency can be high. With fewer validators, consortium and private blockchains can be more efficient.
- Anonymity. Each user can interact with the blockchain network with a generated address. Users can have many addresses to avoid identity exposure. No central party keeps a user's private information. This mechanism preserves a certain amount of privacy on the transactions included in the blockchain. Note that blockchains cannot guarantee perfect privacy preservation.
- Auditability. Since each of the transactions on the blockchain is validated and recorded with a timestamp, users can verify and trace the previous records by accessing any node in the distributed network. In bitcoin blockchain, each transaction could be traced to previous transactions iteratively. It improves the traceability and the transparency of the data stored in the blockchain.

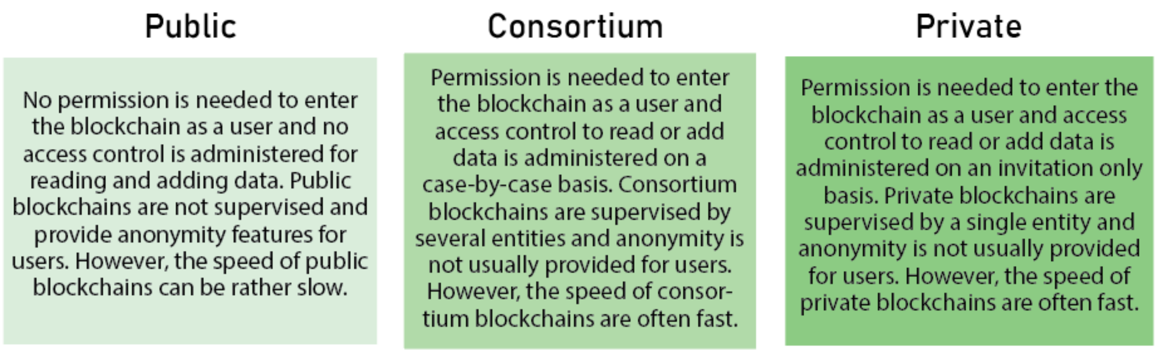
Figure XXXIX. Distributed v decentralised ledgers

- Distributed: running on multiple nodes owned by a single entity where there is one single trust boundary assuring data validation and access control for potential users.
- Decentralised: running on multiple nodes (owned by different entities) where each entity establishes its own trust boundary in relation to the data validation access control for any potential user.

00209 Different types of blockchain

Current blockchain systems can be roughly categorised into three types: public blockchain, private blockchain and consortium blockchain. This has an impact on how consensus is determined, who can read and/or write the blockchains, whether there are permissions required, the transaction speed and who maintains the ownership. A good comparison of these types is shown below.

Figure XL. Differences between blockchain types



00210 Blockchain and the environment

Despite its many advantages, it is not certain that blockchain can be a tool for the environment because some blockchains have very high energy consumption. Some experts believe that blockchains can be very useful when it comes to having precise information to act on, for example to decarbonise the economy. One of the uses of blockchain would be to collect data on the different stages of manufacturing a product to calculate greenhouse gas emissions or to control the origin and management of materials and processes. Given the benefits it offers, this new technology could be given a vote of confidence through IT solutions based on secure and quality technologies that allow the efficient use of financial resources, space, and energy, while ensuring the sustainable and sustained growth of operations and minimising their impact on the ecosystem. In any case, the threat of greenwashing should be considered.

9.2.2 *Information resources*

00211 Suggested reading

The experts suggested the following general sources of more information:

+ Swan, M., *Blockchain: Blueprint for a New Economy*, O'Reilly, 2015;
+ Tapscott, D., and Tapscott, A., *Blockchain Revolution*, Penguin USA, 2016;
+ Primavera de Filippi, P. and Wright, A., *Blockchain and the Law*, Harvard University Press, 2018;

9.2.3 *Impact on society, the economy, world trade and the environment*

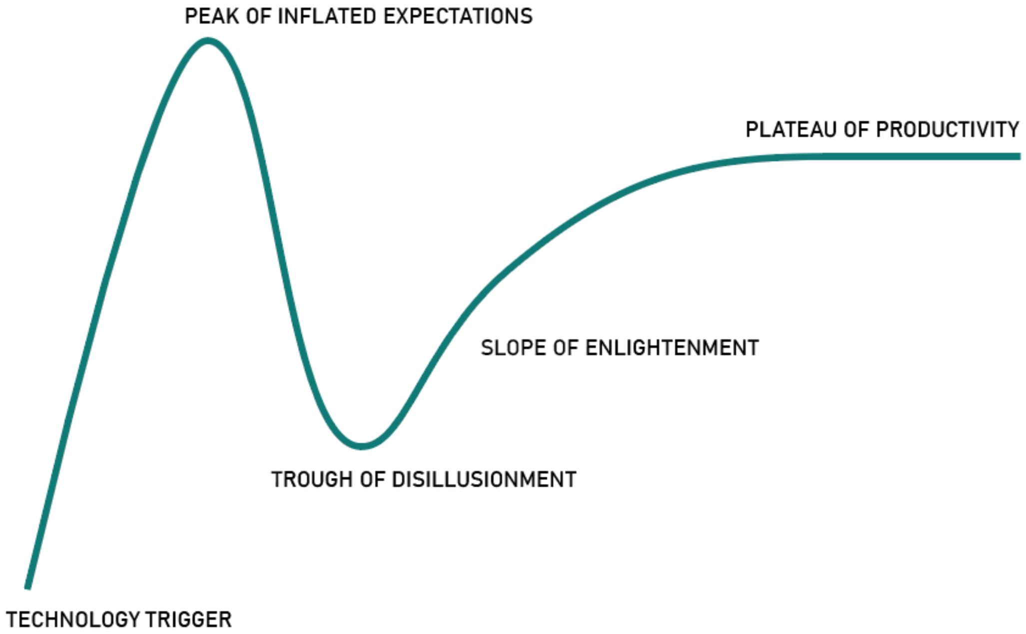
00212 Phases of the technology

One of the experts has drawn attention to the tendency that technologies, to reach full implementation, often follow the 'Gartner hype cycle'. This has four phases:

1. the triggering of innovation;
2. peak of expectations;
3. depression of disillusionment;
4. the slope of enlightenment.

It was noted by some of the experts that cryptocurrencies in recent years have shifted from 'depression of disillusionment' to 'slope of enlightenment', consensus mechanisms and smart contracts have moved into 'depression of disillusionment' and non-fungible tokens (NFTs) appeared in the 'peak of expectations' phase, having skipped the 'innovation trigger' phase. Two blockchain trends expected for next year, according to FinTech, can be highlighted, namely the integration of blockchain into government agencies and the implementation of NFTs and digital archives in the blockchain network. Other trends are Blockchain-as-a-Service (BaaS); authorised/corporate blockchains; state cryptocurrencies; decentralised applications.

Figure XLI. Gartner hype cycle



00213 Cryptocurrencies and other applications

Several experts have pointed out that one of the main impacts of blockchain on the global economy is on payment systems, where blockchain based cryptocurrencies can function without being controlled by the central banks. This system is used, for instance, to send money to emerging countries where the population has no access to credit cards or bank accounts, or where their first currency is very unstable. In that case, instead of sending and receiving money via traditional payment options, cryptocurrencies are used, creating a parallel payment system. However, blockchain technology can have several other applications in fields such as social media, administration of assets, health care, insurance and law enforcement.

Figure XLII. The history of blockchain

1980' A vending machine is connected to the internet to check remotely for cold drinks

1990' The first toaster controlled via the Internet is demonstrated
The term 'Internet of Things' is used for the first time

2000' The first smart refrigerator is announced
Testing of self-driving cars starts

2010' IoT products are commercialised as the speed of mobile networking increases

2020' The number of IoT connections has passed the number of non-IoT connections

00214 Challenges and concerns

Blockchain technology can potentially make transactions and the recording of data cheaper and more dependable as the information entered in the blockchain is traceable, transactions are passed directly without the need for intermediaries, and the system provides reliable evidence of data logged. However, the technology also involves risk as regards the quality of entered data due to the removal of a central trusted authority. Of course, as mentioned by some experts, there are a series of concerns and challenges when using the technology, those identified by some experts were as follows.

- The need to verify the authenticity of the data entered in terms of legitimacy and ownership. What are the rules for ensuring that information is 100 % legitimate and accurate, and how can the participant introducing the information prove authorship and legal ownership? Considering that data cannot be deleted once entered and that the system is not governed by an authority, it remains unalterable.
- The pseudo-anonymity of the blockchain and the removal of intermediaries enables illegitimate businesses to use it for criminal purposes and money laundering, although its traceability opens up opportunities for these crimes to be unravelled.
- New types of intermediaries have emerged, namely the crypto exchanges that are susceptible to the risk of penetration or fraud with risk of loss to the owner of the deposit.
- Another issue is the verification of the legality of physical products linked to tokenised representations in the blockchain and how incorrectly registered product information will be rectified, since there is no way to delete existing data and other nodes must be notified.
- The major concern would be the limitation in terms of capacity and scalability. As more information and data is added by increasing numbers of participants, more storage space and processing power is needed. However, this challenge is already being addressed and it was the expert's view that it will soon be resolved.
- An important threat to consider is quantum computing with its potential to break encryption. Based on this input, it has been decided to dedicate a workshop to quantum computing.
- Blockchain technology is developing into multiple formats and generations. From ripple to Ethereum, from tree ledger to singular line – the technology is evolving too fast to adapt into a multiple scale ecosystem. The technology is only relevant if used in its own context and environment and is currently not suited to interacting between technologies and to interconnected domains. Hence, some solutions need to be proposed to overcome this problem.
- It has also been shown that blockchain is still prone to privacy leakage even when using public and private keys. Users' IP addresses have been tracked.
- Current consensus algorithms such as proof of work (PoW) or proof of stake (PoS) are facing some serious problems. For example, PoW uses excessive electricity while the phenomenon that the rich get richer could be a weakness of PoS consensus. These concerns need to be addressed in the blockchain technology challenges and opportunities.
- Also, as regard blockchains involving a validation of the blocks by a majority of peers, there is a significant risk of 'blocking' if one actor (a State, for instance) manages to control a majority of peers. By doing so, this majority actor becomes able to refuse the validation of the incoming transactions, which will block the whole system.

00215 Europe vs USA and China

Europe is doing well on the academic side of AI and blockchain, but European small and medium-sized enterprises (SMEs) are lagging behind the US or China. An important part of the development in Europe has taken place in educational institutions, especially universities, and the commercialisation of innovations is not their main objective, which could influence, among other factors, the number of patent registrations. The main reason lies in the difference in the economic and sociological aspects of the two cultures. According to one expert, it is due to the cultural aspect of the issue and especially that Europe was often referred to as 'the old continent' and sometimes the mentality of the people was also 'old'. However, the European 'more open approach' could be beneficial to these types of technologies as many of them are not necessarily managed in a very transparent way and the problem is that all this capability was, in a sense, blocking the prospects for better judgment on how these technologies are working. What is already available was quite useful and powerful, so it is necessary to allow people to make a better judgment about what these tools are doing.

00216 Negative environmental impact of blockchain
As pointed out by several experts, the first generations blockchains (e.g. Bitcoin) was based on the Proof-of-Work consensus mechanism that over time has been shown to have a high energy consumption. Increasingly this is being overcome by the application of other consensus mechanisms such as Proof-of-Stake. Another environmental challenge with blockchain technology is the ever-growing size of each blockchain. Large and increasing datasets will necessarily require resources to store and maintain them.

00217 Positive environmental impact of blockchain
As pointed out by some experts, blockchain technology can also have a number of positive environmental consequences. One example is the use of blockchain to trace the full supply chain of a product and make information available about production, raw materials and ecological sustainability of the production. Such applications will empower consumers to be more enlightened when making purchasing decisions. Some experts have mentioned that attempts at greenwashing should be taken into consideration.

9.2.4 IP protection use cases

00218 Protection and registration of IP


Some experts suggested that almost all types of IP can be managed through blockchain, such as the exploitation of TV rights, the registration and distribution of copyrighted contents, or 3D objects. In some countries, smart trade marks are already being explored to stamp websites by means of digital signatures created and stored in the blockchain to help prove authenticity. Blockchain technology is a legitimate candidate mechanism for protecting and registering property rights, including IP (e.g. trade marks) or documenting unregistered rights (e.g. copyright). A number of commercial solutions to protect and administer IP using blockchain already exist. Important applications of blockchain for protection of IP are: registration, use management, evidence of use, confirming priorities and making IP registrations available.

00219 Overview of technological trends related to blockchain and patent protection
Patent activity and patent data are some of the best and earliest indicators of technological activity. In terms of the worldwide patent landscape, the number of patent families has increased from 5 000 to 42 000 in recent years. So far, around 28 % of these families have granted patents. While the number may not seem high at first glance, it usually took 2 to 4 years to get a patent granted; therefore, the number of patents granted was expected to increase significantly in the next few years (probably over the next 2 years). Furthermore, the curve showing patent activity in 2020 and 2021 was expected to continue to grow exponentially. As for the recent activity in the area of patents, it normally takes 18 months for the publication of a patent application, so the overall activity for 2020 and 2021 is not yet available. Blockchain-related deposits have grown much faster than, for example, AI-related deposits. A significant number of patent applications for different patent families were filed by Chinese companies (i.e. around 15 of the top 30 filers were China-based companies). Part of that numerical dominance could be due to the financial incentives the Chinese government has offered parties for submitting blockchain-related applications. It was explained that the group of top filers was very diverse; it was made up of large financial institutions, technology companies like IBM and Microsoft, resellers like Alibaba and Amazon, new fintech start-ups and space companies. The most patented aspects of blockchain technology have been cryptocurrency; smart contracts / decentralised applications; consent mechanisms; payment processing; and identity.

00220 Trade mark and design registration system
Some experts pointed out that it is a direct consequence of the IP protection capabilities of blockchain technologies that they can be used for distributed trade mark and design registration systems. Blockchain-based registration systems for trade marks and designs will make it possible to connect various IP offices

in a network so that each office has copies and updates of all registrations. Through a secure network, the key characteristics of blockchain technology can provide high-quality, uncorruptible, instantaneous and easily accessible rights. Everyone can be given access to the registrations with authorities retaining the role of verification. The EUIPO is fully engaged in such applications through the IP Register on Blockchain initiative.

00221 The wider IP eco-system

Blockchain capabilities, especially cryptographic proof and time stamping, offer a wide range of application possibilities in the IP ecosystem, particularly in the area of copyright, patents and trade secrets. Blockchain technology has the potential to become a kind of universal IP database, although there are still many obstacles to the internationalization of TM rights.

00222 Management of music and performing arts

Examples were given of how blockchain is used in the music and performing arts industries. Smart contracts have been created using digital signatures of involved parties. One example is how musicians can licence music rights to consumers with transparent and immutable terms tailored to each contract's needs. Payments can be automatically triggered according to those terms. Currently, there are different initiatives using blockchain technology to facilitate the direct management of musical works by the rights holders. These initiatives seek to encode the economics of creative works administration into smart contracts to facilitate real-time royalty distribution and transparent reporting and accountability.

9.2.5 Threats and challenges for IP

00223 Territoriality and applicable law

The main legal challenges are related to the fact that blockchain is a decentralised network that raises questions about territoriality and applicable law. Furthermore, the lack of an operator responsible for managing the network also raised an issue of responsibility. Another problem concerns the pseudonym, that is, even if actors engaged in particular activities were identified, it was very difficult to connect them with a real-world identity. These features have given rise to new illicit activities, such as decentralised markets that sell illicit goods, among others.

00224 The state of code and the rule of law

Another element to consider is the discrepancy that emerges between the state of code and the rule of law due to the fact that blockchain has established its own technical framework that is not aligned with the existing legal framework. On the other hand, it was pointed out that some jurisdictions, for example the Supreme People's Court of the People's Republic of China ruled that information on the blockchain could qualify as evidence in court. It was highlighted that the possibility of proving the existence and possession of a certain asset at a certain time has created interesting possibilities, not only in the context of the registration of contractual rights but also in the context of IP registration and the possibility of proving priority rights. Some initiatives in this area have been outlined by notary services and universities.

00225 Regulatory technology

The increase in the use of blockchain as a regulatory technology at the institutional level was highlighted, particularly for automated reporting, real-time audits, identity management and the provision of an execution guarantee. Furthermore, with regard to the new trends in the IP field, the use of blockchain to verify the origin of goods and trace the various steps that a given product has gone through in the supply chain was highlighted.

00226 Copyright infringements

Due to the immutable, decentralised, accurate and transparent nature of blockchain, there is potential for copyright infringement cases via application of the technology. Especially in decentralised networks without a central point of control, copyright infringement could exist with very few realistic means of enforcement response. Moreover, the possibility of anonymisation will make an enforcement response more challenging. Some experts pointed to an existing example of a cryptocurrency-based content-sharing platform. Users can share files on the platform and set a price. Other users who want to access the content will pay in tokens, then, if they share the file, they will themselves get paid. The users can also watch advertising to obtain more tokens, or they can buy tokens. The platform is based on a sound economic idea as long as the system is controlled, although the concept can also be used in an infringing system without control because removal of illegal material will be difficult. It was noted that currently there is very little copyright infringement carried out by way of blockchain technology since it is overly difficult for criminals to use the technology for such purposes. One of the reasons for this could be the fee structure of some of the more popular blockchain solutions as well as the complexity for ordinary users of pirated content to use the technology at this time.

00227 Idea theft

Some experts considered a hypothetical example where a party steals an idea from a musician and records it on the blockchain first. This person would acquire legal rights over the work, therefore, how could the musician prove ownership? There is also the case of the minting of an original work by a person who is not the author who then sells it via an NFT and gets the credit for it.

00228 Misuse in registration of IP

If used correctly, blockchain technology is indeed a great tool to protect and register IP. There have not been obvious cases of blockchain violations yet, but there is the potential for danger due to the lack of rules and central authorities to oversee the correct use of the network, especially when the adoption of blockchain is streamlined and the technology widely adopted.

00229 Threat from decentralised marketplaces

In terms of buying and selling illicit products, decentralised blockchain-based marketplaces could be highly effective. It would be very difficult – especially for individual rights holders – to identify and remove illegal product postings in the marketplace.

00230 Decentralised domain name system

Some experts presented different blockchain-based domain name systems that are fully decentralised, in contrast to the centralised traditional domain name system, the so-called blockchain DNS (BDNS). Such blockchains may not offer any means of preventing cybersquatting and may not provide dispute resolution mechanisms in the event of trade mark infringing domain name registrations.

00231 Blockchain and digital twins

A number of experts indicated that blockchain technology could be used for guaranteeing the integrity of disclosed data by hashing the data set when it is released and comparing it with the hashed data set from the blockchain. Furthermore, this technology could be used in the supply chain to record the steps through which a particular product goes and the actors that are involved. Blockchain does not guarantee the veracity of the information but it assures commitment to the recorded information on the part of the actor. It was remarked that digital twins could be used to tackle counterfeiting by transferring the digital twin together with the physical product and, therefore, guaranteeing the authenticity of the goods and the validity of the transaction. Since 2018, the EUIPO has been exploring blockchain as a means to ensure product authenticity and move away from siloed systems, which can be more easily targeted by criminal networks and used to their advantage due to their isolation. In 2020, the EUIPO started a strategic project to develop an Anti-Counterfeiting Blockathon Infrastructure, that would provide the means to transfer a product alongside its virtual equivalent, with the latter being stamped with an immutable digital signature from the brand owner.

00232 Tokenization

A token is a set of digital information within a blockchain that confers a right on a specific subject, tokenisation is the conversion of the rights of an asset into a digital token registered on a blockchain. Tokenisation has to overcome several legal challenges. Some countries have already implemented new regulatory frameworks to specify the conditions under which they will be regulated. Additionally, asset-backed tokens were presented. It was explained that they were indications of existing assets and by transferring the tokens, ownership of those assets was also transferred. The last category was non-fungible tokens (NFTs), which raised a number of questions about copyright and IP in general. Furthermore, they have given birth to new ways of counterfeiting, namely the minting of NFTs related to someone else's work. In these cases, it was difficult to apply traditional principles of intellectual property law, so law enforcement and stakeholders had to rely on commercial law.

00233 Decentralized finance

Another major trend related to blockchain has been decentralised finance (DeFi). It was explained that a number of systems were simply replicating the authors' model, adding their own tokens and providing a very high return on investment based on these tokens. This situation raised a question from an IP perspective as to whether, and to what extent, forking these models was potentially infringing the rights of the original platform. Furthermore, this also raised the question of whether new types of licenses should be established to account for the possibility that fork, while encouraged in open source systems, could be highly problematic in blockchain systems due to liquidity.

00234 Cybercriminality and misuse of cryptocurrencies

Another threat to take into consideration is the different types of computer hacking, fraud, identity theft and other types of cybercriminal activity. For example, if a cybercriminal registers third-party information in the blockchain, who would the legal owner be in such a case? The lack of a central governing body makes it difficult to prove real ownership and without a central entity to contact for removing or correcting the information it is difficult to attribute liability for the actions. Another example would be blackmail or extortion of company secrets or IP where a criminal would post the trade secrets on a blockchain rather than a third party hosting such as paste-in. In this sense, additional mechanisms to ensure the authenticity of the content and holder are needed.

00235 Money laundering

It was noted by some experts that cryptocurrencies are to some extent used as a means of payment in IP violations and tools, to money launder the proceeds from IP crime.

9.2.6 *Investigative and enforcement opportunities*

00236 Problems of criminal investigations

The issues encountered during a criminal investigation in the real and digital world are fundamentally similar. In investigations dealing with money, intermediaries such as banks and other financial intermediaries could be exploited to seize these assets. However, in the blockchain, this is slightly more complicated as although prosecutors locate the assets, they don't have the means to seize them. However, alternatives are available, that is, if the responsible actors were identified, law enforcement could try to find out how to recover the private key or find alternative resources that could be seized to compensate for the loss. The transnationality, combined with the pseudonym and the lack of intermediary operators, makes it difficult for traditional law enforcement authorities to seize blockchain-based assets.

00237 OSINT: cryptocurrency payments

Some cryptocurrency ledgers may be investigated, although at this point certainly not all of them. The current OSINT tools to investigate cryptocurrency payments does not facilitate investigation of all cryptocurrencies. Most of the tools focus on bitcoin forensics, although some also support other platforms and it is expected that in the future an increasing number of currencies will be covered. Based on this, it was decided to look further into this issue in the next workshop. See more below in the section on cryptocurrency and smart contract forensic investigation tools.

00238 Other OSINT

As the use of blockchain technology increases, it might make OSINT investigations easier in regard to, for example:

- land registries;
- company registries;
- IP rights registries (e.g. EUIPO´s IP Register on Blockchain).

00239 Securing supply chains

Use of blockchain technology has a potential in securing supply chains and making the identification of goods as genuine and counterfeit easier for enforcement authorities. However, considering that large corporations produce thousands, millions or even billions of articles per year, this also raises numerous obstacles that will need to be overcome. Supply chain and logistics systems use very diverse solutions so tying systems safely together through interledger communication and use of AI will have to be explored. There is also the interest of consumers who want easy-to-use smart systems. Solutions on how to create and track digital twins (tokens) of physical products are already under development so primary and secondary marketed products can be connected using a digital signature.

00240 Last mile problem

The issue here is not how to register the trade mark, but how to link it to the mass production of goods. Where there are billions of goods, the ledger is heavy, encryption must be unique and the complexity of the ledger to compile and enter all the different goods and place them into a container for shipping is extremely complicated. Trade mark enforcement and patent linking is a problem within the ledger. The blockchain is excellent for trade marks and designs, but enforcement of a single product in the mass production of goods regarding what is genuine and what is counterfeit is very poor. The capacity of the server is a problem here; depending on which new generation of blockchain is used, there is a higher cost. In addition, the physical capability of the server and the infrastructure to house the reporting system is costly.

00241 Evidential issues

How can we make sure this is a dependable, reliable tool? Some experts pointed out that although the use of hash codes is accepted in court as a tool to prove veracity, the evidence must be corroborated and never based on one piece of information. It takes investigation to rely on the information recorded in the blockchain. It has to come from a reliable source and we cannot allow people to be truly anonymous on the internet.

9.2.7 A look at non-fungible tokens (NFTs)

00242 Tokens

A token is a digital representation of goods or services written on a blockchain that can represent anything. Unlike fungible goods, which are interchangeable, non-fungible goods are unique. The specific standards of smart contracts existing in the Ethereum environment are fungible tokens: ERC-20; improved fungible token: ERC-223; non-fungible tokens: ERC-721; token for transferring funds: ERC-777; and token to transfer copyright: ERC-1190.

00243 Types of NFTs

NFTs can be divided into three groups:

- the work was uploaded in its entirety to the blockchain (this was very rare due to the price);
- the NFT was a smart contract that supposedly transferred copyright (this was also not common); and
- the NFT was just code that was loaded onto a blockchain (this was the most common type).

00244 NFT metadata

NFTs usually contain the following metadata: the blockchain address, the token ID, the job URL, and the creator's wallet address. According to statistics, the average selling price of NFTs was below USD 15 for 75% of assets and above USD 1 594 for 1% of assets. An expert noted that an NFT is a reproduction of a work of art by another creator, so it could be considered a copyright infringement as this was the element that gave value to the object.

00245 Jurisprudence concerning NFTs

According to UK jurisprudence, the instructions explaining how to do something did not consist of copyright infringement, what was generating the value was the underlying asset. However, an NFT was not the asset itself, but a link to the business. Therefore, it may be necessary to generate a new exclusive right of the author which would be an 'exclusive right to profit from someone's work'. If so, it would be an exclusive monetisation right that does not even exist. However, an NFT did not contain instructions on how to make a work, it was simply a link to the work; it would therefore be necessary to examine the jurisprudence on communication to the public.

00246 Environmental impact of NFTs

While still in a nascent state, the NTF technology poses many interesting potential positive environmental effects. NFTs allow the enjoyment of art through screens and portable devices, this contributes to sustainability since the actual work does not need any material resources to be exhibited and enjoyed. However, the digital work is stored in a data centre that needs electricity to function and maintain an adequate temperature. The higher or lower impact on the environment in this sense would depend on the sophistication of the artwork, which in most cases will be more sustainable that producing the actual work.

9.2.8 Cryptocurrency and smart contract forensic investigation tools

00247 Cryptocurrencies as means of payments

In the early 2020s, the cryptocurrency market underwent a major shift towards becoming a mainstream medium of both payment and banking. Although cryptocurrencies such as Bitcoin and Monero are prevalent in darknet marketplaces, the line between the use of cryptocurrency payments for legitimate and counterfeit goods is becoming increasingly blurred.

00248 Investigating crypto transactions

'Attribution' Attribution' in the cryptocurrency realm refers to identifying the owner of a crypto wallet's private key, as they have access to the funds in that crypto wallet. The investigation usually initially involves blockchain forensics, although the owner may then be identified through OSINT searches. These may help in linking and correlating cryptocurrency addresses with pieces of information external to the cryptocurrency ecosystem(s), such as IP addresses, emails, and so forth. The latter would then be further searched in order to identify physical locations and/or individuals. Unlike credit and debit card numbers, cryptocurrency addresses can be trivially generated, and there may therefore be a much higher number of addresses potentially linked to individuals.

00249 Cryptocurrency exchanges

Bitcoin ATM Machine

The crypto exchanges are in essence 'exit points' where cryptocurrency can be converted into traditional, fiat currency. The exchanges require identity verification, for which the user needs to submit out-of-band identification documentation (passport, bank statements, etc.).

00250 Blockchain forensics

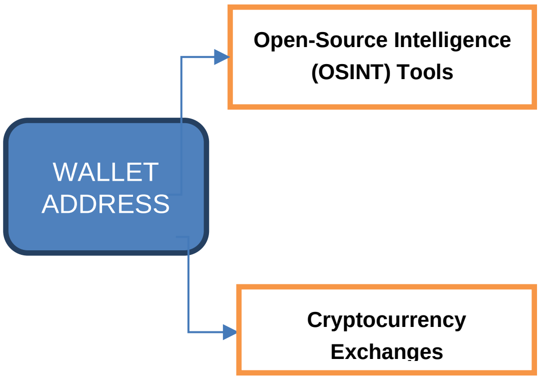
At an abstract level, a cryptocurrency transaction involves a coin identifier, the amount transferred (i.e. a fraction) and a destination wallet/address. Transactions are joined up and associated through the transferred coins, and this information is stored in a publicly accessible distributed ledger (i.e. the blockchain). To uncover the purpose of a transaction and (eventually) identify a physical person associated with one or more transactions, the blockchain must be contextualised by superimposing external information on the addresses. For example, if a coin reaches an address/wallet that is known to be involved in ransomware activity, then it can be inferred that a ransomware victim was coerced into paying to resolve a particular security incident. Exchange wallets are of particular interest, as these are used to exchange cryptocurrency with fiat currency; as such, the exchanges are expected to have performed some degree of due diligence and identification of the beneficiary.

00251 Crypto wallets

Crypto wallets are digital assets used for storing cryptocurrencies. These are anonymous by design (i.e. the name of a crypto wallet by itself does not betray the identity of its owner). However, in order for a transaction to happen (i.e. the transfer of a cryptocurrency coin in or out of the wallet), there needs to be a purpose (execution of an agreement of a service, purchase of goods, exchange with other currencies including fiat, etc.). Therefore, the purpose of the transaction primarily exists outside the cryptocurrency realm, and in many cases evidence of this can be found in online media. There a many formats for crypto wallets:

- desktop wallets;
- web wallets;
- wallet applications on mobile devices;
- pocket litter wallets;
- hardware wallets.

Figure XLIII. Wallet Address



00252 Crypto wallet seizures

When the individual in possession of the cryptocurrency has been identified, the search and seizure process need to focus on the acquisition of the private key(s), as without these it is impossible to access and seize the cryptocurrency itself.

10 CONCLUSIONS

This discussion paper is based on a unique methodology to assess the impact of new and emerging technologies on the infringement and enforcement landscape related to IP. The methodology has been developed by the Impact of Technology Expert Group of the European Observatory on Infringement of Intellectual Property Rights that was established in early 2019.

The methodology is named 'The Intellectual Property Tech Chain' and divides the application of new technologies into four phases:

- **exploration**: exploring the technology to ascertain whether it could be applied to protect, infringe or enforce IP;
- **conversion**: converting the technology to enable it to achieve the identified goal;
- **weaponisation**: finalising the development of the application;
- **monetisation**: using the application to protect, infringe or enforce IP.

Additionally, the methodology distinguishes (applying a double-edged sword metaphor) between each phase as regards:

- IP infringing application of the technology;
- use beneficial to IP.

It has, in the development of the methodology, been the ambition of the expert group to take a broad societal and economic view of the issues.

In the four workshops aimed at applying the methodology, the expert group has discussed different technologies (**Robotics, 3D Printing, Nanotech, Spatial Computing, Artificial Intelligence, Internet of Things, Blockchain and Distributed Ledger Technology, 5G/6G Mobile Networking, and Quantum Computing**) in relation to six specific topics relevant to the scope of the expert group:

- key features of the technologies;
- identification of essential information resources;
- impact of the technologies on society, the economy and world trade;
- IP protection use cases;
- threats and challenges for IP;
- investigative and enforcement opportunities.

Most recently, the impact on the environment, sustainable development and consequences for climate change has also been added to the discussion.

From the discussions at the four Tech Watch workshops and other fruitful interactions with the expert group since 2019, the following 13 significant horizontal points can be identified:

1. The nine technologies are all rapidly evolving and have not yet reached their full potential, not least in relation to their impact on IP.
2. All nine technologies will, in varying degrees and forms, have a significant impact on labour, the economy and world trade. However, it seems that the most significant impact occurs when the technologies successfully interact with each other.
3. The technologies all have essential roles to play in reaching the global sustainable development goals, such as securing good health, industrial innovation, well-functioning infrastructure, reduced inequalities, and justice. all of which are essential for the fundamental role of IP for

sustainable development.

4. With the growing importance of the protection of biodiversity, countering desertification and fighting or mitigating climate change, the technologies' role must be increasingly scrutinised for their positive as well as potentially negative environmental impact.
5. Predictions about the application of the technologies range from potential significant improvements in humanity's living conditions (e.g., better-quality products and services) to major threats and dystopian visions (e.g., increased inequality, unemployment, mass surveillance or collapse of the international financial sector).
6. A key characteristic of all the technologies is the potential to automate processes, including in the production and marketing of goods and the setting-up and administration of governmental and commercial activity, almost all of which have a significant impact on IP.
7. All the technologies raise questions about the protectability of innovation and creativity related to the technologies themselves: for example, the protectability of innovations involving artificial intelligence applications; of innovations and creations made by autonomous, artificial intelligent or quantum computing-based systems; of files used as a basis for 3D printing; of the datasets that are vital to all the technologies and their application; and the increasing importance of protection of trade secrets.
8. Some of the technologies can make IP protection more effective and provide higher-quality registration, monetisation/exploitation and documentation systems.
9. All the technologies – often in combination – can be applied by IP infringers to either make future production, marketing and distribution of counterfeits more effective (e.g., cheaper production by using robots, use of local 3D printing facilities for production purposes avoiding custom checks, and more appealing presentation of products using augmented reality). However, they can also be used in new, IP-infringing ways (e.g., cybersquatting in decentralised domain name systems and copyright infringement in virtual applications) and in IP-related cyber fraud or cyberattacks (e.g., trade mark registration invoice fraud, cybersquatting, phishing attacks supported by deepfakes, or theft of trade secrets).
10. Consumers and internet users can easily be deceived by criminals misusing new and emerging technologies through a variety of scams and deceptive practices, including greenwashing and other practices with negative IP implications.
11. Most of the technologies can be used as tools for IP enforcement: for example, to protect supply chain integrity; facilitate product individualisation and identification of counterfeits; improve investigations by law enforcement; improve customs risk analysis; and make notice and takedown procedures more effective.
12. A characteristic of all the technologies is that they represent new evidential opportunities and challenges for legal systems due to their complexity and the enormous amount of generated data, but also the reliability of the information (e.g., the probabilistic nature of artificial intelligence and quantum systems, the increasing number of distinct blockchain applications, and the potential pollution and manipulation of large datasets), not least in IP infringement and IP crime cases.
13. **Overall observation:** all the technologies have already shown themselves to be important emerging and disruptive technologies impacting businesses, the economy, the environment, government administration and the daily lives of many people, and pose potential challenges and/or opportunities for IP.

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The work of the Impact of Technology Expert Group will continue and will in future workshops analyse more important and emerging technologies.

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