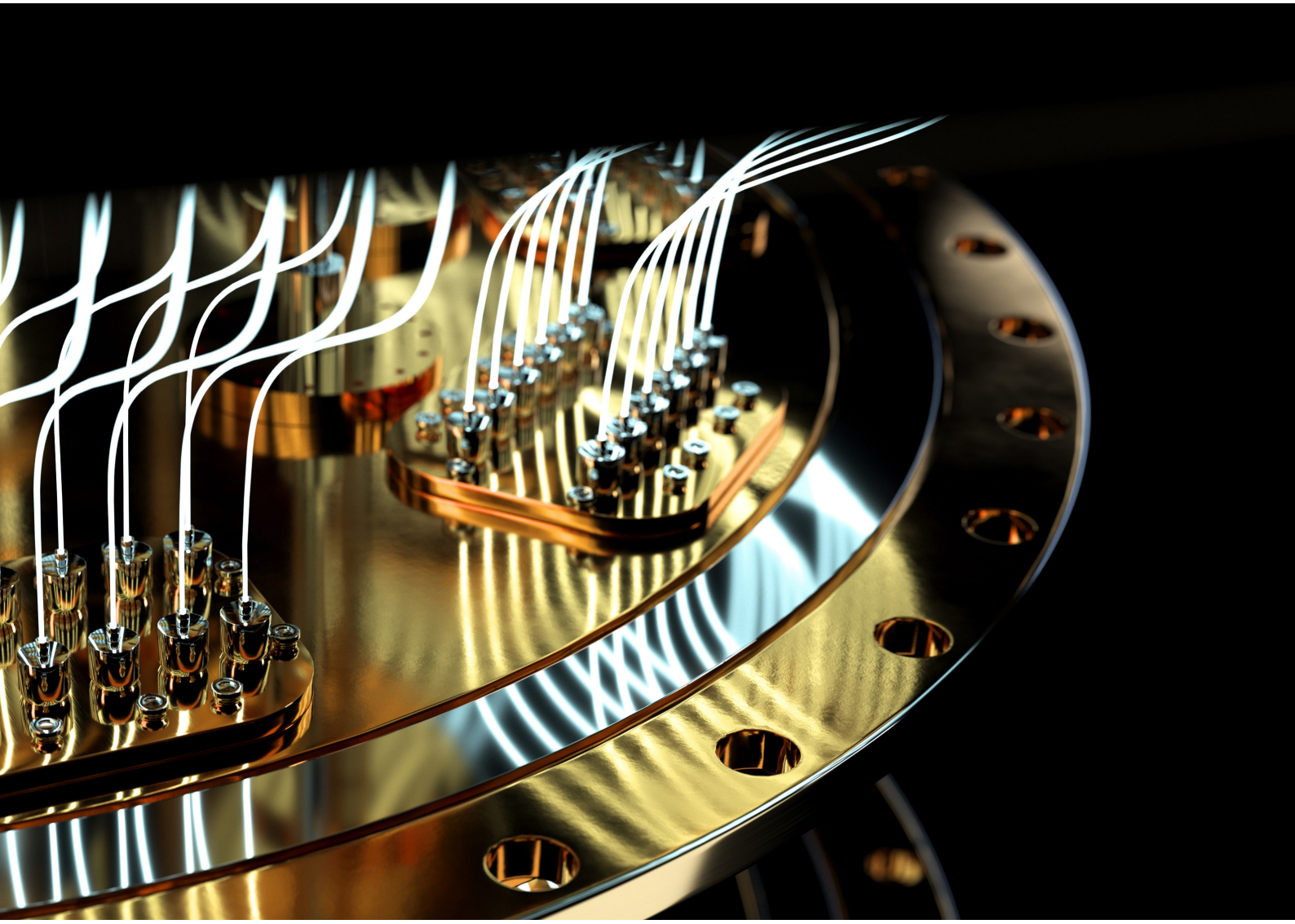

IP Guidelines for Quantum Technologists

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On behalf of the Quantum Flagship Coordination and Support Action QUCATS

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GLOSSARY

AI	Artificial Intelligence
ASTP	European Association for Knowledge Transfer Professionals
AUTM	Association for Technology Transfer Professionals
CEN	European Committee for Standardization
CENELEC	European Committee for Electrotechnical Standardization
CEO	Chief Executive Officer
CTO	Chief Technology Officer
DESCA	Development of a Simplified Consortium Agreement
EC	European Commission
EU	European Union
EUCAR	European Council for Automotive R&D
FRAND	Fair Reasonable and Non-Discriminatory Conditions
FTO	Freedom to Operate
GA	Grant Agreement
IEEE	Institute of Electrical and Electronics Engineers
IP	Intellectual Property
IQM	Quantum Computers
ISO/IEC	International Organization for Standardization/ International Electrotechnical Commission
KPI	Key Performance Indicators
KQCircuits	Python library developed by the Aalto University and IQM Quantum Computers for automating the design of superconducting quantum circuits.
M&A	Mergers & Acquisitions
MCARD	DIGITALEUROPE MCARD-HEU: Model Consortium Agreement for Research, Development and Innovation Actions under Horizon Europe
MPEG	Moving Picture Experts Group – Group behind so called MPEG standards for video compression
MUSD	Million US Dollars
NISQ	Noisy Intermediate-Scale Quantum
NPV	Net Present Value
OSSW	Open-Source Software
PPH	Patent Prosecution Highway
PRO	Public Research Organizations
QUCATS	Coordination and support action of the European Quantum Flagship
QUIC	European Quantum Industry Association
QPU	Quantum Processing Unit

R&D	Research and Development
R&I	Research & Innovation
RE	Reverse Engineering
ROI	Return on Investment
RTO	Research and Technology Organization
SAM	Serviceable Available Market,
SEP	Standard Essential Patent
SOM	Serviceable Obtainable Market
SW	Software
TAM	Total Addressable Market,
TRL	Technology Readiness Level: Maturity level scaling- system from 1 to 9. Originally developed by NASA
TTO	Technology Transfer Office
UP	Unitary Patent
UPC	Unified Patent Court
VCs	Venture Capitalists
VTT	Technical Research Centre of Finland VTT Ltd

1. Introduction

This IP guideline targets those who, in the quantum technology domain, need to build sustainable IPR management and valorisation strategies to support their business activities. There are many references throughout the guideline to European Council recommendations on the matter of IPR utilization and if special focus on quantum technology related topics is needed, those are considered as well. It should be noted that in terms of IPR technicalities, quantum technologies do not differ from other forms of deep technology innovation. However, there are indeed types of IPR that have more significance than others e.g., computer implemented inventions in patent domain (Chapter 2.2), copyright (or –left[1]) on software domain and ever-increasing intellectual asset domain of data.

For the most part, this document focusses on the challenges of IPR exploitation and what best practices could be adopted to get best impact and/or Return on Investment (ROI). It should be noted that these two targets, in optimal conditions, can co-exist but quite often can lead to barriers in getting technologies into the marketplace and slow down the exploitation or even prevent it from happening. Therefore, there will be special considerations on how to avoid these pitfalls and satisfy both parts of the equation. Collaborative enterprises with several different stakeholders might have varying interests and targets (even changing) in their co-operation and one should at least be both aware and prepared to deal with those needs. This guideline will offer reflections on the difference between the public and private side as well as between different maturity levels of companies (start-up vs. scale-up vs. big corporations). Nevertheless, the focus will be on the ability to create disruption in the marketplace. Europe tends to fall behind, especially in its ability to renew the economy when those disruptions are about to happen and often struggles to build long term and protective strategies towards exploitive competition. European competitiveness should be built on its dynamical abilities rather than regulative bureaucracy.

Within European Quantum Flagship there is a separate white paper prepared by QuiC IP working group about Quantum computer patent landscape to provide baseline to understand European competitive position at the moment (1st version to be delivered in early 2024). These results target the needs of Quantum Strategic Industry Roadmap (SIR) and the findings have been reflected to the contents of this IP guideline as well. Those findings are summarized in following key aspects:

IP strategy for building a patent portfolio in quantum: the patent filing activities of US and Japanese companies are substantially higher when compared to European companies, despite the fact that the scientific output on quantum technology in Europe is at least at the same level as the US and Japan. This imbalance in patent filings in Europe compared to other important geographic regions may impose barriers for European companies to enter these markets and to exploit their technology within Europe. This imbalance also impacts the valuation of companies by investors. As this topic of IPR strategy is in focal point IPR commercialization, it has been covered in Chapter 3. to the extent where deep technology enterprise (start-up, spin-off or any company adopting quantum technology) has secured necessary resources to be utilized in the marketplace. European companies, in particular SMEs, in quantum should be actively encouraged to improve their IP position viz a viz its

[1] Source Wikipedia: Copyleft is the legal technique of granting certain freedoms over copies of copyrighted works with the requirement that the same rights be preserved in derivative works.

competitors. An IP strategy should be essential part of the business plan and budget should be allocated to execute such strategy.

Interplay between TTO's and spin-offs: to give university/PRO spin-offs a head start in building a patent portfolio, a smooth transition of patents from the university/PRO to the spin-off is preferable. Investors would like to see that the IP is owned by the spin-off. In that context, it is advisable that initially agreed licensing and co-ownership schemes include a provision that IP can be transferred to the spin-off (when possible). From TTO perspective it is advisable to adopt mechanisms that take care both on the possible financial challenges (lack of funding to grow as expected and even insolvency situation) and securing that the solution (IP) actually is utilized in the marketplace as fully as possible. As this part of TTO and spin-out interplay is in the innovation pipeline before the actual commercialization, it is covered mostly in Chapter 2. with some necessary background about basic terminology and concepts within Intellectual Assets.

Patentability of software-related inventions: A substantial part of startups and spin-offs develop applications for quantum computers and quantum communication. These applications include software and algorithms, including AI-related algorithms. For these companies it is important that effective patent protection for such software applications can be obtained in a similar way as in other important geographical areas such as the US and Japan. There is a need for harmonization on this point in which the European Patent Office (EPO) plays an important role on this point. This is the only specific form IPR that has special significance in a sense that it may require perspective consideration from regulative bodies among quantum computer related technologies and therefore it has a bit deeper dive within Chapter 2.

Appendix 1 is meant to be updated with relevant companies from the Quantum computer field to give practical examples on how industry players build their respective IPR position in the marketplace. European Union has taken funding approach where competing solutions can still exist, and marketplace will with time show which one will prevail. In the first version there is just one example in Appendix 1, IQM's superconducting technology-based qubit approach. The list should be updated with others (and in minimum European players) like PASQAL (cold atoms), XEEDQ or SaxonQ (NV centers), QUANDELA or QUIX Quantum (photons) and Alpine Quantum Technologies (trapped ions). Appendix 2 provides quick view on the legal framework around European funded collaborative projects to emphasize the possibility to safeguard critical Background IPR within such projects but still also enable one to enter such collaborative programs.

2. Intellectual Property Rights and Intellectual Assets Introduction

Each country within Europe has their own policies and strategies on how to build their respective competencies in prioritized focus technologies. There are even guidance reports (by WIPO, World Intellectual Property Office) on how to build national IPR strategy[2], but those are considered only when implications are evident on their business use. However, given the common motivation and need to build functioning European quantum technology ecosystem, it is good to reflect the current assessments on European level about IPR, its role, challenges, and recommendations to improve the utilization of IPR within European deep (disruptive) technologies from public sector. This has significance in the European context especially because European research innovation capability as such has always been in the forefront but the ability to push those results into marketplace to be deployed by European industry falls often behind competing economies of USA and Asia.

European Research Area Policy and Agenda (2022-24) has only one visible remark on IPR related activity in Priority Area of "Deepening a truly functioning internal market for knowledge", where the focus on this matter is on upgrading EU guidance for a better knowledge valorization (item 7). The set target has resulted in Commission Recommendation 2023/499 (1st of March 2023) on a Code of Practice on the management of intellectual assets for knowledge valorization in the European Research Area[3].

Besides Commission Recommendation above, there is another one 2022/415 (2nd of December 2022) that gives the "guiding principles for knowledge valorization" and it defines it as following; "Knowledge valorization" is the process of creating social and economic value from knowledge by linking different areas and sectors and by transforming data, know-how and research results into sustainable products, services, solutions, and knowledge-based policies that benefit society. The same Recommendation defines "Intellectual assets" that is considered to cover any results, services or products generated by any R&I (Research & Innovation) activities, such as patents, copyrights, trademarks, publications, data, know-how, prototypes, processes, practices, technologies, inventions, software, or business models.

The first Commission Recommendation 2023/499 outlines three topics:

1. Establishing strategy for the efficient management of intellectual assets
2. Managing intellectual assets in joint research and innovation activities, and
3. From intellectual assets creation to the market.

Each of these topics focuses on a set of recommendations. For "Establishing strategy for the efficient management of intellectual assets" these are "Defining and adopting strategic intellectual assets management practices", "Intellectual asset management in a way to enable open science and open innovation", and "Investment in education, training and awareness". For the Second topic, "Managing intellectual assets in joint research and innovation activities", the recommendations focus on "Clarifying ownership of intellectual assets as early as possible", and "Establishing clear collaboration conditions". Finally, for "From intellectual assets creation to the market" the focus is

[2] https://www.wipo.int/ipstrategies/en/
[3] https://eur-lex.europa.eu/eli/reco/2023/499/oj

on “Means of control”, “Carrying out valuation of intellectual property” and “Establishing monitoring, transfer, and licensing practices”.

Most of the above recommendations or their motivation angles should at least be considered within this IP guideline as well. Some of them are considered more briefly than others since they require more case specific tailoring. In the following chapters their relevance and practical implications are considered on a level that is considered sensible. Quantum technology relevant examples are provided on some specific topics – keeping in mind that the technology is still emerging, and a lot of the actual promise remains to be seen.

2.1.Forms of Intellectual Property Rights and Intellectual Assets

Intellectual Property Rights as a sub-category of intellectual assets comes from their clearer legislative position with target scope of protection, process to achieve and validity period, which are clarified in table below. The most effective forms of IPR (note: rights don’t always need formal registration) in the early phase of development mode or productization, are marked in the table with green colour.

Table 1. Forms of Intellectual Property Rights

Form of IPR	Target	Validity period	How to get
Copyright	Original creative or artistic forms	70 years after death of the creator	Automatically upon creation of the work
Patent	New and inventive inventions	20 years	Filing and examination of patent application
Utility Model	New inventions	10 years	Filing and examination of utility model
Plant variety certificate	Right to utilize professionally	25/30 years	Registration
Integrated circuit design	Layout design	10 years	Registration
Trademark	Distinctive identification	10 years (forever if renewed)	Registration or use
Trade name / business name	Doing business name / legal name	dependent of legal jurisdiction	Registration or use
Geographical indication	Agricultural products with qualities of geographical origin	10 years of as forever (dependent of legal jurisdiction)	Registration
Domain name	Web page and email	1-5 years, can be renewed	Registration
Design right	External appearance	5 years, can be renewed, max. 25 years	Registration or use
Database rights	Database structures that have been compiled even when there is no “creative” aspect	Following of TRIPS agreement and requirement of treatment as copyright	Comparable to but distinct from Copyright
Trade secret	Any confidential business information what provides an enterprise a competitive	As long as not published	Reasonable efforts to keep secret

Form of IPR	Target	Validity period	How to get
	edge (e.g., formula, practice, process, design, instrument, pattern, commercial method, compilation of information)		

Intellectual assets besides IPRs include know-how (that isn't necessarily a trade secret), data, business models, processes, tacit knowledge, which may be codified or not. An important part of utilization of this part is in awareness. What it includes and at least how the European Commission wants to see certain parts like data to be as widely available and accessible as possible for future use in the spirit of Open Science and Open Innovation. As the know-how and data are becoming more and more valuable in digital economies, it is sensible to build a strategy of its own on how those interfaces are managed between public and confidential domains. As data is often in core of building competences, there should be careful consideration on how, for example, industrial espionage and data secrecy is considered. Open Science and Open Innovation should not be blind (naive) about the brutality of the world in this sense. Awareness starts from asset management especially in the sense of this interface management.

2.2.Software and Computer Implemented Inventions (CII)

2.2.1. Introduction

Nowadays software plays a very important role in innovation. The IPRs related to software are copyright, patents, and trade secrets. While copyright provides an effective remedy against illegal copying of the source code, e.g., illegal downloads, and provides a legal basis for licensing (including open-source licensing) it cannot be used to prevent others (third parties) from independently developing software that provides the same or similar functionality. In that case, patent protection can be used.

It is a general misconception that software cannot be patented in Europe. On the contrary, in Europe, i.e., the geographical area covered by the 38 member states of the European Patent Convention, software inventions - often referred to as computer implemented inventions - can be patented as long as the software invention can be presented as a technical solution to a technical problem. This is the case even if the invention is 100% software (so no hardware involved at all). This requirement is valid for all inventions but for software it is especially important because some software, such as e-commerce software or algorithms for optimizing a stock portfolio, are prima facie non-technical.

2.2.2. Patent protection vs trade secrets

A further point of discussion is whether to rely on patent protection or to keep the software invention secret. This discussion is not relevant if access to the software can be gained. Often, however, software can also be exploited without explicit access to it, e.g., as a service in the network (e.g.,

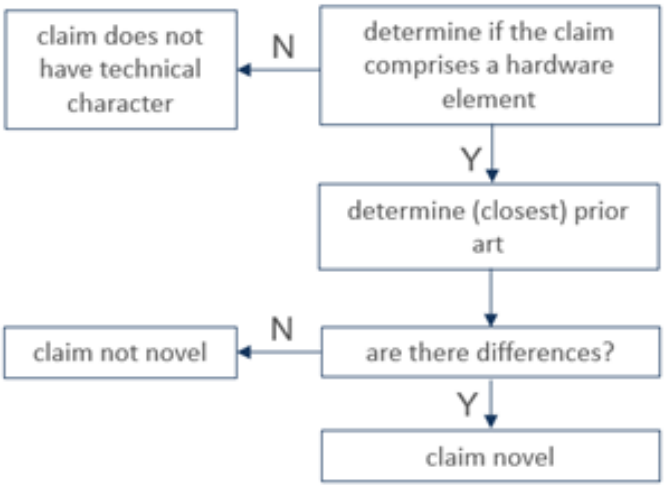
Software as a Services SaaS). In such situations, one could opt for protection as a trade secret and not for patenting.

Nevertheless, it is still prudent to evaluate such situations carefully. If access to the software by third party is needed in the context of a cooperation, then patent protection (in the form of background IP) may secure that information that diffuses out of the organization cannot be used by third parties. The same holds for situations where employee – inventors leave the organization. Moreover, in case of technical field that has an academic component and/or technical field in which the patent activity is high – such as quantum computing – publication of the technology may be strategic and valuable (for reasons of academic prestige and defensive publishing). In such situations, patent protection of the software invention can be important.

2.2.3. Examination of computer implemented inventions

The European Patent Office (EPO) have developed a framework for patenting computer implemented inventions, which covers software, database technology, graphical user interfaces and algorithms, including AI-type algorithms such as deep learning models based on trained deep neural networks. This framework is sometimes referred to as the COMVIK approach (adopted from case law kind of approach). To comprehend it, it is important to understand that the claims define the invention for which protection is sought. During examination, the claims of a patent application are evaluated by an EPO examiner in view of the prior art (i.e., public information before the filing date of the patent application: the claimed invention must be new and inventive in view of the prior art, and it should relate to a technical solution to a technical problem.

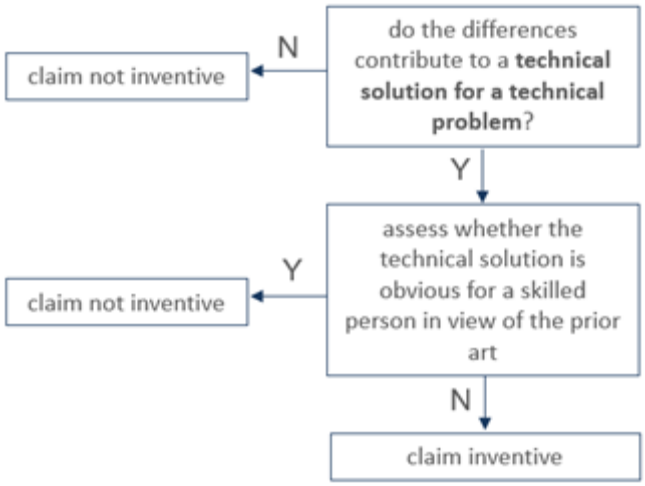
The examination of claims of a computer implemented invention by the EPO may be illustrated in the following flow charts:



Flow chart 1. EPO examination process

As shown in the flow chart above, first it is determined if the claim has technical character. This test is very simple. Any hardware element (e.g., a computer, a sensor, a transmitter, a processor, etc.) will introduce technical character to a claim. Without such hardware element, the claims have no technical character and are not patentable. Then, the claim elements are compared to a prior art document and

if one or more claim elements are not disclosed in the prior art – the differences - the claim is new (or novel).



Flow chart 2. EPO examination process

In the next step, the question is posed if the claims elements not disclosed (the differences) contribute to a technical solution for a technical problem. If that is not the case, the claim is not inventive, since an invention should be a technical solution to a technical problem. The Guidelines for Examination before the EPO[4] and the case law of the Boards of Appeal of the EPO[5] give many examples of what is considered technical and what is considered non-technical. In certain fields of technology, such as encryption or telecom, most of the inventions are considered prima facie technical. Other fields however, such as logistic or natural language processing, are not considered technical.

For example, a difference could be a mathematical step (representing the solution) for compressing data or for encrypting data (representing a technical problem). If that is the case, the final question is whether this technical solution is obvious for a skilled person in view of the prior art (typically a second prior art document that hints to the claims solution). If, however, the difference is a mathematical step (representing the solution) for computing a prime number (without any further context) then the mere computation of a prime number is considered to be a non-technical, mathematical step. In that case, the claim is not inventive.

The above framework is used by the EPO to evaluate patentability of computer-implemented inventions, including software and algorithms in quantum computing. In particular, the EPO considers a typical NISQ type quantum computer as a hybrid computer system comprising a classical computer connected to a quantum computer. When drafting claims that define execution of a quantum algorithm (e.g., a quantum circuit) by such hybrid computer, the EPO requires that the claim clearly defines which steps are executed by the classical computer and which steps are executed by the quantum computer.

Further, the EPO considers a quantum circuit defining gate operations per se, without any context, as abstract mathematical operations. However, when put in a technical context, e.g., the gate operations are defined such that a computation can be executed within the coherence time of a NISQ quantum

[4] https://www.epo.org/en/legal/guidelines-epc/2023/index.html
[5] https://www.epo.org/en/legal/case-law

computer, the execution of such quantum circuit may define a technical solution to a technical problem.

2.2.4. Sufficiency of disclosure

Besides the above-explained evaluation of novelty and inventive step, the patent application should also disclose the invention in a manner sufficiently clear and complete for it to be carried out by a person skilled in the art. This means that somebody with a technical background in the field of the invention should be able to reproduce the invention. Hence, the software and, in particular, algorithms need to be explained in enough detail so that the technical effects and advantages produced by the software or algorithms are sufficiently supported by technical information (which may e.g., technical data such as simulations or measurements). For AI-related inventions, this means that also the training of the model needs to be explained in adequate detail.

Finally, it is important to remark on the very strict disclosure rules applied by the EPO. When filing a patent application, the application will receive a filing date, which defines the prior art (namely all public information, published or orally disclosed, before the filing date of the application is prior art). Preferably, the application as filed should disclose the invention as completely as possible so that all subject matter in the application will get the filing date as effective date. Any technical subject matter added after the filing date (within the so-called priority year) will receive a date stamp of the day that the information was added. This may cause potential problems when amending claims based on technical information that was introduced after the filing date during the priority year. In that case, a scientific article published just after the filing date of the application (which in an academic context is a very realistic situation) will become prior art for the amended claims. Hence, relying in Europe on “a provisional patent application”, having a disclosure that is incomplete can be risky, since it may give the inventors the impression that it is possible to file for patent protection based on a quickly written draft disclosure. Alas, this is not the case.

2.3. From Intellectual Assets to Sustainable IP and IPR strategy

As different intellectual assets can affect the marketplace in quite different fashion, it is necessary (as in any strategy build-up) to first understand what one actually owns at any given point and, if one sets a certain target, what one must gain (or even get rid of or use as means of exchange) in order to reach it. This is the very basis of IPR strategy build-up (Figure 1) and even if it sounds trivial to understand what one owns, its surprisingly often not clear at all in the context of Intellectual Assets in the beginning. For example, employment invention laws have some differences between jurisdictions, but the basic principle tends to be the same. This means that employees need to have a process to take IP rights when it is legally possible. For example, when the company has business activity in the application area of described invention and/or has invested in the development of such invention internally or this has been agreed on employment contract. Taking the rights also includes the necessary compensation towards inventor(s); this practice may vary between jurisdictions. The process must be clearly and fully documented. This documentation is usually the first item on the list,

when one needs to go through the scrutiny of so-called IPR due diligence [6](part of full legal due diligence) that one faces in investment situations from the investor.

The ownership and the understanding of its importance are most often disregarded in organizations, companies or businesses that are not operating in the global competition field of commercialization (limited reach of operation) or are just starting to build that competence. Typically, this lack of knowledge is challenged when the entity is either trying to grow through market entry into new areas (global reach) or looking for needed funding (quite often both). It is important to tackle this question as early on as possible since it may pose a major obstacle in making such market entry or involve at least additional risk in relation not only to the to safeguard one's own assets but also in relation to infringing 3rd party IP rights. The awareness of latter is usually reached through an "IP landscape analysis" (described more in Chapter 3.1.4), which in small scale is always done for example for individual patent applications – but in the case of any given technology, it needs to reflect the whole setup and all those features within (blueprint of individual products, if you will). This analysis is quite often a precondition for a more in-depth "Freedom-to-Operate analysis" (which is stricter on IPRs actual protection area like patents and trademarks, where the possibility to circumvent isn't always that easy and/or infringement situation is more visible, in Chapter 3.1.5).

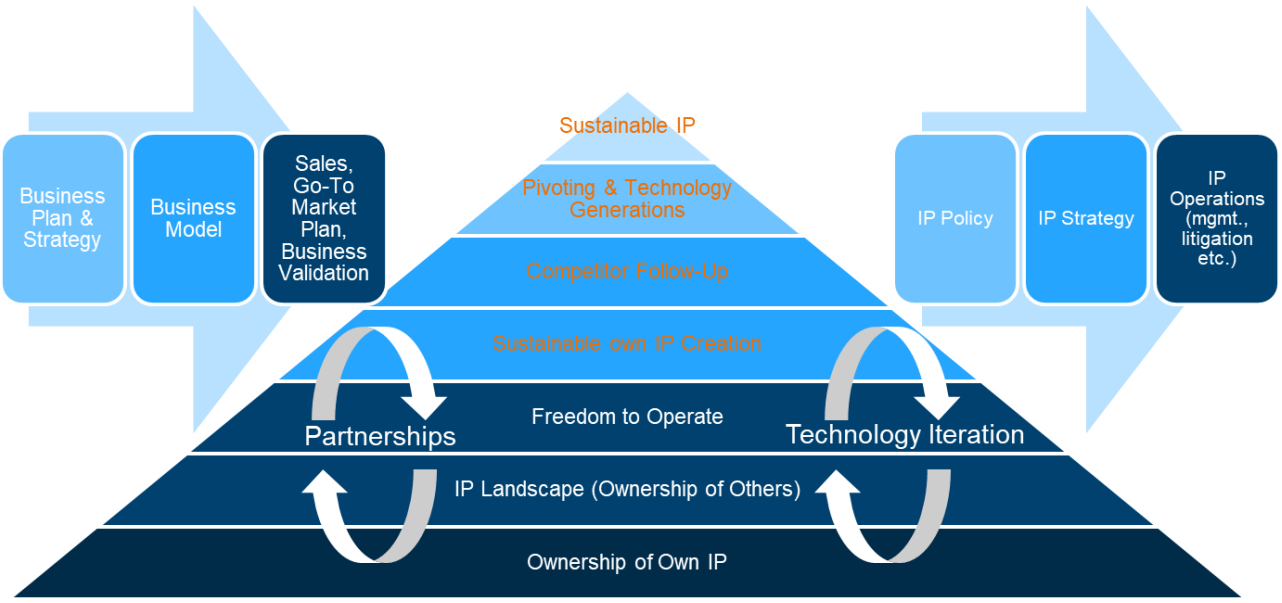


Figure 1. Step-by-step approach to build better alignment with business activities of Enterprise.

When one starts the whole process of IP Asset (and on parallel Right) strategy build-up, there should be different needs covered (as for example in the way in Figure 2). Ultimately, it is all about supporting business strategy; but even in business strategy there are several layers which have different priorities. While some of the actions are more urgent than others, most of them need to be

[6] Source Wikipedia: Due diligence is the investigation or exercise of care that a reasonable business or person is normally expected to take before entering into an agreement or contract with another party or an act with a certain standard of care.

iterated and reiterated as the technologies or solutions are developed further though the whole life cycle and perhaps even several generations forward.

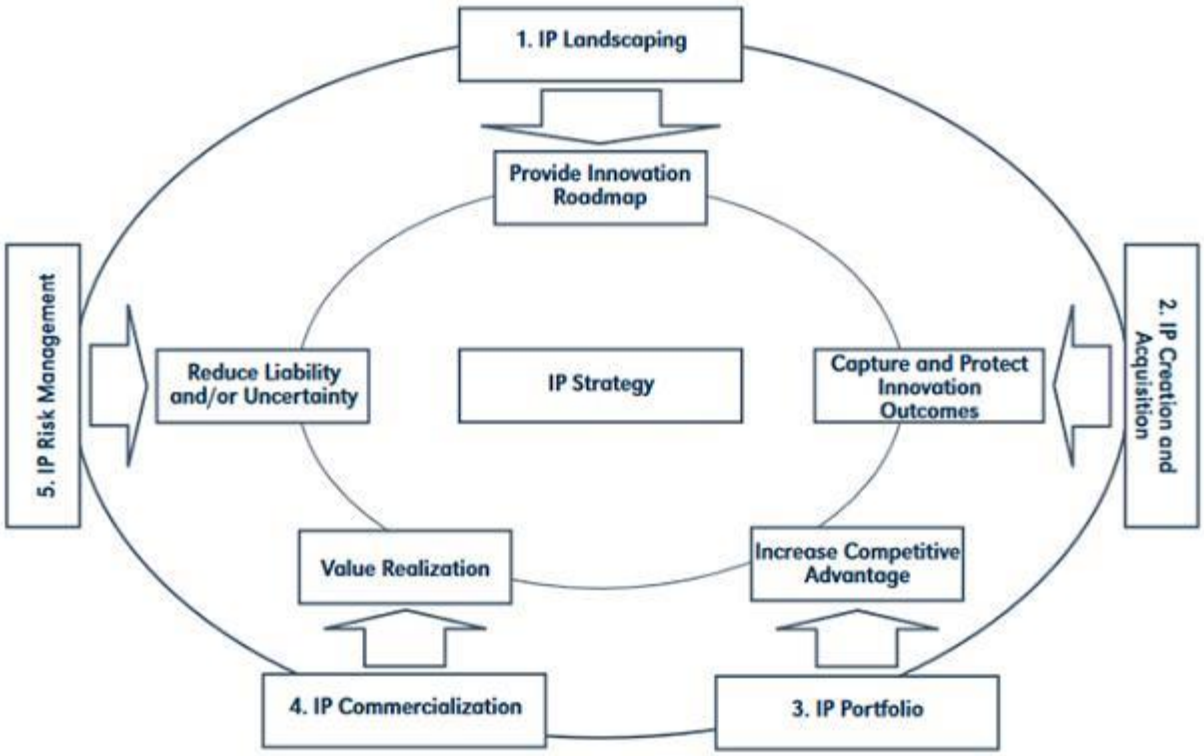


Figure 2. Needs of IPR strategy (source: IP Business Academy).

With the new AI enhanced IP analysis, one has quite powerful means to grasp both the bigger IP landscape picture as well as more specific assessment about the Freedom-to-Operate (considered as a specific item under IPR commercialization), thus providing clarity on whether there is any granted 3rd party patent protection on any particular technology solution that one wants to offer to the marketplace. The best practice approach on this matter is to start with IP landscape, as it quite often already reveals the closest prior art patent protection and opens the venue for next steps of consideration. These include challenging that 3rd party IP (invalidation, Inter Partes Review etc.), circumventing 3rd party IP (technology iteration), in-licensing 3rd party IP (either directly or through partnership) and even in worst case scenario IP litigation, which hopefully can be avoided with careful Standard framework implementation.

2.4. IPR strategy for Public Research Organizations

IPR strategy is an essential building block of the overall business strategy in the knowledge-based economy since most of the value within companies and businesses is no longer in tangible property but in intangible assets. However, it's not only the share of the value but also the dynamics of certain technology domains and particular features or types of IP that dominate (software vs. know-how vs. patents etc.). Even though, it might be simple for one individual company to make its own assessment about the direction and motivation for IP investments, the more collaboration there is, the more challenging it becomes and there might be a constant need to compromise on one level or another.

The recommendations from European Commission (Chapter 2 above) are targeted especially to this joint enterprise approach, since the European funded projects fall in this category, and especially big European research programs, like The Quantum Technology Flagship program,) are fundamentally based on collaboration and enforcing competitiveness, resilience, and sustainability of Europe as whole. One should notice though that ownership – if to be shared with competition without any exclusivity – might also limit the private sector's interest to invest in it. Therefore, even standards and FRAND (Fair, Reasonable and Non-Discriminatory) terms should exist in this domain, there should also be enough space for building competitive differentiation possibilities as businesses undertake the largest share of R&D in most economies and more than 60% of OECD R&D expenditure[7] and about same average in EU28 countries.

The current expectation for Quantum technologies is that it will be a Platform technology, as envisioned in Figure 3, and therefore there are both multiple market needs and technologies utilized in this kind of technology. This results also in higher expectation value and business opportunity that attract investments. However, there are certain expectations that one needs to fulfil. Those expectations and needs are considered next, especially from the point of view of Intellectual Assets.

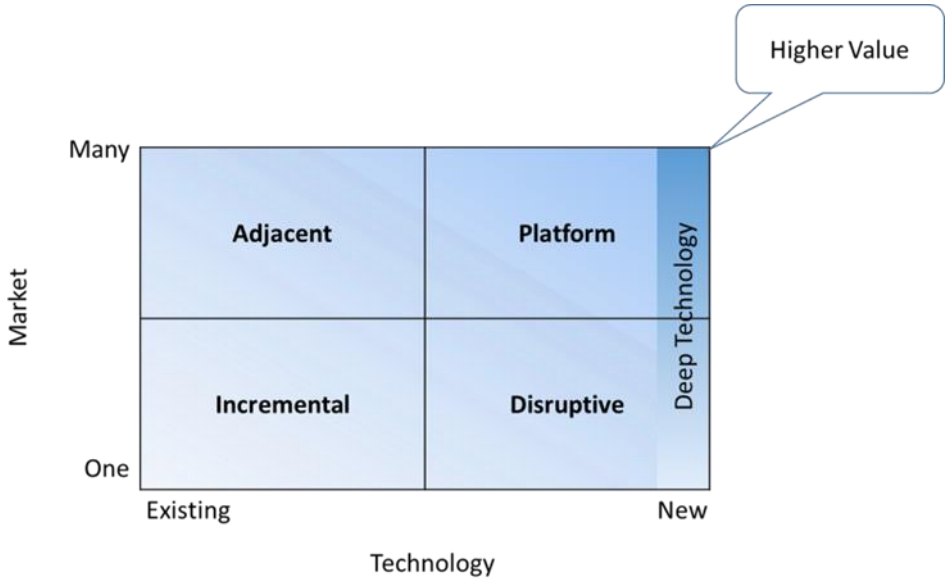


Figure 3. Positioning Quantum technology as Platform technology with High Value expectation.

Although the European Union and national public funding efforts are in themselves big, private sector investment is still needed to increase TRL (Technology Readiness Level) of the technology for it to be to be deployed in the industry more directly. Experience shows that as in Figure 4, technologies often are a lot easier to deploy by industry when TRL is 6 and above.

[7] OECD Science, Technology, and Industry Scoreboard 2017

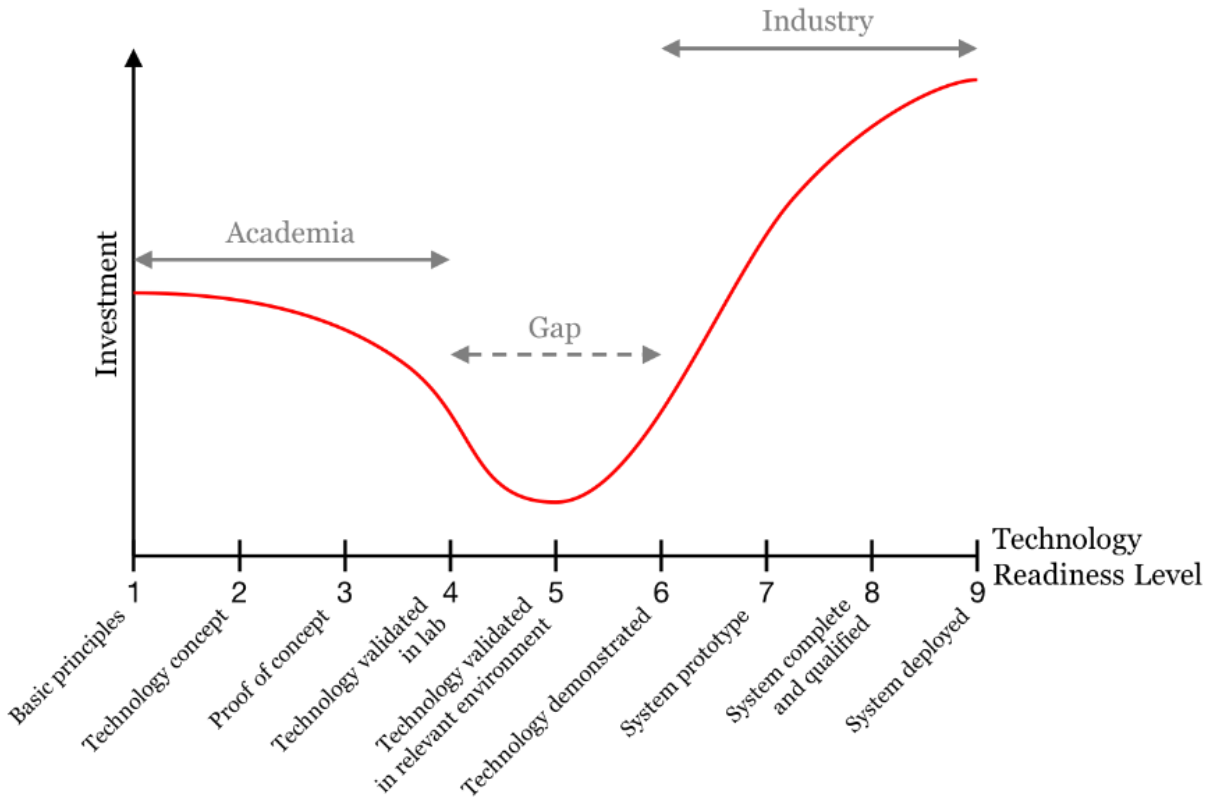


Figure 4. Technology Readiness Level Gap between Academia and Industry[8].

The gap (typically between TRL 4-6) is most challenging as it is out of scope for most academia funding and quite often too early for most of the industry players and represents the so called "Valley of death". The European Union has taken more interest in focusing on this gap and it is indeed critical to develop strategies that enable the crossing of it. This requires mechanisms that on the other hand make public sector more effective and create added value in their technology transfer functions but also on industry side, willingness to see that this added value makes them globally more competitive and therefore more interested to be involved.

There has recently been a debate on what the pricing for such added value from the public side could be, some (often industry side) even claim that there shouldn't be any. Both sides have their angle on the matter. The public sector can develop value visibility only by understanding the commercial value better – and, when that is elevated, it's only natural that the demand for better prices is elevated as well. If this is not paid by the recipient, then there should be a mechanism in which society supports academia in pushing outcomes that traditionally aren't part academia KPIs (Key Performance Indicators). In some European national legislation one can already see such targets but they might be pointless if there are no incentives for both the organizations and individuals involved. This fact has been recognized and developed in EU funded program[9].

[8] Technology Readiness Level framework originally developed by NASA in 1960s and the concept of "Valley of Death" between new technology and adaptation in marketplace by Geoffrey Moore in 1990s.
[9] https://ec.europa.eu/research-and-innovation/en/statistics/policy-support-facility/mutual-learning-exercise-knowledge-valorisation-focus-skills-intersectoral-cooperation-and-incentive-0

The industry side, on the other hand, tends to challenge the charging on items that, from their perspective, create too little added value or were not recognized at all to be needed. Whether this is true, it is a fact that there is natural pressure to face higher prices with better awareness of value. A middle ground could be offered by payments through actual revenue created, i.e., weighting royalty component or milestone payments instead of upfront payments. Even this has inherent danger for the seller since it may be circumvented along the way, and if its conditional to for example utilized patent rights, there is often a way to later avoid that right and related payments (even when the technology factually ends up to products in the marketplace). Therefore, public sector organizations have two possible paths: they either negotiate unconditional product bound payment (often denied by bigger companies) or have solid understanding on the strength of their respective patent protection. The former option is dependent on negotiation power while for the latter one the skill set required is reached only by such entities that have experience on patent litigation, which is still rarity among European public sector research organizations and universities). This latter point is heavily dependent on "patent protection quality", which is too often disregarded as it requires disciplines that often didn't exist within academia or public sector research. We will come back to this point when we speak about IPR commercialization in chapter 3.

Considering the challenges that one faces in licensing negotiations, it's no wonder that spin-out creation as an alternative commercialization pathway has increased its popularity, as it most commonly opens the possibility for in-kind investment with equity component. This, in turn, offers a heightened opportunity for Public Research Organizations (PRO)/universities as well to have upside on their investment. A Spin-out also provides an alternative career path for some academics and therefore creates an additional incentive mechanism. On the negative side, spinouts face obviously heightened market related risks if they fail to reach the targets that funders set or if simply the timing isn't right. In relation to IPR strategy, Freedom-to-Operate becomes a dominant factor and as mentioned before, this is considered separately as it is one of the recommendation items by Commission (item 50 in reference to Chapter 2) and in practice it is of paramount importance in both raising funding and avoiding market-related risks in advance.

Professional technology transfer function within PROs and universities requires resources and there are several ways to set those functions. TTO (Technology Transfer Office) office can either be internally funded and targeted to be self-funding through commercial agreements or it can even be incorporated to be fully owned by one PRO (to lower related risks on other PRO related functions) or with shared ownership of several PROs to lower the risk even further. There are quite often also models, where TTO related services are a continuation of the internal research funding and legal services. All these models have been in use and the results vary. Both in Europe (ASTP, European Association for Knowledge Transfer Professionals) and in USA (AUTM, Association for Technology Transfer Professionals), there are technology transfer professional associations that share best practices and educational programs to professionals in the field plus reports on their respective KPIs. To leverage sensible KPIs, the European Commission has also released a report[10], "Knowledge Transfer Metrics, towards a European–wide set of harmonized indicators" (2020) and as one can see from attached figure below, the targets are wide ranged.

[10] https://publications.jrc.ec.europa.eu/repository/handle/JRC120716

Figure 5. Knowledge transfer metrics visualized by European Commission backed report (2020)[10].

The wide range of impact indicators available (none mentioning IPR directly), show that there are many ways to sub-optimize one's targets but as PROs and universities at the end receive their funding through taxes, it is at the end up to governments to set targets and means to reach those targets. It is probable that in the end, the overall competitiveness is rather something that is based on sustainable economy (which is much more than just jobs and gathered taxes) than short term wins. The overall IPR strategy needs to reflect society's resilience as whole and especially therefore disrupting technologies should be invested in with careful planning supported by scenario-based thinking. The European Commission has also a separate platform for sharing best practices and surveys on knowledge transfer and intellectual asset management activities, called "EU Knowledge Valorisation Platform[11] which is advised to be visited regularly to update one's own strategy considerations.

As IPR in one form or another is the core context, which is delivered as research output, it is sensible to go through some basic aspects and legalities of those forms but more than that also their respective position in different value chains of technology transfer.

2.4.1. Impact through research generated IPR

More and more universities or PROs are generating start-ups and spinouts in order to create impact in the marketplace as, that is generally accepted to be one of motivations why public funding is invested into research on so many levels. Research generated results and solutions to global problems deserve a platform to commensurate with their worth. Companies seem to also be more willing to adopt technologies when they have something additional besides IPR alone. This is evident from just making comparison on how challenging it has been for research organizations to push solutions to the market with licensing approach alone. When inside a spin-out the technology maturity (TRL) is developed higher and pivoting of application direction shows real opportunity, there is something that can readily be adopted also through already existing available distribution channels – and if a win–win scenario with the owner (often established company) of this channel can be foreseen. The sustainable equity model should also provide the home organization incentive to be involved within this in-kind investment approach. Chapter 3.1.6 tries to give perspective on just what all is needed to make this kind of Agreement with the public research organization. Together with elements of

[11] https://research-and-innovation.ec.europa.eu/research-area/industrial-research-and-innovation/eu-valorisation-policy/knowledge-valorisation-platform_en

licensing (Chapter 3.2.) one should have all the necessary tools to make sustainable technology transfer from lab-to-market.

2.4.2. IPR and Its Value

As in Figure 5 above, the research outputs can be presented also as in Figure 6 below. It merely makes a distinction between researchers and new knowledge to be either human capital (quite often not codified) or intellectual assets (codified). To understand, why codified IP might at the end be critical part of the equation for investor, one should remember that whereas human capital can leave the enterprise at any given point, intellectual asset and especially intellectual property typically remains as structural capital of the legal entity. Another point in this figure is that IP has no inherent value without execution capacity (complementary business assets), which includes those of manufacturing, distribution, and sales channels.

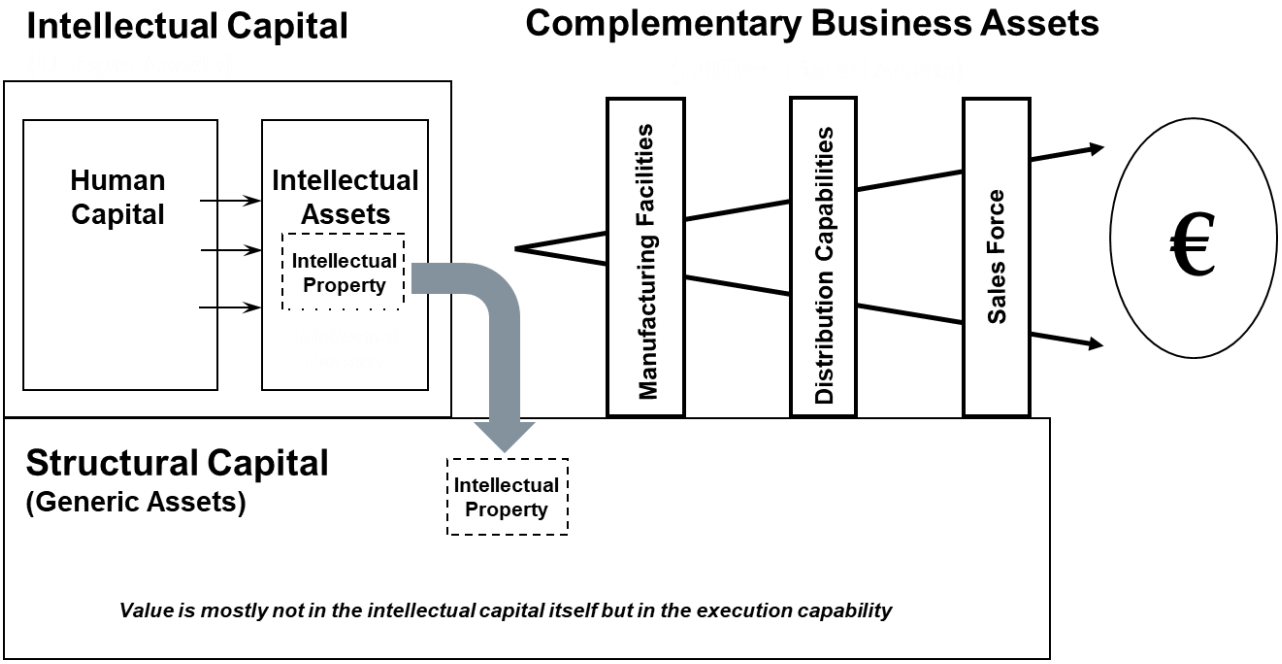


Figure 6. Value extraction from Intellectual Capital and Intellectual Assets. Source: Intellectual Capital Management Group

The role and value of IPR becomes evident through its capacity to reduce risks. Economics often refer to capital by term "liquid" as it behaves similarly in relation to the expected ROI (Return on Investment) with certain risk. Meaning, if the risk is high, the expected ROI needs to be high and if the risk is low, a lower ROI is acceptable. High or deep technologies (with long development cycle and high investment need) are always high-risk investments and therefore the expected ROI is also high. One should understand that if the maturity of the technology (TRL) is low and there is a long way ahead before any product can be launched, the timing for spin-out activities might be too early to satisfy private funding entities like VCs without losing significant proportion of equity along the way. Therefore, timing is important and exit strategy (meaning; investors cashing out their investment) considerations must be planned. That said, one should carefully consider not to deploy

the so called “bootstrapping” approach, where one is trying to avoid external funding too long. Scaling and speed-to-market is rarely possible without significant capital investments.

2.5. Open Science and Open Innovation to Leverage Knowledge Valorization

The European Commission recommendation (2022/2145) makes a strong point on the following fact that; “Widening the scope from a narrow focus on management and protection of IP rights will also broaden the value creation opportunities. Leveraging the full value of intellectual assets generated by R&I activities requires organizations performing R&I activities to manage intellectual assets in a broad sense, both those that can be legally protected, such as patents, copyrights and trademarks and other intellectual assets that could be used in valorisation activities. This requires the development of management strategies and promotion of specific and transversal skills to leverage the full value of intellectual assets generated. Efficient management of intellectual assets is crucial for knowledge valorisation.” This statement underlines that those different forms of IPR, as well as any other intellectual assets (including data, tacit knowledge and even all uncodified know-how) needs better management strategies to be effective and lead to better valorisation results. However, in practice, this statement leads to a short list of practical guidance on the matter of intellectual asset management, namely:

a) Ensure that policies and practices for intellectual asset management are defined, implemented, shared, publicized, and promoted in all organizations involved in knowledge valorisation.
b) Raise awareness among universities, research organizations, public authorities, and businesses of the importance of managing intellectual assets in an international environment, while taking into account sovereignty issues.
c) Ensure that intellectual assets developed by publicly funded R&I activities in the Union are managed and controlled in such a way that the socioeconomic benefit, including contribution to sustainability for the Union as a whole, is considered and maximized.
d) Increase awareness and uptake of intellectual asset management practices and tools in Open Science as well as in Open Innovation to facilitate the use of results and data for innovation.
e) Increase efficient management of intellectual assets, for example by supporting active portfolio building and by promoting platforms linking offer and demand for intellectual assets, to maximize value creation for all involved.

Even though these guiding principles clearly show that the EC wants to leverage intellectual asset management to the better good of society, it is in fact quite silent about the practical steps that those stakeholders involved need to take. What one can take out of this is really that the Commission would like to see Open Science and Open Innovation policies to be adopted on the side. Open science is simply an approach to provide open access to all European level publicly funded research whereas Open Innovation was defined (with a note that it is constantly changing) in European Commission, Directorate-General for Research and Innovation, Open innovation, open science, open to the world: a vision for Europe, Publications Office, 2016, p. 13 to rather make distinction to Closed Innovation by making a comparison with following table.

Table 2. Comparison of Closed vs. Open Innovation principles[12].

CLOSED INNOVATION PRINCIPLES	OPEN INNOVATION PRINCIPLES
The smart people in our field work for us.	Not all the smart people work for us. We need to work with smart people inside and outside our company.
The profit from R&D, we must discover it, develop it, and ship.	External R&D can create significant value; Internal R&D is needed to claim some portion of that value
If we discover it ourselves, we will get it to market first.	We don't have to originate the research to profit from it.
The company that gets an innovation to market first will win.	Building a better business model is better than getting to market first.
If we create the most and the best ideas in the industry, we will win.	If we make the best use of internal and external ideas, we will win.
We should control our IP, s that our competitors don't profit from our ideas	We should profit from other' use of our IP, and we should buy other' IP whenever it advances our own business model.

Source: Table 1-1 from Open Innovation: The New Imperative for Creating and Profiting from Technology by Henry Chesbrough (Harvar Business Review Press, 2005)

The evolving nature of Open Innovation (Open Innovation 2.0 if you will) is made with the notion of its movement towards inclusion of users and ECO-system as whole into the equation. Even though this might be true and through those certain implications (or complications) to the ownership related matters have followed, the IPR system as whole hasn't changed a lot.

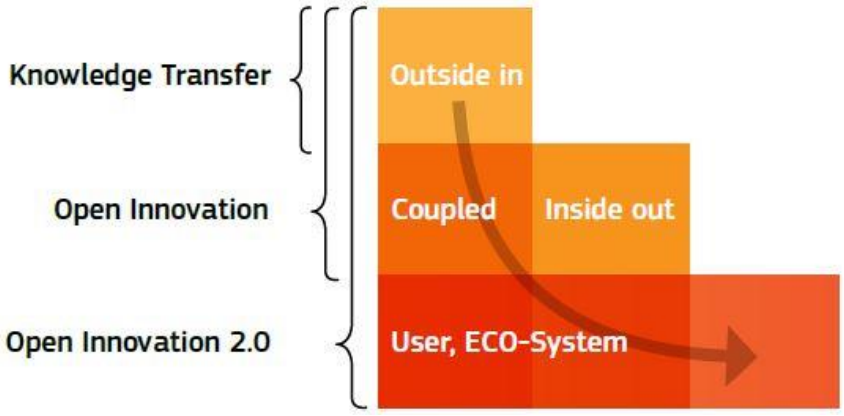


Figure 7. Visualization of Open Innovation concept evolution[12]

There is the next evolving step behind the corner, namely Artificial Intelligence (AI) as part of the equation and there the consequences might be a bit more drastic yet remain to be seen.

[12] Source: European Commission, Directorate-General for Research and Innovation, open innovation, open science, open to the world: a vision for Europe, Publications Office, 2016, p. 13

3. IPR Commercialization

From the value perspective (presented in Figure 6), it is evident that IPR capitalization typically requires, as with any business, understanding of respective value chains and those complementary assets that are needed to take technology into the marketplace. IPR asset in essence gives the owner two main options, either to go to the product business yourself (Chapter 3.1) or license (Chapter 3.2) it to others. There is also the third option that is a combination of these but as one can interpret from these two options what is required in this third one, it is not considered separately. Whichever option one chooses to deploy, IPR ability (resources and processes) besides IPR strategy (targets and roadmap) is needed to support that business track. The following chapters try to give perspective on what needs to be considered in minimum from IPR side in commercial arena to support best utilization path.

3.1. IPR activities and competences in Start-ups vs. Scale-up vs. Corporations

Even though the setup for building competitive advantage around intellectual ownership differs between start-ups and bigger corporations, it is still useful to take example of ways to build strategy in big corporation, like IBM (

Table 3 below), and reflect the reality that one faces as a newcomer. In this corporation level IPR strategy visualization there are three operational levels, “Direct”, “Control” and “Execute”. They separate strategic decisions (Direct), management checks (Control) and business actions (Execute) on business competencies. Even though this is built for big corporation needs, it also shows in a single table that what one needs to have in place when IPR portfolio is significant, competition happens on global scale and investment stakes are high. There is natural development cycle to evolve in IP utilization and this which is well visualized in so called IP expectation hierarchy by Patrick Sullivan and Suzanne Harrison. Figure 8 below visualizes this hierarchy, to which most companies can position themselves. It should be noted that the position is not dependent on the size of the company but its ability to extract value from the invested IP. Also, relative position can be different for different IP categories or forms (

Table 3).

Figure 8. IP expectation hierarchy. Source: Edison in the Boardroom[13]

- Defensive level. Companies at this level use their IP for defensive purposes only. Their goals are to protect their own innovations, to ensure that they don't infringe the IP of others, and to obtain more IP. The costs in filing fees, enforcement and other legal expenses can be high.

- Visionary. At this level of IP management sophistication, companies take a long-term view of the company's role in business and in its industry. They seek to use the company's IP to create more strategic value.
- Integrated level. Here the company's business units have grasped the power of using IP for a range of business roles. IP use for business becomes integrated across all of the company's business activity.
- Profit center level Companies reach this level once they begin to license out their IP, or otherwise to use it in support of their company business activity.
- Cost control level Companies at this level still have a defensive approach, but now focus on finding ways to obtain protection while simultaneously minimizing the costs of creating and maintaining their IP.

Table 3. IBM's IP Component Business Model to position different IPR related activities.

<table>
<tr><th></th><th colspan="2">PLAN</th><th colspan="2">CREATE</th><th colspan="3">LEVERAGE</th></tr>
<tr><th></th><th>Evaluate</th><th>Enable</th><th>Invent</th><th>Manage</th><th>Defend</th><th>Influence</th><th>Capitalize</th></tr>
<tr><td rowspan="4">Direct</td><td>IP Assessment</td><td rowspan="2">Culture of Innovation</td><td rowspan="2">IP Pipeline</td><td>Ip Policies</td><td>Enforcement Guidelines</td><td rowspan="2">Influence Innovation and IP Network</td><td rowspan="2">Leverage Innovation and IP Network</td></tr>
<tr><td>IP Strategy</td><td rowspan="2">IP Tools</td><td rowspan="2">Risk Management</td></tr>
<tr><td>IP Landscape</td><td rowspan="2">Communications</td><td rowspan="2">IP Portfolio</td><td rowspan="2">Reputation Building</td><td>Sales / Licensing Guidelines</td></tr>
<tr><td>Partner Landscape</td><td>IP Budget</td><td>Negotiation Leverage</td><td>Collaboration Guidelines</td></tr>
<tr><td rowspan="4">Control</td><td>IP/Business Strategy Align</td><td>Organisational Change Management</td><td>Deploy IP Organisation Enablement</td><td>Allocations</td><td rowspan="2">Manage Infringement Assertations</td><td>Legal / Regulatory</td><td>IP Asset Valuation</td></tr>
<tr><td rowspan="2">IP Needs list</td><td rowspan="2">IP Organisation Infrastructure</td><td rowspan="2">Deploy Inventor Enablement</td><td>IP Portfolio Management</td><td rowspan="2">Industry Standards</td><td>IP Asset Marketing</td></tr>
<tr><td>Quality Management</td><td rowspan="2">Performance Measurement</td><td></td></tr>
<tr><td>Performance Measurement</td><td>Performance Measurement</td><td>Performance Measurement</td><td>Performance Management</td><td>Performance Measurement</td><td>Performance Measurement</td></tr>
<tr><td rowspan="4">Execute</td><td rowspan="2">IP Strategy Implementation</td><td rowspan="3">IP Organisation Enablement</td><td rowspan="2">Inventor Training</td><td rowspan="2">Invention Evaluation</td><td>Invention Identification</td><td>Asset Donation</td><td rowspan="2">IP Engagement Enablement</td></tr>
<tr><td rowspan="2">IP Leaks</td><td rowspan="2">Open Innovation</td></tr>
<tr><td rowspan="2">Regulatory &Legal monitoring</td><td rowspan="2">Invention Harvesting</td><td rowspan="2">Invention Review Process</td><td rowspan="3">Defensive Leverage Creation</td><td rowspan="2">Standards Participation</td><td rowspan="2">Product Sales Enablement</td></tr>
<tr><td rowspan="2">Landscape Monitoring</td><td rowspan="2">Inventor Enablement</td><td rowspan="2">Strategic Invention Development</td><td rowspan="2">Publications</td><td rowspan="2">Asset Negotiation</td></tr>
<tr><td>Licensing</td><td>Legal/Regulatory Intervention</td></tr>
</table>

When a start-up and later hopefully a scale-up builds its competence around IPR, there are far less resources and one must apply prioritization on every aspect of the process. However, all the steps that one takes should support the growth and sustainability of the business.

For start-up (or spin-out) companies the constant search for funding is typically what dominates the modus operandi on management level and especially within deep technologies like quantum technology, one needs to understand the decision criteria for VCs (Venture Capitalists). As risk investors, they typically accept the rule of the game to be such that 10% of the cases funded create the actual revenue. Nevertheless, they are also interested in increasing this proportion and therefore

[13] Patrick Sullivan and Suzanne Harrison, Edison in the Boardroom.

try to find a winning recipe for doing so. There are a lot of parameters and criteria one can set to make the actual selection but typically VCs focus at least on the following aspects: team competence, technology readiness, business opportunity and IPR. The role of the IPR is to guarantee the clarity of ownership and level the risks in relation to competition in the field.

Besides risk capital or any institutional funding, it is advisable to look also at public funding sources. As regional ones provided through the EU or national ones, can easily double the funding. From the beginning, it should be acknowledged that with each funding round, the founder's equity share will decrease but, the funding should increase value that is justifiable from the investment point of view. Otherwise, one runs into the risk of having the relevant (and contributing) people, finding the incentives too insignificant. Figure 9 below gives one possible example on which IPR tasks probably are on priority list of a growth company when it passes through the funding rounds.

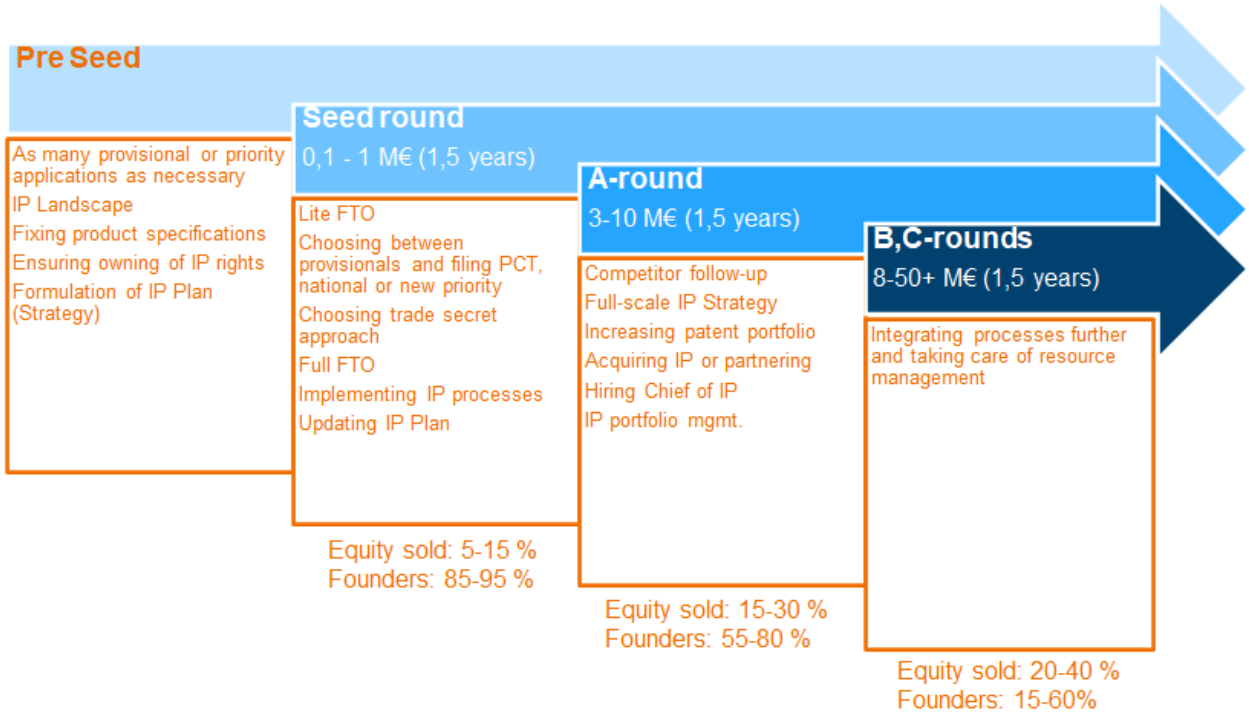


Figure 9. Example runway of one possible imaginary IPR roadmap (with equity sold) from lab-to-market along the funding rounds.

It is important to remark that, if possible, a company should strive to self-fund through product sales, thus avoiding unnecessary funding rounds.

For start-up or spin-out in deep technology company, there typically in the beginning isn't a huge Intellectual Asset portfolio to take care of but usually after bigger investments it needs grow to lower the risks in relation to ownership of the technology. With smart outsourcing of IP protection, start-up can manage up-to 10-20 patent families but even then, it tends to take a significant amount of management time. To make smooth transition to organization that can climb in its ability to manage IP (hierarchy of IP management, Figure 8 above), one should early on implement IP management process which is aligned with IP and business strategy; meaning that all the IP investments are rated and for example patent protection investments are reflected against decision criteria that takes into consideration in minimum following factors; technology readiness (for example TRL), business readiness and IP readiness (including factors like grants, strength and scope of IP protection). There

are several parameters within that one can optimize to make decision making process effective and to support different levels IP expectation hierarchy. The sooner one can reach the top level however, one can expect to get significant support for competitive position.

3.1.1. Building foundational IPR abilities in a start-up

Typical start-up founders among deep technology fields don't often have separate IPR experts among their team members, which means that the duties fall to either CTO and/or CEO roles. This is part of the transition period where all the people within the team must be much more flexible and do almost everything that isn't typically required for their role in bigger corporations or even medium-sized companies. This period provides participants with the opportunity for a learning curve that is at its best enjoyable, but at its worst is terribly consuming. It is therefore advisable for start-up teams to reserve enough either funding for outsourcing certain elements and/or include into the advisory board such experts that have the skills and experience necessary to support building this competence and scaling. It is important to notice that since IPR, especially within deep technologies, is a core business competence, these advisors or experts must be committed to common interest. Typically, this means that they are included in the shareholder program. Besides IPR expertise, legal expertise is usually among those skills that are not often represented in the founding core team. Fortunately, these days there are good support organizations and if one finds a competent VC funder, they even require that these skill sets are present to support the team.

In relation to building this foundation, there is readily available good reading material that is focusing to IPR alone like: "Intellectual Property Management for Start-ups: Enhancing Value and Leveraging the Potential" by authors Martin A. Bader and Sevim Süzeroğlu-Melchiors. Additional related reading material is available from European Patent Office website.

3.1.2. IPR strategy and Porter's five competitive forces

Especially in new emerging technologies, it might be hard to implement traditional strategy tools, but many IPR related dimensions might reveal elements that are necessary in building the overall business strategy which IPR supports. As with any business strategy, IPR strategy is there to support business and therefore it is important to understand one's own position in the competitive environment. There are numerous business development tools to support a business strategy build-up[14] and one can use either all or just one of them[15]. The important aspect is that the selected tool(s) must suit the task at hand; in IPR related technologies this method has the ability to see through lengthy development processes with higher risks involved in deep technologies.

Sustainable own IP creation is part of patent protection quality and therefore, it is considered as an item of its own. Unfortunately, this isn't enough in a dynamic world, and one needs to establish updated IP landscape (or competition) follow-up which gives away possible changes in the field. That

[14] Examples of such tools are Business Model Canvas, NABC – Need, Approach, Benefit, Competition tool by SRI or more traditional SWOT analysis Examples of such tools are Business Model Canvas, NABC – Need, Approach, Benefit, Competition tool by SRI or more traditional SWOT analysis

[15] There is good amount of information on how to use these tools available, as for example BMC has been productized through Strategyzer in a Business Model Generation Handbook form

needs to be considered also along the way when new pivoting opportunities and technology generations are developed. All following IPR focused tools are filtered through Porter's five competitive forces (Figure 10). The later extension to Porter's five forces or so-called 6th force of complementors[16] that provide related products or services in the market can affect also in relation to quantum computer technologies if it is not able to deliver the promised potential or is able to do it only partially. In quantum computer domain, this could mean for example the current HPC (High-performance Computing) solutions that do not directly compete and are estimated even in the current environment to rather complement quantum computers than directly compete with them.

Figure 10. Porter's five forces of theory (competitiveness)[17].

3.1.3. Patent protection quality (Porter: Threat of New Entrants)[17]

The key aspect in patent protection is the realization that, at the end, it is a prevention right to exclude competition from coming into the claimed area of protection (in commercial arena). This leads to a fact that every patent should be drafted (especially the claims) with the anticipation that competitors will want to replicate, improve upon or design around your solution, either now or up to 20-25 years from now[18]. The quality of patent claims is essential in all aspects of bargaining power that one can build in the market as well as blocking substitute products or new entrants.

[16] Brandenburger, A. M., & Nalebuff, B. J. (1995). The Right Game: Use Game Theory to Shape Strategy. Harvard Business Review, (Vol. 73, No. 4), 57–71.
[17] Michael E. Porter, "How Competitive Forces Shape Strategy", Harvard Business Review, May 1979 (Vol. 57, No. 2), pp. 137–145.
[18] maximum validity period for patents is 20 years and in pharma even up to 25 years.

There are certain key elements that define a good quality patent protection. The following indicators are examples of those and reflect not only the patent formulation but also the aspects of business and technology that it captures.

- Claimed invention provides significant benefits and/or cost benefits in comparison to competing solutions (Value proposition & Business opportunity)
- Claimed invention provides a solution that targets big enough market volume (Business opportunity and maturity)
    - Target expectation for annual TAM (Total Addressable Market) is over 100 M€ (reasoning below – TAM, SAM, SOM explained in Figure 11 below)
    - Royalties in licensing is in the range 1-20% and most often under 10%, i.e., 1/100 of TAM is good case scenario for expected royalty revenue (1-10 M€ annual revenue).
    - SOM (Serviceable Obtainable Market) tends to be on the same scale as Royalty in the short term.
- Claimed invention works on real-life environment and is scalable (TRL or technology maturity)
- Is patentable, i.e., novel, and inventive in comparison to the public prior art. (Patent formulation and prior art landscape)
    - The sooner one is aware of the closest prior art, the better one can carve out the value of the invention.
- Is not dependent on 3rd party IP that isn't accessible – Freedom to Operate (Prior art landscape with 3rd Party granted protection)
    - Essential for spin-out path
    - Accessible IP means that one can in-license (or cross license) it and the costs of it need to be taken into consideration within the financial projections.
- Claimed invention is written in clear and understandable language, and a disclosure that explains the invention in sufficient detail, typically including drawings and preferably some proof that claimed technical effects are plausible (Patent formulation and disclosure)
- Possible infringement is easy to see or prove from the product in the marketplace. (Patent formulation)
    - Process related patents without structural elements require access to production line and are harder to prove and therefore often even impossible to enforce
- It is difficult to circumvent or replace with new technologies without significant R&D effort.

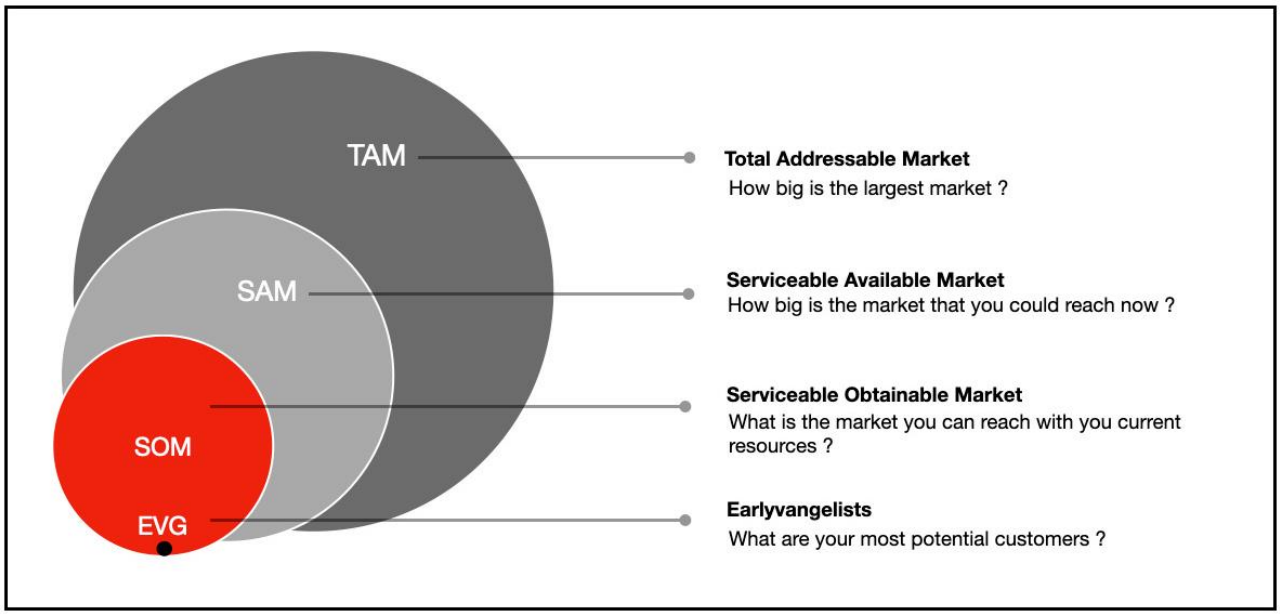


Figure 11. Total Addressable Market, Serviceable Available Market, Serviceable Obtainable Market explained. SOM is the relevant figure to estimate for early phase financial projection in spin-out path. TAM is a reference point for investors on the growth base opportunity.

3.1.4. IPR as information source - competition analysis or IP landscape (Porter: existing competition) and IP follow-up (Porter: new entrants)[17]

If one is about to build a new IP Asset strategy, it is good practice to use IPR databases as a source for competitive information. The additional diligence requirements often pay up in the end: after all, nobody wants to end up noticing after significant R&D investment that one has either huge risk in infringing 3rd party IP rights and/or having to pay for in-licensing those rights.

There is a whole lot of diligence required to get full benefit from all the information provided and it is by no means a one-time activity. One should note that through free public patent databases (like European Patent Office – Espacenet) it is possible to access over 150 million national patent applications in over 100 countries. Moreover, with professional (even AI supported) data-mining tools one can today achieve very accurate perspective about the state-of-the-art situation. There is of course, one caveat: there is still a blind spot of 18 months – about 1 and a half years – where patent applications are by default secret before they become public.

Another aspect is that patent documents often are not published in scientific journals. It is estimated that even 30% of overlapping R&D development could be avoided with the diligent use of patent databases. Besides the obvious finding of already invented solutions that are freely available for use (as most of the public patent documents are either not in force anymore or have never been granted due to other publications at the time), there is also the angle of Freedom to Operate (FTO) in the space when there are granted rights. As FTO assessment requires additional aspects on data analysis, it is considered as a separate item.

As IPR analysis needs vary, one should understand what the most common ones are. Patent authorities often do “Patentability assessment”: where the applied patent claims are compared to what is published before filing date. If the novelty and inventiveness criteria is fulfilled and there seems to

be so called industrial applicability, the patent can be granted. One should understand that inventiveness criteria include a definition of so called "expert in the field" who has the ability to combine known publications with certain limitations and typically the argumentation about inventiveness requires most of the effort in the process. Typical granting time for a patent application varies between different patent authorities but is quite often in the range of 3-5 years since the filing. These days, one has also a possibility to use the so-called PPH (Patent Prosecution Highway) system which can speed up the process as the authorities within the system can utilize other authorities' decisions more effectively. It requires however that the applicant actively informs other authorities on positive granting decision and asks this to be taken into consideration.

Patent invalidation analysis is something that companies usually do themselves when they notice that competition has either filed a patent application which is not yet granted but seems to endanger their ability to operate in the area. Even in case of an already granted patent, there are instruments for protecting a company from preventive rights of patent. There is in fact the so-called opposition period which is in European Patent Office 9 months. During this time the public has opportunity to challenge the patent to be granted with a lower bureaucracy expectation.

Although harmonised on many levels, one should not forget that patent laws still maintain some differences between different jurisdictions, and some of those might have differing approaches for practices such as the opposition. Finally, even after the opposition period, there is certainly the possibility to invalidate but the expenses get higher.

While IP landscape analysis is usually considered a prerequisite or even recommended before FTO, which requires more multidisciplinary expertise and collaboration and is therefore often more expensive, that is not always the case. IP landscape can give valuable information about the competitors in the field and their activities in it. There are many ways to approach the matter and quite often this might happen when a company is launching a new product or looking to fund. IP landscape analysis allows to have a bird's-eye view on the competition, and it might also generate continuous follow-up for certain areas. If a product is of core interest for a company, they quite probably have radar or follow-up activities on critical and sometimes even wider aspects of that technology.

Without going too much into details of making actual data analysis, there are both commercial search tool providers and service providers (if internal resources don't exist) for these assessments and for more in-depth analysis, professional service is advisable to be used. Besides more traditional search string-based tools where technology can be searched from full text databases with traditional Boolean searches, plethora of AI based, and AI guiding data analysis tools are now available. These latter tools require perhaps less expertise to make these assessments, since the AI is able to do a lot of the heavy lifting. To support the search work, patent databases have many value-added data fields like Patent classifications (several available) and usually these are used on parallel. It is sensible to seek advice from IPR professionals in the field, concerning what tools are available and what are respective strengths and weaknesses if any. Analysis is always the first step towards strategical decision making.

IP citation analysis is a of sub-category of the competition analysis. Its necessity comes from the fact that after any entity files a patent application, the patent authorities identify any relevant prior art (so called backward citation – and this can sometimes include also include publications that have been

identified by 3rd parties or competitors). On the other end, there are also citing publications (so called forward citation) that are published after this the patent application and are citing it. The applicant is not automatically informed about their existence, and they require an active search. On this subject, it is recommended to follow-up especially on the so-called X-relevant citations as they are considered, at least at certain stage such as the claim scope, to be patentability restrictive documents. This can obviously reveal a potential infringing party and/or licensee candidate(s). Figure 12 below shows how this kind of information can reveal a lot more information about the competition and can be utilized for many purposes, be it collaboration opportunity, roadmap ideation, monetization lead generation etc.

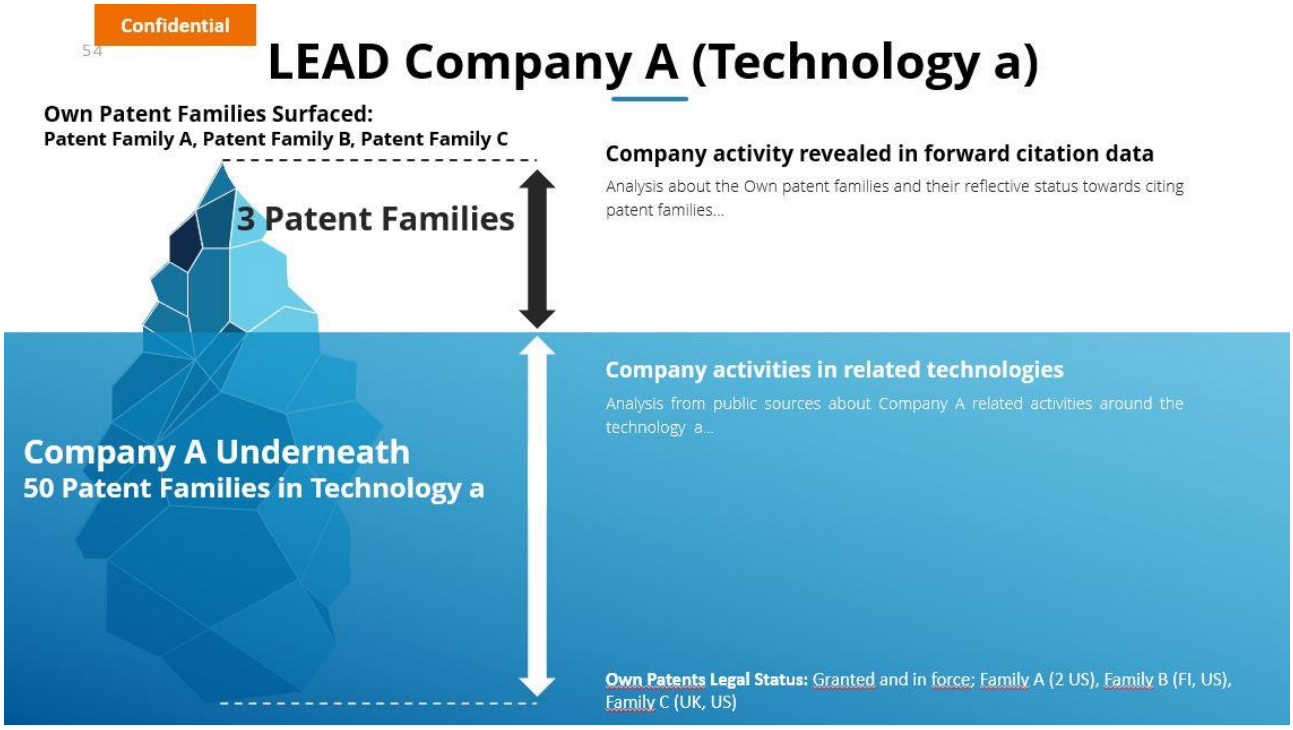


Figure 12. IP citation analysis template to visualize existing competition and relative bargaining power.

3.1.5. Freedom-to-Operate (FTO)[17]

One critical part of overall IPR due diligence is the so-called Freedom-to-Operate assessment. It tends to be misunderstood among those who have not been involved with infringement situations before as no matter how many patents or other forms of IPR protection one might have, it doesn't guarantee you necessarily the freedom to operate if there is already existing and granted 3rd party IPR that your IPR is dependent on. The positive aspect of this is that in the case of patent rights, the rights are both time limited and regional. Therefore, even if one faces limiting patent rights (or utility model rights), those may be expiring and/or in-force in countries that have little or minor effect on building business case around the proposed solution. Another aspect of FTO assessment that one should understand is that it is targeted towards the product as whole (blueprint) and in many new entrant cases, the own IPR is focused on new (novel and inventive) aspects of the solution but not necessarily all supporting aspects of the product. For example, if the product is a bike and one has granted patent on the control

rod and competition has granted patent on the frame and wheels, there is no FTO in bike as business with control rod patent alone. Even after the negative results of FTO assessment, one has several options ahead. Those options are considered in the next chapters, but these can be precautions as well – as prevention right requires the owner the right to also prohibit the infringer from actively doing what is under those prevention rights. One should, however, be aware that for example in the USA wilful infringement of those rights can lead to triple damage claims. All these options require some effort – so before one proceeds with them, it's sensible to consider if one needs them at all, meaning; evaluate if the protection right is still enforceable (in force, payments paid etc.) and in force where the commercial action will take place (as rights are region or country specific). FTO assessment requires typically a so-called claim chart analysis, where the patent claims are simply gone through point by point against the features/elements in product to be represented in the manner described below in Figure 13. Claim charts can be done in various ways but the common feature among them is that often-complex claims and their even more complex counterpart in products are compared towards each other in this table form to prove without a doubt that overlap either exists or not. As product language us quite typically different from the patent language, this often requires some translation on terminology used.

Patent Number: US6577099B2			**Filing Date:** May 4, 2001	
Title: Method and apparatus for providing and storing power in a vehicle			**Publication Date:** June 10, 2003	
Assignee: Delphi Technologies, Inc.			**Family Member:** EP1254804A3	
#	**Company/Research Institute**	**Independent Claims**	**Product references**	**Reference links**
1	**Panasonic Corporation**	Claim 1: **Element1:** A power supply for a vehicle, comprising	The **12V Energy Recovery System for idle-stop vehicles** converts deceleration energy into electrical energy so that it is able to reduce the need of power generation by the gasoline engine	
		Element2: a plurality of first batteries; and a plurality of second batteries being connected in parallel with said plurality of first batteries,	The **12V Energy Recovery System**, which is designed to be **connected in parallel with the main lead-acid battery**, has the same 12 V voltage as the main battery. Panasonic's **12V system uses 10 1.2 V Ni-MH battery cells**	
		Element3: said plurality of first batteries and said plurality of second batteries being configured to provide and receive a source of power from an electric machine; and wherein said electric machine is a motor/generator being configured, dimensioned, and positioned to provide either a negative or positive torque force to a vehicle drivetrain.	This system is designed to complement the performance of main lead-acid battery by **supplying power to the vehicle's electrical components as well as the drive assist motor**, thus increasing the functionality of idle-stop system and improving fuel economy	

Figure 13. Example of patent claim chart analysis vs. product features to prove infringement situation. Source: SciTech Patent Art

3.1.5.1. Technology iteration

This is typically the option that one tries to adopt if the limitation by 3rd party IP is minor or "weak" in its width and therefore avoidable with small modification. However – if the protection area is wide and therefore harder to circumvent, this can cause significant additional R&D cost and be in the end an even worse solution to the problem at hand. Simplifying the often-complex assessment situation, there is often a heightened probability to circumvent the protection area when the claim is lengthy. Nevertheless, given that there are three different transition phrases "comprising", "consisting of" and "consisting essentially of" that signal inclusion or exclusion of certain elements one should be careful in making hasty conclusions. Patent attorney expertise is advisable to be used at least when there is doubt about the interpretation.

3.1.5.2. Invalidation process

If technology iteration or circumventing the protected solution isn't possible, the 2nd option is to go through the scrutiny of analysing the possibility to invalidate the granted protection rights. This could mean, for example, finding prior art material that wasn't found by patent authorities when the protection was granted, or pointing out that the described invention couldn't work with described setting. Besides these options, the granted protection could be challenged through procedural errors like naming wrong inventors, but these require some insight that isn't evident for outsiders. As with going around or circumventing protection area, claim chart analysis is the basis of defensible invalidation cases.

3.1.5.3. In-licensing, cross-licensing, and/or partnership

If both circumventing patent protection area and invalidation of the IP right are not viable options, there is always the option to license in the IP from the holder of the IP right. Keeping in mind that the need for that license might be only for limited region and limited time. In the best-case scenario, there will be wider collaboration or partnership with the licensor which can include cross-licensing elements in which both parties license their own IP to the other party, if both parties have complementing IPRs. The short-term effect is that one needs to make new financial planning and estimate the strain on price margins but if the market is still viable, this shouldn't be a problem and cross-licensing again can often be done in a way where immediate transfer of funds is not needed. Similar approach is often done through patent pools and considered later in Chapter 4.

3.1.6. IPR valuation (Porter's five: as its best should consider all angles)

As Commission Recommendation 2023/499 specifically mentions IPR valuation as one concrete action in building IPR strategy, this Chapter gives some guidelines on how to approach this aspect. There is a lot of literature on this topic, and various methodologies on how to do valuation. Some of these literature references, are very extensive like BVR's Guide to Intellectual Property Valuation[19], and some provided even by Public Patent Authorities like WIPO[20] and there are already also national or regional assessments about advantages and disadvantages of IPR valuation in practical use. Whatever the angle is, it is good remember that IPR valuation's target is not to give absolute correct answer on the value of IPR but rather a range (where several methodologies are used, often in minimum being either cost or market-based valuation) that enables seller and buyer to start

[19] Pellegrino, M. 2012. BVR's Guide to Intellectual Property Valuation, 2nd Edition
[20] https://www.wipo.int/wipo_magazine/en/2016/01/article_0002.html

negotiations – and perhaps even common ground for respective argumentation on different views on the matter.

IPR valuation and its relative importance as core function determines also whether it is something that needs to be done with internal valuation experts or is it rather more external exercise. For technology transfer functions and M&A functions (that are doing this all the time), this requires internal expertise; for a start-up or spin-out, this happens only during funding rounds. Even then, it's better to have unbiased (outsourced) review on the matter. This approach has also the advantage to reveal the inherent challenges of the opportunity offered. One should note however that outsourcing doesn't mean that there wasn't a necessary skill set to understand the logic within and the strategic implications it has and that the pricing decision itself is in the hands of the owner. The buyer or investor will anyhow make their own assessment of the situation.

3.1.6.1. Cost based valuation

The cost-based valuation is often used as a sort of baseline for valuation and in principle it shouldn't be the final condition on which to base the price, as there are many factors that need to be considered and using it alone could also provide licensor with the wrong kind of incentive structure. However, if the confidence to market-based valuation isn't high enough, it may get higher relevance. To set it up, one takes for example 8 years of cumulated investments (protection costs included) and their respective return factor for investments, product lifespan, the rights granted to licensee (non-exclusive, exclusive…), the portion of projects costs that target to the licensable IP and quality factor of IP package (discount factors). Also, in some national laws, public entities are required to price their IPRs with a market-based approach. Private companies obviously don't have this limitation.

3.1.6.2. Market based valuation

There are many market-based valuation methodologies (which are left to be considered and self-studied from sources like Pellegrino's BVR's Guide to Intellectual Property Valuation[19] and as an example here is the so-called Relief from Royalty method. There the basis is in so called Net Present Value (below)

$$NPV = \sum_{t=0}^{n} \left(\frac{R_t}{(1+i)^t} \right)$$

- where Rt = net cash inflow-outflows during a single period t
- t = number of time periods
- i = discount rate or return that could be earned in alternative investments

and as the royalty rate should reflect profitability of the business, it tends to be heavily dependent on industry and kind of generally accepted royalty rates in respective industry domain. For example, in the semiconductor and electronics industry the median royalty rates are well below 5% but there are other industries like pharma or bio where those same rates are well over. In general, it is rarely over 10 % though. There is also the so called "Goldscheider Rule of a thumb" – also known as "entire market rule" that 25% of EBIT can be considered fair royalty rate – however this doesn't take into consideration that what proportion of the whole product pricing is coming from this license alone.

Meaning, if licensee and licensor agree that the contribution is 10% (and 90% is coming from other sources) then that should be considered as well. Quite often it tends to be also so that profit margins are considered trade secrets and therefore can probably only be estimated indirectly from the product to be or from operating profit (balance sheet) of the company. Reasonable royalty rate has been under scrutiny in several court cases and for example the USA case law has identified following factors to decisive pointers on what it could be:

1. The royalties received by the patentee for the licensing of the patent in suit, proving or tending to prove an established royalty.
2. The rates paid by the licensee for the use of other patents are comparable to the patent in suit.
3. The nature and scope of the license, as exclusive or non-exclusive; or as restricted or non-restricted in terms of territory or with respect to whom the manufactured product may be sold.
4. The licensor's established policy and marketing program to maintain his patent monopoly by not licensing others to use the invention or by granting licenses under special conditions designed to preserve that monopoly.
5. The commercial relationship between the licensor and licensee, such as, whether they are competitors in the same territory in the same line of business; or whether they are inventor and promoter.
6. The effect of selling the patented specialty in promoting sales of other products of the licensee; the existing value of the invention to the licensor as a generator of sales of his non-patented items; and the extent of such derivative or convoyed sales.
7. The duration of the patent and the term of the license.
8. The established profitability of the product made under the patent; its commercial success; and its current popularity.
9. The utility and advantages of the patent property over the old modes or devices, if any, that had been used for working out similar results.
10. The nature of the patented invention; the character of the commercial embodiment of it as owned and produced by the licensor; and the benefits to those who have used the invention.
11. The extent to which the infringer has made use of the invention, and any evidence probative of the value of that use.
12. The portion of the profit or of the selling price that may be customary in the particular business or in comparable businesses to allow for the use of the invention or analogous inventions.
13. The portion of the realizable profit that should be credited to the invention as distinguished from non-patented elements, the manufacturing process, business risks, or significant features or improvements added by the infringer.
14. The opinion testimony of qualified experts.
15. The amount that a licensor (such as the patentee) and a licensee (such as the infringer) would have agreed upon (at the time the infringement began) if both had been reasonably and voluntarily trying to reach an agreement; that is, the amount which a prudent licensee who desired, as a business proposition, to obtain a license to manufacture and sell a particular article embodying the patented invention would have been willing to pay as a royalty and yet be able to make a reasonable profit and which amount would have been acceptable by a prudent patentee who was willing to grant a license.

3.2.Licensing negotiations

Basically, the same tools that were used in valuation apply to pricing in preparing the case towards licensing technologies and indeed "technology licensing" is the current way of operation for most technology transfer functions. The licensing may be carried out by a private company established by the RTO, by the RTO itself, or by a company contracted by the RTO. The technology license will be full package including not only patents or trademarks but also know-how, material, prototypes, designs, software etc. that is needed to deploy the technology to the full scope of license.

Experience shows, however, that many European-based RTOs have challenges in licensing their technology. This is partly due to capacity constraints within the RTOs and also the terms and conditions expected from the licenses.

The license may often have two components – one component which is exclusive (or semi-exclusive) to the licensee and another component which is background IP that is required to implement the licensed technology, but which is licensed out also to other companies on a non-exclusive basis. Research organizations often do parallel development projects to a variety of customers using the related Background IPR and thus cannot give exclusivity.

The best practice for carrying out license negotiations is to do them in phases. The starting point is a term sheet (often non-binding) to agree on the general terms and conditions. It may also include a licensor's "red lines", I.e., those conditions which are non-negotiable and that often concern things like liabilities, warranties etc. The term sheet should include the main business aspects of the future license agreement, like scope of the license (technology – preferably in a separate annex, field of application, territory, and degree of exclusivity). The compensation model should be described as completely as possible (upfront payment, royalty, milestone payments, annual fees or minimum royalties, royalty cap etc.).

The actual license negotiation can be carried out based on the term sheet. The license will need to include those legal details that if discussed too early might side-track the discussion unnecessarily. The final license agreement may also have an option clause, which is usually included when there is still a lot of uncertainty about the actual performance of the technology under license. Such clause needs to be confirmed by licensee before the actual commercial license activates and until that work is done under development license conditions.

Experience shows that public research organizations prefer to have non-exclusive licenses to spread the technology as widely as possible. This can be challenging for a commercial entity to accept. Commercial entities need to invest significant amounts of money to bring technology developed in the RTO to commercialization. Thus, commercial organizations, and their funders, are generally looking for a competitive edge through some degree of exclusivity. Experience also shows, however, that the policy of some RTOs excludes exclusivity, and this can be an impediment to licensing the technology. The most important argument for public entity is that non-exclusive license keeps the option open for licensor to look for more effective paths to market if licensor for one reason or another is not able to do that. It is true that exclusivities of long duration are rarely given, and many RTOs prefer shorter limits of three to five years. Many RTOs will also give exclusivity in limited fields of

application, e.g., a new cooling technology that could be generally used, but a license could be exclusively licensed to be limited for qubit cooling in quantum computers.

Other difficult selling clauses that some European RTOs are adopting are the so-called improvement clauses, where the licensor reserves a grant-back from the licensee to any possible future improvements to the technology that has been licensed. The purpose of this kind of approach is to secure FTO in the field, where RTO is active. To sweeten the deal, it may include a symmetry where licensor promises similar right to the licensee on their respective improvements.

In technology licensing, the licensee quite often would like to see the licensor's commitment to enforcing the IP rights However, public research organizations rarely want to take full responsibility on enforcing IP rights, as it can be expensive (in US, a typical patent litigation cost is around 1-3 MUSD). Nevertheless, public research organizations should consider taking actions against infringement situations (at least when infringement is evident) as otherwise there might not be too much credibility in the threat aspect of prevention rights that they own.

The lack of exclusivity and the challenges in enforcing rights are probably the reasons why public research organizations have little success in patent licensing alone. Licensees quite often have different reasoning for taking the license, namely the otherwise hard-to-get know-how or trade secrets that many research organizations have as well. Experience shows that quite often most of the value in the technology licenses is around know-how IP and this might create an inherent danger to RTOs that are not able to either secure it or due to this value in-balance lose focus on investing in good quality patent protection.

Licensing can also be used to enable Freedom to Operate between companies. The large number of patent applications being filed in the quantum space and the similarity of technologies means that it is almost inevitable that quantum companies will require access to patented technologies from other companies. It is common practice in information and communication technologies for cross-licenses to be granted to enable both companies to exploit technologies. Such cross-license agreements may also require the payment of balancing payments when one company has significantly more filed patent applications and granted patents than the other company.

The license agreement needs also to include trade and export clauses to cover different regulations that follow from respective international agreements between nations. A licensor must have reporting and audition clauses to reserve the right to monitor that the reported license fees are paid according to the reported figures and that those figures are real. Audition programs are usually implemented and followed by a ruling that licensor wants to follow.

3.3.Post grant procedures: patent litigation and opposition before the EPO

A patentee can seek relief against an alleged infringer in a patent enforcement action before the national court. Similarly, if a party is of the opinion that a patent is invalid or that it does not infringe a patent, that party can seek relief before a court in the form of a declaratory judgement regarding the validity or infringement respectively. Forms of relief include amongst others:

- an injunction ordering a party to stop infringing activities
- a declaration that a party is infringing or not infringing a patent
- (partial) revocation of the patent
- Order to seize of infringing goods, including customs seizures
- Order to preserve evidence of infringing goods
- A recall order for retrieving / destructing infringing goods
- payment of damages
- compensation of costs of the litigation (including fees of lawyers, patent attorneys and experts, etc.)

Typically, infringement and validity (e.g., as a counterclaim by the alleged infringer) are dealt with together by a single court. In some countries however, such as Germany, infringement and validity are dealt with by different courts.

The question of which court is competent depends on factual circumstances such as where the infringing activities take place and/or the place of business of the parties. The rules relating to which court is competent to hear a case in an international lawsuit are governed by the so-called Brussels I Regulation. Popular venues of patent litigation include Germany, UK, France, and The Netherlands. Costs and the court proceedings can differ substantially between different jurisdictions.

Up to 1st of June 2023 patent litigation in Europe was dealt with by national law, i.e., the national patent law and code of civil law of the country where the action takes place. Hence, up to that point, a national competent court decides on patent related issues. In international cases, it often happens that court cases in different European countries are pending, all related to one European patent, with the risk that different courts may decide differently on the same or similar infringement or validity case.

Since the 1st of June 2023 it is possible to obtain a European patent with unitary effect in 17 EU member states[21] that ratified the Agreement on a Unified Patent Court (the UPC agreement). Such European patent with unitary effect is referred to as a Unitary Patent (UP). The court that is competent to hear cases related to UPs is the so-called Unified Patent Court (UPC), which is an international court set up by participating EU Member States to deal with the infringement and validity of both Unitary Patents. In an (extendable) transition period of 7 years, the court is also competent to hear cases related to European patents that have not opted-out. The UPC has a decentralized structure with local and regional divisions located in the contracting Member States, a central division and a

[21] Current EU member states that ratified the UPC agreement are: Austria, Belgium, Bulgaria, Denmark, Estonia, Finland, France, Germany, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Portugal, Slovenia, Sweden.

common Court of Appeal seated in Luxembourg. The UPC panels will sit in a multinational composition and consist of both legally and technically qualified patent judges. The procedure is designed in a way that judgments at first instance can be expected within approximately one year of filing the action. The UPC eliminates or at least substantially reduces the need to initiate multiple cases in different European countries. The court also will play an important role in generating a harmonized European approach towards infringement and validity.

Patent litigation is expensive and should be carefully reviewed and evaluated before taking such a step. Only a few patents end up being litigated in court and it is very important to fully understand the process and the costs involved and to carefully decide on a strategy, including e.g., selecting a patent, evaluating the evidence, and selecting a court. The costs may easily vary between 200k-500k Euros (for a case in DE or NL) and a few million Euros (in the UK) for a court case on the merits. These costs not only include the price tag of the patent litigators, patent attorneys and experts that often take part in these proceedings, but also factors in the rule in Europe that the losing party will bear a substantial part of the costs of the winning party. Moreover, typically in Europe patent litigation cases are front-loaded meaning that when filing an infringement action proof of infringement needs to be provided, which may need the involvement of technology experts and sometimes quite challenging Reverse Engineering (RE) assessments on the suspected patent infringing product.

Depending on the circumstances, the validity of a European patent may also be challenged using the so-called opposition procedure before the European Patent Office. An opposition must be filed within 9 months of the mentioning of the grant of a European patent. The procedure is less formalistic and cheaper (10-50k Euros) compared to a revocation procedure before a court. If the opposition is successful, the European Patent (including possible UP and EP registrations) will be revoked. This decision is appealable to the Boards of Appeal (which can take a long time).

4. IPR and Standards

Standards are necessary in certain technology platform areas where several different technologies need to work together effectively, and their accessibility needs to be secured for a wider audience. The conflict with preventions rights (like patents) might arise when standard related technology utilizes patent protected technology and monetary compensation isn't acceptable to either party. To mitigate this risk, SSBs (Standard Setting Bodies) provide their own patent policies, where participants are required to set forth any relevant patents they own and agree on specific licensing conditions that must be granted under fair reasonable and non-discriminatory conditions (FRAND) or that the license must be royalty free. Quantum computer and communication technologies in European context will be adopting this approach and therefore it is necessary to understand what it typically entails if one is participating as a patent owner. Licensee should for example understand that FRAND conditions and the non-discriminatory part gives other potential licensees (meaning their competition) the same conditions for licensing and therefore no additional competitive edge them as licensee from IP license alone.

4.1.Patent tools

Patent pools are efficient collaborative ways for licensees to access a bundle of patents instead of a single patent at FRAND conditions, and for licensors to see a return on their investments while mitigating costly patent disputes with other patent owners in the same technology.

These patent pools then provide standard licenses in respect to licensees who may be members or not of the pool and allocate to each member of the pool (licensor) a licensing fee according to the agreement of the pool, e.g., typically proportional to the contribution of the licensor to the pool. The bundling of technologies under a single license does provide simplicity and through that simplicity speeds up or even eliminates the license negotiation process (this obviously has its advantages and disadvantages). Open questions still might remain about its effect on IP owners that might have put more value on the table than others. However, to be involved and to contribute through standards gives leverage and there is typically a separate process within patent pools to ensure that those contributing more value on the table get more out of generated revenue.

There are two types of patent pools: open and closed pools. Open patent pools are outsourced to professional management companies/pool administrators such as joint ventures. They add new eligible patent owners and coordinate with them regarding licensing fees for a third party. In closed patent pools, there are several patent owners. Out of these, usually only one can license the pooled patents to third parties on everyone's behalf. Open patent pools have usually an independent administrator who organizes the pool and evaluates the patents to be shared in the pool. Patent claims of the patents submitted to the pool are carefully examined by these evaluators who decide whether the patent in question should be part of the pool (i.e., if they are standard essential patent or SEPs)

Open questions for the formation of patent pools in quantum technology are:

- Around which technology should the pools be established? Potential candidates could be, e.g., in a specific type of quantum algorithms but also hardware could be covered.
- Which type of rules could be defined for "quantum" patent pools? Large patent pools typically rely on the mass adoption of the standard (for example MPEG standard). and licensees pay

small royalties to the pool members (licensors) per unit of product sold (electronic device) implementing the standard. Quantum technologies could not rely on such mechanisms as the technology readiness level is still rather low and applications are not supposed to be that spread yet. However, other mechanisms still based on FRAND conditions can be certainly envisaged.

- Who could be the independent administrator of such patent pools? Are those going to be open or closed patent pools? Patent pools are organized and negotiated well before the standard is actually commercialized.

APPENDIX 1: Practical IPR Business examples from Quantum Computer domain

IQM IP Business Story

The history of Finnish-based quantum computing scale-up, IQM Quantum Computers (IQM), dates to 2018, when IQM was still a napkin story for the four founders, having scientific background in Aalto University and VTT Technical Research Center of Finland (VTT). With tens of years of expertise of VTT and Aalto university in low temperature physics and superconducting technologies, it was only natural for the founders to come up with the idea of starting to develop commercial quantum computers based on superconducting transmon qubit modality. When IQM span out in 2019, it also acquired some IP including 5 patent families from Aalto and VTT to start building IP portfolio of its own. This all including the ability to attract the right talent had an effect of being able to secure seed funding of 11,5 M€ at the same time.

From the beginning of IQM's journey it has been natural to open offices in Europe in locations where public funding and talent is available. This choice also promotes the goals of IQM becoming key enabler for Europe's global ambitions in quantum computing and creating ecosystems building technological and business capabilities required for quantum advantage. Therefore, already in 2020 IQM Germany was established, later followed by IQM Spain in 2021, and IQM France in 2022. Finally, to pursue Asian markets, IQM Singapore was opened in 2023. At the same time the company has been able to increase its headcount to almost 300 employees of almost 50 nationalities and more than 40 % PhDs, secured private investment funding of more than 200M€ and being able to sell 2 on-premises upgradable quantum computers to VTT in Finland and LRZ (Leibnitz Supercomputing Centre) in Germany.

One of the essential elements for IQM's success has been putting effort into how professionally manage IP. Of course, IQM's talented R&D organization, where many employees have scientific background has had positive implications in generating IP in the first place and it has been further promoted by IQM's IP function with such activities like arranging idea challenges, invention harvesting workshops, annual innovation award events and having global employee invention award scheme in place. During the years IQM's IP portfolio has increased from the initial 5 patent families to already 90 patent families protecting IQM's technological progress across the full technology stack, reflecting the company's differentiation approach ranging from QPU design and fabrication methods to co-design solutions. On top of that there are a few design rights and trademarks, not to mention a bunch of trade secrets in the areas that IQM wishes to keep confidential.

IQM has a team of five IP professionals concentrating on IP portfolio generation and management, IP risk mitigation matters and in supporting IQM's business with solid IP strategy. IQM's IP function led by Head of IP is situated organizationally under CEO office and reports to co-CEO/CTO having thus possibility to strategically serve both business and technology functions. Additionally, IP Function is tightly integrated into Technology teams to ensure that their IP needs are satisfied, and IP awareness is being promoted in large with different kinds of IP training. All the decision-making including patenting, trade secrets, open sourcing, and publications in general is done in IP committee having members from IP, Technology, and Product functions. IQM also uses the expertise of many external IP law firms to help with the patent drafting and prosecution work.

IQM has defined a set of KPIs to measure its' IP activities progress and to benchmark against competitors. These include, e.g., number of accepted invention disclosures and number of annual priority applications among other metrics. Based on the latter IQM is doing relatively well in comparison to some of its main competitors. Recently IQM's IP function has put a lot of effort into IP portfolio management to ensure strategic decision making based on portfolio valuation and possibilities for ROI generation in the long run, setting up legal framework for collaboration projects to ensure optimized models on IP ownership and licenses for collaboration projects and creating patent landscapes and freedom-to-operate analysis.

As a relatively small company IQM benefits from collaborating in open quantum computing ecosystems in selected technology areas by using of and contributing to Open-Source Software (OSSW) and by supporting creation of open interface standards, which may potentially generate Standard Essential Patent (SEP) portfolio in the long run to extract value from. IQM has e.g., open-sourced its QPU design SW, KQCircuits, for automating the design of superconducting quantum circuits and is participating in such standardization organizations as CEN/CENELEC, IEEE and ISO/IEC. Still, on top of this with core differentiating technologies IQM intends to build a strong patent and well managed trade secrets portfolios. To guide these activities, IQM IP Function has defined a set of policies and guidelines including open source, trade secret, scientific publication, and employee invention policies. While IP currently has the main role in ensuring IQM's freedom of action, protecting product differentiation, and ensuring further investments, in the long run as the company and technologies evolve into more mature state, there should be more focus on influencing business environment, and extracting business value from the portfolio. This all is being prepared for with already now within IQM' IP Function, but it requires naturally tighter integration with not only R&D, but other parts of the company like Business development and Product organization and setting up internal collaboration models that serve these organizations' needs.

APPENDIX 2: Legal framework in European funded projects (Grant Agreement vs. Consortium Agreement)

This is for introductory reading only and to remind that as exploitation related rights are agreed in advance, it is good to re-check one's own position carefully especially in co-funded projects with several partners, different targets, and motivations. As with any internally funded projects, the ownership (trusting that the ownership is taken care of and with the limitations of law) is simple, this Chapter gives perspective to terminology that tends to be often not so clear for technology or business developers. This terminology in minimum requires that one has clarity on what is "Background IPR", "Foreground IPR" (Results) and even in some cases "Sideground IPR". Through these definitions it should be clear that where the IPR ownership is, will be and what are the actions needed if one wishes to negotiate on certain access rights, license rights or even ownership.

Grant Agreement

The purpose of the Grant Agreement is that the granting authority awards a grant for the project. The beneficiaries accept the grant and agree to implement the project under their own responsibility and in accordance with all the obligations, terms, and conditions it sets out. Inside the Grant Agreement can also be so called Accession Form that is signed by other beneficiaries; meaning entities that participate performing the project without receiving funding from the granting authority. Specific Rules in Annex 5 include important rules for implementing the project, e.g., concerning IPR. General model of Grant Agreement

Basic IPR rules in Grant Agreement
Article 16 in this general model simply states the following.

1. Background and access rights to background
   The beneficiaries must give each other, and the other participants, access to the background identified as needed for implementing the action, subject to any specific rules in Annex 5. 'Background' means any data, know-how or information — whatever its form or nature (tangible or intangible), including any rights such as intellectual property rights — that is: (a) held by the beneficiaries before they acceded to the Agreement and (b) needed to implement the action or exploit the results. If background is subject to rights of a third party, the beneficiary concerned must ensure that it is able to comply with its obligations under the Agreement.

2. Ownership of results
   The granting authority does not obtain ownership of the results produced under the action. 'Results' means any tangible or intangible effect of the action, such as data, know-how or information, whatever its form or nature, whether, or not it can be protected, as well as any rights attached to it, including intellectual property rights.

3. Rights of use of the granting authority on materials, documents, and information
   The granting authority has the right to use non-sensitive information relating to the action and materials and documents received from the beneficiaries (notably summaries for publication, deliverables, as well as any other material, such as pictures or audio-visual

material, in paper or electronic form) for policy, information, communication, dissemination and publicity purposes — during the action or afterwards.

The right to use the beneficiaries' materials, documents and information is granted in the form of a royalty-free, non-exclusive and irrevocable license, which includes the following rights: (shortened from original)

a) use for its own purposes
b) distribution to the public
c) editing or redrafting
d) translation
e) storage
f) archiving
g) third parties to act
h) processing, analyzing, aggregating the materials, documents and information received and producing derivative works.

If materials or documents are subject to moral rights or third-party rights (including intellectual property rights or rights of natural persons on their image and voice), the beneficiaries must ensure that they comply with their obligations under this Agreement (in particular, by obtaining the necessary licenses and authorizations from the rights holders concerned).

Joint ownership – exploitation of jointly owned results
Unless otherwise agreed in the joint ownership agreement or consortium agreement, each joint owner may grant non-exclusive licenses to third parties to exploit the jointly owned results (without any right to sub-license), if the other joint owners are given:

- § at least 45 days advance notice, and
- § fair and reasonable compensation

The joint owners may agree in writing to apply another regime than joint ownership.

Consortium Agreement

In addition to the Grant Agreement the consortium signs a Consortium Agreement, which sets out the internal rights and responsibilities within the consortium and towards each other in implementation project. Consortium Agreement cannot include terms that contradict with the terms of the Grant Agreement.

IPR rules in Consortium Agreement
Basic rules of Grant Agreement and complemented with IPR rules of Consortium Agreement. Certain definitions that are already defined in Grant Agreement follow into Consortium Agreement, like Background, Results, Access Right, Exploitation and Fair and Reasonable Compensation.

Background
Consortium Agreement has an attachment for this purpose, i.e., listing the background that is available for implementing the project. Background can be listed in the attachment also when the intention is to use it only for own work and when it's important to distinguish what existed before the project (background) from what is achieved the project (results).

Ownership of results

Results are owned by the party that generates them.

Two or more parties own results jointly if:

- They have jointly generated them and
- It is not possible to:
    - establish the respective contribution of each party, or
    - separate them for the purpose of applying for, obtaining, or maintaining their protection.
    - joint owners of results must agree in writing on the allocation and terms of exercise of their joint ownership ("joint ownership agreement"), to ensure compliance with their obligations under the Grant Agreement, such as protection and exploitation of the results.

Consortium Agreement models also include an option for a right to exploit joint results without any prior notification or compensation to the other joint owner(s) and this is often desired by industry partners. For many public research organizations, the exploitation of joint results without compensation might not be acceptable because of State Aid legislation (Country dependent reference needed?)

Access Right to Background
Access Right means a right to use another party's background or results. Access Right can be given/received either:

- § For implementing the project tasks (typically royalty free)
- § For exploitation of own results outside the project (either royalty free or on fair and reasonable conditions)

Access Right must be given only when it is "Needed" which according to DESCA model it is defined:

For the implementation of the Project:

- Access Rights are Needed if, without the grant of such Access Right, carrying out the tasks assigned to the recipient Party would be technically or legally impossible, significantly delayed, or require significant additional financial or human resources.

For Exploitation of own Results:

- Access Rights are Needed if, without the grant of such Access Rights, the Exploitation of own Results would be technically or legally impossible.

Confidentiality
Consortium Agreement sets out the rules for handling confidential information. Obligation for confidentiality is in force for a period of 5 years after the final payment by granting authority. Confidential documents should be labeled with "Confidential" marking and when disclosed orally, it has been identified as confidential at the time of disclosure – and has been confirmed and designated in writing within 15 calendar days from oral disclosure at the latest as confidential information by disclosing Party.

- Different models for Consortium agreements (DESCA, MCARD, EUCAR, etc.)

Conclusion about Legal Framework on IPR terms

The general European funded legal framework above shows that there really are all the possibilities to safeguard one's own assets if needed and the only requirement really is to allow the use of contributed IP in the context of the funded project. However, this is just where the actual building blocks are set on the table and work begins. As the actual commercial exploitation is very much dependent on those different stakeholders, one should note that especially commercial exploitation is very much dependent on the possibility to differentiate and reserve rights (even limited scope, temporal or both) and future private investments (as any) are dependent on risk vs. opportunity scenario. As the Legal Framework doesn't define the result of commercial exploitation rights, it is very much up to negotiation partners' vision and willingness to push solutions into reality.