Essentiality Checks for Potential SEPs:

A Framework for Assessing the Impact of Different Policy Options

Written by:

Dr. Justus Baron Northwestern University

EUROPEAN COMMISSION

Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs
Directorate
European Commission
B-1049 Brussels

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Contents

1. INTRODUCTION

1.1.Background

This study was drafted as part of an Impact Assessment Study, which was commissioned by the European Commission (GROW/2021/MVP/0010). The contract for the study was awarded to iplytics GmbH after a call for proposals, based upon a proposal by a consortium consisting of lead researcher Dr. Justus Baron (Northwestern University), Dr. Tim Pohlmann (iplytics and TU Berlin), Dr. Pere Arque-Castells (University of Groningen), Dr. Amandine Leonard (University of Edinburgh), and Dr. Eric Sergheraert (University of Lille and darts-ip).

Within the framework of its contract with the European Commission, the consortium has produced two studies. The first study, "Empirical Assessment of Potential Challenges in SEP Licensing", ['Empirical Assessment'] was jointly drafted by the five members of the consortium, assisted by an advisory board. The present study was authored by lead researcher Dr. Justus Baron, in consultation with the European Commission. Both studies were prepared to provide possible inputs to the European Commission's own Impact Assessment of potential policy options regarding Standard-Essential Patents (SEP). The studies are published simultaneously with the Commission's Draft Regulation Proposal and Impact Assessment Report.

This study focuses on the impact assessment of potential policy options with respect to one specific policy issue, namely transparency regarding the actual essentiality of patents declared to be potentially standard-essential (declared SEPs) ('SEP transparency'). This study does not include any assessment of possible regulatory actions on other policy issues falling within the scope of the Commission's Impact Assessment Report. Nevertheless, policy choices regarding some of these other issues may have a moderating effect on the potential impacts of policy options with respect to SEP transparency; i.e. the potential impacts of some policy choices with respect to SEP transparency are likely to depend on policy choices with respect to these other issues. Where relevant, the present study attempts to account for these interdependencies by describing different scenarios, in which different policy options with respect to SEP transparency may have different impacts.

This study assesses three different policy options, which were defined by the European Commission. The five members of the consortium have participated in discussions regarding the definition of policy options; and for the purpose of carrying out an impact assessment, the author of this study has drafted descriptions with interpretations of each policy option. The policy options assessed in this study may differ from the options assessed by the European Commission in its Impact Assessment Report, as these policy options were revised and refined in parallel to the author's work on this assessment. The assessments in this study are exclusively based on the policy options as they are described and interpreted in this study.

1.2.General methodology

The purpose of the study is to assess the *costs* and the *benefits* of each policy option. For both costs and benefits, we aim to consider the *impacts* of the policy option, independently of whether these impacts are *intended* policy goals of the intervention.[1] We include both *direct* and *indirect* impacts in our assessment. Our assessment of each policy option is based on a comparison of costs and benefits; i.e. we do not seek to assess whether costs and benefits are small or significant in absolute terms, or in comparison to some external benchmarks; but we seek to assess whether benefits are likely to outweigh costs.

To proceed to an analysis of the potential costs and benefits of each policy option, it is necessary to first determine how the policy option will be *implemented*. By implementation, we do not mean a further regulatory act or decision, but the participation decisions of potential users of the instruments for SEP transparency that would be created under each policy option; including the choices of different owners of potential SEPs to submit their patents for registration and potentially for checks, as well as the importance and role that different types of decision makers assign to the information that is being produced through these instruments.

Within each policy option, stakeholders' participation decisions are likely to depend on the type of information that is being created through the new instruments for SEP Transparency. The amount and quality of new information that is being generated in turn depends on stakeholders' participation decisions. This potential circularity is prone to multiple equilibria, i.e. very different outcomes may be equally plausible outcomes of the same set of regulatory actions. These different outcomes are captured in different scenarios; where external factors (including policy choices by the Commission on other policy issues) may increase or decrease the likelihood for different scenarios to arise.

After assessing how a policy option would likely be implemented by the relevant stakeholders, we proceed to assess direct and indirect costs. Direct costs are costs that are specifically related to activities that are created or required by the policy option. Such direct costs may involve labor costs, costs for procuring necessary services (such as lawyer fees, technical experts, etc.), and other compliance costs. We also account for payments of fees, where we consider fees to be transfers, rather than costs – i.e. a fee paid by one party is a revenue to another party (which may be a public authority). If the fee is related to costly activities to be carried out by a public authority; it is the level of these costs, rather than the level of the fees, that enters into the assessment of overall costs of the policy option.

Indirect costs are costs (or cost savings) that are not specifically related to activities created or required by the policy option, but which – in our assessment – may arise as a consequence of the implementation of the policy. If the policy e.g. induces patent owners to increase (or reduce) the number of patents that they file, the cost of these additional (or cost savings related to the reduced number of) patent applications is an indirect cost (or cost saving) produced by the policy option.

In order to assess the benefit of each policy option, we first assess the information that would be produced by the policy option. As already stated above, the nature and quality of that information depends on the implementation of the policy option by stakeholders. Three types of uncertainty related to SEP Transparency are potentially relevant to SEP Licensing:

[1] See in particular Tool #18 of the European Commission's Better Regulation Framework, defining *impact* as follows: "As a direct result of an option, someone somewhere will be incentivised to do something differently (or maintain a certain activity) than would have been the case without the policy intervention."

uncertainty whether any particular patent is both valid and essential to a standard; uncertainty over whether a portfolio contains any patent that is both valid and essential to a standard; and uncertainty over how many such patents are in a particular portfolio.[2] Consequently, in this study, we seek to assess what information about these aspects would be produced by each policy option.

The policy instruments assessed in this study do not address uncertainty regarding the validity of patents. Nevertheless, the policy instruments may provide information about which potential SEPs are likely to be actually essential. Furthermore, the policy instruments that we assessed may legally limit the number of potential SEPs that may be asserted *as SEPs* in EU courts. Both these effects may have the consequence to focus scrutiny of patents' validity on a smaller set of patents. These indirect effects on uncertainty regarding the validity of patents are a significant aspect of the overall potential effects of the policy options, and ignoring patent validity would lead to substantially different results regarding the effect of the possible policy instruments on overall uncertainty in SEP licensing.

When assessing the information that is being produced by the policy instruments, we are forced to make several simplifying assumptions to keep the analysis tractable. We consider that patents either are or are not essential (and either are or are not valid). Our intention is to apply a practical, rather than an absolute concept of essentiality (or validity): for the purpose of our analysis, a patent is essential (or valid) if it would be found essential (or valid) in the final instance of an authoritative deliberative process that is effectively available. Uncertainty regarding patents' essentiality (or validity) thus means that people are unsure, and/or have different beliefs, about whether a patent would or would not be found essential (or valid) if the essentiality (or validity) of the patent was tested to the fullest extent that is effectively available.[3] For the purpose of simplicity, we will simply say that a patent is essential (or valid) if that patent's essentiality (or validity) would be established and/or upheld in such a deliberative process.

While patents either are or are not essential (and valid), available information about patents' essentiality (and validity) is usually probabilistic; i.e. the available information about different patents' essentiality (and validity) consists in beliefs about the probability that these patents are essential (and valid). When describing these beliefs, we make a strong assumption, which is clearly not fully descriptive of the empirical reality, but necessary for a tractable analysis: beliefs are more or less informative, but always accurate. A stakeholder without access to any information assigns the same probability to be essential to each patent in the population. A more informed stakeholder may assign a higher probability of being essential to one part of the population, and a lower probability of being essential to another part of the population. A fully informed stakeholder has fully discriminating beliefs, i.e. assigns a probability of 1 of being essential to actual SEPs, and a probability of 0 of being essential to patents that are not SEPs. No stakeholder erroneously assigns a probability of 1 of being essential to a patent that is not essential – i.e. more information produces more informative beliefs, but does not correct mistakes.

Except where explicitly stated otherwise, we assume that all stakeholders have access to the same information. The most common exception we make is that we often assume that patent owners have better information about the essentiality (and validity) of their patents than third

[2] In most instances, rather than the absolute number of valid and essential patents in a portfolio, it is more relevant to know the share of the total number of valid SEPs for a standard that are in a certain portfolio, or the relative number of valid SEPs in one portfolio, as compared to another portfolio. For reasons explained in this study, it is possible that there is less uncertainty regarding this *relative* number of patents than regarding the *absolute* number of valid SEP in a portfolio.

[3] There thus can be certainty (or near-certainty) regarding a patents' essentiality (and validity) even though there may be persistent disagreements about what it means for a patent to be essential and valid (as long as the criteria that are being applied in the examination of these patents are clear and known).

parties; but we do not assume that patent owners have perfect and costless information about these characteristics of their own patents.

Most systems that produce information about patents' essentiality (or validity) have the effect to make beliefs about patents' essentiality (or validity) *more* discriminating, i.e. they allow stakeholders to better discern between groups of patents that have higher and lower probabilities of being essential, but they do not produce fully discriminating beliefs – i.e. no system that is realistically available allows to distinguish between patents that are and patents that are not essential (or valid) with certainty. In order to measure the usefulness of the information that is being produced, we thus have to compare the distribution of probabilities *ex ante* (i.e. in the absence of a the proposed policy instrument) and *ex post* (i.e. in a situation in which the information produced by the proposed policy instrument is available).

After assessing the information that would potentially be produced by each policy option, we proceed to assess how that information may affect SEP licensing. All the benefits of the policy options that we assess are transmitted by the effect that these policy options may have on SEP licensing conditions. While the policy options may produce benefits through alternative channels (e.g. facilitate the internal management of R&D by patenting companies), we do not attempt to assess these other channels.

To assess the effects of the new information on SEP licensing, it is necessary to make assumptions about how the information will be used. All policy options entail some measures that have binding effects; where the outcome of an analysis of some patents' essentiality has a direct effect on the actions that the owner of such patents would be allowed to take under the new policy. We can thus directly assess these binding effects. Some policy options further entail measures that produce non-binding effects, e.g. publication of a non-binding opinion on the number of SEPs in a portfolio. We assess different scenarios, which differ in the extent to which stakeholders assign weight to this non-binding opinion for the purpose of forming a belief about the FRAND rate for a certain SEP license. While we choose one scenario as the "preferred scenario", this does not mean that this is necessarily the scenario that produces the most favorable outcomes, but that (based on general considerations, rather than a fully conclusive quantitative analysis) we assess that this is the scenario that is most likely to arise.

Our assessment of whether the non-binding information that is produced through the proposed policy instruments is likely to significantly impact the determination of FRAND rates for SEP licenses is totally independent of our assessment of whether that information is objectively relevant to a FRAND determination. We make no normative assessment whether stakeholders *should* assign weight to that information based on legal or equitable considerations or theoretical principles of economics.

Finally, throughout our analysis, we make one further (particularly strong) assumption; which is essential to the correct interpretation of our assessments: we assume that the assessed policy options will not modify the general balance of bargaining positions between SEP holders (licensors) and implementers (licensees), i.e. not change the aggregate level of royalties that are paid. Whether this assumption is realistic or not is highly contingent on the specific implementation of the policy options. In particular, all policy options that we assessed entail new obligations for SEP holders (licensors). For these policy options not to modify the balance of bargaining powers, the strategic effects of these new obligations would need to be compensated. Based on discussions with the European Commission, we assume that the newly confirmed policy instruments confer a *presumption of essentiality* to patents that are subject to an affirmative essentiality check, and that this presumption of essentiality should assist with the enforcement of these patents. To keep the analysis

tractable, we assume that the strategic advantages offered to licensors by this presumption of essentiality exactly offset the strategic advantages offered to potential licensees through the creation of new obligations for licensors.

We caution that all effects that we specifically assess in this study are orders of magnitude smaller than the current aggregate level of royalties for SEP licenses. Any significant effect of the policy options on the balance of bargaining powers between licensors and licensees is thus likely to largely outweigh all the effects of the policy options that are specifically assessed in this study. We assess that there is currently no conclusive empirical evidence on whether aggregate royalty levels for SEP licenses are either too high or too low from the point of view of total social welfare; which means that it is impossible to reliably assess the welfare effects of a policy that affects the bargaining position between licensors and licensees in such a way as to either decrease or increase the aggregate level of royalties.

1.3.Description of policy options

Each of the three options assessed in this study entails the creation of a system of essentiality checks of potential SEPs. In each option, a register of (potential) SEPs is created under the auspices of the EUIPO. Checks are carried out by independent experts. The register is limited to one granted and active patent per European patent family.[4] Patents that lapse, expire, or are invalidated should be withdrawn from the register.[5]

Under each option, a technical scope of the register will be defined, consisting of a list of *standards*. A *standard* is defined as a relevant unit of observation for purposes of SEP licensing – e.g. 5G, WiFi6, HEVC.[6] If a patent family includes European members (potentially) essential to various such standards, various observations should be created in the register (e.g. if a European patent family includes European members essential to both WiFi6 and 5G, there should be one observation for that patent family's essentiality to WiFi6, and one for 5G).

The list of standards should consist of *new* standards, i.e. including standards that are developed and released after entry into force of the regulation. The register should also extend to standards that are relatively recent at the time of entry into force of the regulation, and for which important new implementations are under development that are not yet widely licensed at that point in time.

In each option, at least some of the potential SEPs submitted for registration in the register will be checked by an independent expert. We call potential SEPs which received a positive essentiality evaluation "*confirmed SEPs"*.[7] We assume that confirmed SEPs registered in the database will benefit from a presumption of essentiality in infringement proceedings in EU

[4] A European patent family is an international patent family with at least one granted and active member in at least one EU Member State. There should be a general determination on the precise patent family definition to be used (inpadoc, docdb, ETSI). If applicable, the registered patent should be a granted EP patent. Otherwise (if the family does not include a granted EP patent), a patent granted by any of the national patent offices in the EU should be registered. After entry into force of the unitary patent, preference should be given to the registration of unitary patents (if a family includes granted unitary and national patents, the unitary patent should be registered).

[5] If other members of a registered patent family remain in force, the expired, lapsed, or invalidated registered patent should be replaced by one of the European family members remaining in force.

[6] A standard thus defined may consist in one or many technical specifications, and technical specifications may relate to different standards.

[7] We call patents that underwent an essentiality check (positive or negative) "checked SEPs"

courts. Only confirmed SEPs registered in the database can be asserted *as SEPs* in EU courts. This means that a patent owner may only rely on an implementer's use of a standard in alleging infringement of a patent if that patent is a confirmed and registered SEP; and allege infringements of other patents only because of product features that are not required by any of the standards included in the database.[8]

The options differ in terms of whether only those patents that are potentially asserted in EU courts should be registered and checked for essentiality, or whether the register is intended to provide information about larger portfolios. In Option 1, the checks and registration of potential SEPs in the database is limited to 50 patents per portfolio. The register thus explicitly provides no information on the total population of SEPs related to a standard (e.g. their number and/or value). In Option 2, all potential SEPs may be checked and registered; and (in addition to defining which patents may be asserted as SEPs in EU courts) the register is intended to provide comprehensive information about the patents to which a company needs to be licensed for the purpose of implementing a standard, which may also be used when determining the FRAND value of the licenses needed for implementing the standard. In Option 3, all patents licensed as SEPs may be registered in a register, from which random samples will be drawn for essentiality checks. In addition, SEP owners may self-select certain SEPs for a check, so that they can be asserted as SEPs in an EU court.

For each option, we will assess a variety of *scenarios* defining how the policy options could unfold, depending on the use of the EU SEP database by European and foreign courts, and the parties in SEP licensing negotiations. How the database will be used determines how the database will be populated. Based on an assessment of firms' strategies in different scenarios, we can then evaluate the likelihood for each scenario to arise and assess the expected impact of each option.

Patent holders will submit a patent to a database if the benefit of submitting the patent outweighs the cost. The cost includes the direct submission cost: if the database requires information that is more specific, and/or more current, than the existing SDO declarations, this may entail a cost of producing relevant information. If the patent will also be checked for essentiality, the submission cost further entails the cost of essentiality checks. The consequence of submitting a patent will vary depending on whether a patent is confirmed to be essential; i.e. there is a different payoff to submitting a patent that will eventually be confirmed to be essential, found not essential, or not assessed.

1. OPTION A: CHECKS OF A LIMITED NUMBER OF SELF-SELECTED POTENTIAL SEPS

A. 1: Explanation of policy option:

A register of confirmed European SEPs is created. SEP holders submit self-selected potential SEPs along with a high-level claim chart for essentiality checks. Upon a positive essentiality evaluation, the SEP is included in the database along with an indication of the relevant patent claim, and technical specification(s) (with version and section numbers) for which the claim(s) was (were) found to be essential. Assertion of

[8] We take no position on the legal mechanism through which this effect would be achieved.

SEPs in EU courts is limited to registered and confirmed SEPs. The number of patents that a company may submit for checks related to a particular standard is capped at 50.

No representation is made that the register (or the number of confirmed SEPs) is representative of the size of companies' portfolios of true SEPs. To the extent that companies wish to use counts of (presumed or confirmed) SEPs for determining FRAND rates, these counts would need to be established through a separate process.

Explanation of policy option: This policy option aims to enable implementers to easily find out from which SEP holders they need a license to implement a standard, and to reduce transaction costs and litigation regarding the likelihood that a license is needed. It is unlikely, and not intended, that licensing contracts would be limited to specifically identified individual patents registered in the database. No representation is made that the number or the characteristics of patents in the database are indicative of the FRAND value of a license to a particular portfolio.

A. 2: Implementation

In this section, we assess how the policy option is likely to be implemented, including with regard to how many potential SEPs patent owners would submit for checks, how many of these patents would be found to be essential, and what share of essentiality assessments would be appealed. Furthermore, we assess how the policy option impacts incentives to challenge the validity of the patents registered in the database, incentives for patent owners to renew potential SEPs (or let them lapse by failing to pay renewal fees), and what impact (if any) the policy option may have on the number of patent applications.[9]

A. 2.1.: Number of patents submitted for checks

We estimate that the vast majority of owners of (potential) SEPs that plan to license these patents on FRAND terms would choose to submit at least some patents to be checked for essentiality. While it is possible to license portfolios of potential SEPs that do not include at least one single confirmed SEP registered in the database, this option does not allow such patent owners to assert any of their patents *as SEPs* against unwilling licensees in EU courts. Implementers who observe that a patent holder has no confirmed SEPs in the database may thus have limited incentives to agree to license these patents. Even net licensees, who have no intention to actively license out their potential SEPs to other implementers, may wish to preserve the possibility to assert their potential SEPs as SEPs, e.g. as part of licensing negotiations/disputes regarding their own use of the standard, in a cross-licensing situation. Nevertheless, once a company has some confirmed SEPs in the database, the incentives to increase the number of confirmed SEPs decrease and vary between firms.[10]

[9] We only assess in this section incentives to file for patent protection for a given invention. We assess possible effects of the policy option on innovation incentives (i.e. effects on the number of new inventions) further below.

[10] i.e. the marginal value of submitting one (additional) potential SEPs for essentiality checks decreases in the number of already confirmed SEPs that a company owns.

Owners of potential SEPs would probably choose to constitute (small) portfolios of confirmed SEPs for each standard that they intend to license separately.[11] Patent holders would seek to constitute a portfolio of a certain (useful) size. Licensing negotiations and disputes are generally based on small numbers of selected patents, which (based on practitioner input) we estimate to be usually no larger than 15.[12] Patent holders may wish to submit larger numbers of patents for a variety of reasons. First, owning a larger number of confirmed SEPs preserves flexibility in SEP licensing (possibility to assert different patents against different implementers; less predictability for potential licensees against which patents they would need to defend themselves in possible litigation). Second, smaller numbers of confirmed SEPs in a publicly available database would become preferred targets of validity challenges and appeals of essentiality checks; if a company owns a larger number of such confirmed SEPs, the incentives to attack individual patents are reduced, and the negative impact on SEP owners if a patent is successfully attacked is diminished. Companies may also anticipate losing some of their confirmed SEPs to validity challenges and build a larger "reservoir" of confirmed SEPs. Third, for smaller to medium size portfolios, even a register capped at 50 confirmed SEPs could become a tool to demonstrate the size of the portfolio, i.e. the total number of actual SEPs owned by a company, which a company may choose to rely on as an indication of the FRAND value of a license to its portfolio.

These different considerations determine companies' desired registered portfolio size, i.e. the number of confirmed SEPs that they seek to register in the database. In order to seek to constitute a portfolio of a certain size, companies that face uncertainty regarding the essentiality of their own patents may need to submit a larger number of potential SEPs for a check.[13]

How the number of patents submitted for essentiality check compares to companies' desired number of confirmed SEPs depends on the consequence of a negative essentiality check. If a negative essentiality assessment is published, a patent that has been checked and not found essential may be worth less than a patent that has not been checked. Furthermore, patent owners may be accused of bad faith behavior if they tried to license patents as potential SEPs without disclosing that these patents were found not to be essential. Therefore, a negative essentiality assessment may carry negative consequences. In this case, companies may be more careful in selecting the patents they submit for a check, and only submit patents with a sufficiently high likelihood of being found essential.

If there are no consequences to a negative essentiality check, a patent is submitted for a check whenever the incremental value of being confirmed as a SEP, multiplied by the probability of being confirmed, is larger than the cost of the check. Given the relatively low cost of the check, this is likely to be true whenever the desired size of the portfolio of confirmed SEPs has not yet been reached.

Presumably, companies would submit for essentiality check some of their (known) strongest potential SEPs, for which the probability of being found essential is relatively high.[14]

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[11] e.g. if a company holds patents that are potentially essential to WiFi6 and 5G, and some implementers only use WiFi6, whereas other implementers only use 5G, these patent holders may wish to preserve the possibility to assert their patents against both types of implementers, by constituting portfolios related to each of these standards.

[12] See 'Empirical Assessment' p. 24; noting that a majority of respondents agreed that technical discussions in SEP licensing negotiations involve less than 20 patents. Some practitioners refer to these patents as "proud list patents"

[13] E.g. a company may decide to submit 30 potential SEPs in an effort to populate the register with 20 confirmed SEPs.

[14] Nevertheless, the outcome of regular essentiality checks is intrinsically stochastic – even an essential patent has a certain probability of not being found essential in a check, and a non-essential patent has a certain probability of being found essential. In the essentiality check pilot study (Bekkers et al. 2020, 2022), these Type I and Type II error rates were significant (25% and 36%, respectively)

Furthermore, before submission, companies are likely to spend some resources on assessing the individual patents that they would select for inclusion in the database, reducing the extent of companies' uncertainty regarding the essentiality of their own patents.[15]

Based on these arguments, we can estimate the number of patents that would be submitted for checks.

As a first step, we need to estimate the number of different types of SEP portfolios. First, there are large portfolios including more than the 50 potential SEP families allowed to be submitted for checks. Bekkers et al. (2020-1; on p. 29) list the 25 companies with the largest number of patent families (according to ETSI's family definition) declared to ETSI to be potentially standard-essential; which appear all to exceed the threshold of 50. Pohlmann (2016; p. 28-29) lists the 30 companies with the largest number of SEPs declared to any SDO, where the smallest portfolio includes 66 SEP families (inpadoc family definition). On one hand, both these compilations may include families without any granted and currently active and valid European family members. On the other hand, both compilations exclude the most recent SEP declarations (which are still increasing in number), as well as most patents potentially essential to standards that are not subject to a specific disclosure obligation (the study by Bekkers et al., 2020-1 is specifically limited to ETSI).[16] Furthermore, both compilations report the number of potential SEP families by company, whereas we seek to assess the number of portfolios of patents potentially essential to a particular standard. Overall, it seems plausible to estimate that there are approx. 50 large portfolios of more than 50 potential SEP families each (only counting families with at least one granted and valid European family member).[17]

Not all of these portfolios are the subject of active licensing. Several companies own large portfolios of declared SEPs for defensive purposes, and do not seek to collect royalty revenue from other implementers (although they can assign value to their respective portfolios in a cross-licensing negotiation). Some large SEP licensors may own large portfolios of patents that are potentially essential to multiple standards, but they only actively license their patents to implementers of some of these standards (e.g. several large WiFi SEP owners have no stand-alone WiFi licensing program even though they may be actively licensing patents for cellular standards, and WiFi SEPs may be included in such licenses). We estimate that approx. 30 out of the 50 largest SEP portfolios are actively licensed out to implementers, and individual patents from these portfolios may be asserted in EU courts.

In addition, there are numerous smaller portfolios. ETSI's database alone currently lists declarations made by 365 different companies.[18] In addition, many more portfolios of small

[15] Companies are more likely to invest resources in assessing their own patents prior to check if the cap of 50 checks is binding, i.e. if companies have to make a selection which of their potential SEPs they can submit; or if there are negative consequences if a patent is found not essential. If $v_{i,s,c,\bar{e}} = v_{i,s,\bar{c}}$ and neither the cap nor the desired number of confirmed SEPs have been reached, companies' only incentives to spend on assessing their own patents is to avoid the expense of a (presumably more costly) external assessment for patents that are very unlikely to be confirmed. We assess that a relatively light-touch assessment of a patent's essentiality has a low consistency rate with a relatively more thorough (but still error-prone and somewhat stochastic) essentiality check. Companies investing small amounts in a light-touch assessment would thus learn relatively little about the probability that their patent would be confirmed essential in a relatively more thorough essentiality check. We thus believe that in this scenario, companies that have not yet reached the cap or the desired number of confirmed SEPs would submit all potential SEPs for a check, without investing significant resources in prior internal assessments of these patents.

[16] Business reports suggest that there may be approx. 10 portfolios with more than 50 patent families potentially essential to WiFi 6. https://sagaciousresearch.com/blog/wi-fi-6-and-wi-fi-6e-patent-filing-trends-next-evolution-in-wlan-technology/

[17] Some companies owning more than 50 patent potential SEP families may not own 50 patent families potentially essential to any individual standard; other (few) companies may own portfolios of more than 50 patent families potentially essential to multiple standards.

[18] https://ipr.etsi.org/ (last consulted on 13. October 2022)

numbers of patents are declared potentially essential to other SDOs' standards. Clearly, not all of these portfolios are being licensed. We estimate that bilateral SEP licensing is subject to significant costs (see 'Empirical Assessment', Section 6.2.3.), which means that independent licensing of small portfolios of potential SEPs may often not be viable. Patent pools offer an opportunity for owners of such marginal portfolios to collect royalty revenue. Several hundred SEP portfolios are being licensed through patent pools. Nevertheless, not all companies licensing their SEPs through a pool need a credible threat of assertion, as implementers may be sufficiently incentivized by the threat of enforcement from other members, or the general value of being licensed to a technology they use, to take a pool license. Not all companies licensing their SEPs through a pool thus will find it necessary or profitable to create a portfolio of confirmed SEPs in the EU register. We estimate that approx. 150 smaller portfolios would benefit from some amount of credible threat of assertion in EU court. Owners of these portfolios would probably aim to include at least some of their potential SEPs in the register, in order to preserve the possibility to assert their patents as SEPs if needed.

Based on these assumptions, we can assess the number of patents submitted for check for each type of portfolio. For the approx. 30 large and actively licensed SEP portfolios, we estimate that most SEP owners submit the maximum allowed 50 patents for check. We thus estimate an average of 45 submitted patents per portfolio in this group. Many of these companies will conduct internal assessments of even larger numbers of potential SEPs before selecting the patents that they submit for a check. Especially in the largest portfolios, there will be a significant self-selection of patents. If negative essentiality assessments are published, SEP owners have even stronger incentives to carefully select the patents they submit. Only the largest portfolios of potential SEPs are likely to include 50 families of patents with a high likelihood to be found essential. Patent owners in that case have incentives to submit somewhat lower numbers (approx. 40 on average) of more carefully selected patents.

The other large portfolio owners who do not have active licensing programs (perhaps because they are also large implementers or are in the supply chain for relevant products) and may only wish to preserve a possibility to assert SEPs defensively in litigation with other SEP owners, may generally select smaller numbers of patents for check and registration. If negative assessments carry no consequences, these companies also have limited incentives to invest in the selection of the patents that they submit. In particular, as these companies are not constrained by the cap of 50 patents and own significantly larger portfolios of potential SEPs than their desired portfolio size of confirmed SEPs, they may choose to submit patents sequentially until reaching the desired portfolio size.[19] We estimate that these companies submit on average 20 patents, selected based on prima facie likelihood of being essential. If negative essentiality assessments are published, the desired portfolio size of confirmed SEPs remains unchanged, but firms would submit a smaller number (approx. 15) of more carefully selected patents.

Firms with smaller portfolios, who wish to potentially license these portfolios to implementers, are unconstrained by the cap of 50 patents per portfolio. If negative assessments are not published, licensors with small portfolios have incentives to submit all their potential SEPs for checks, including patents with a low likelihood of being essential. Given the large potential value of positive assessments, even a small probability of a patent being confirmed essential would justify the cost of the check; and because of the difficulty

[19] ; i.e. if a company seeks to constitute a portfolio of three confirmed SEPs, it would only submit a fourth patent if one of its first three patents was rejected

to correctly predict the outcome of essentiality checks, the potential cost savings that can be achieved by withholding weaker patents from the check do not justify the cost of internal assessments. These firms may however have some incentives to withhold weaker patents from a check for negotiation purposes if the outcome of a negative essentiality assessment is published, or may become discoverable. We estimate that the average number of patents submitted for check in this group is 12 potential SEPs per portfolio if negative assessments are confidential, and 10 potential SEPs if negative assessments are published or may otherwise become known to other parties.

Table A1: Number of patents submitted for checks in different scenarios, by type of portfolio

		negative checks confidential		negative checks public	
	# portfolios	# patents submitted	prior selection	# patents submitted	prior selection
Large portfolios	50				
Large portfolios (actively licensed out)	30	45	moderate / intensive	40	intensive
Large portfolios (not actively licensed)	20	20	limited	15	moderate
Small portfolios (potentially licensed)	150	12	none	10	limited
Total	200	3,550		3,000	

A. 2.2.: Which patents are submitted for checks?

It is also important, but difficult, to estimate *which* potential SEPs would be submitted for checks – i.e. to what extent will owners of potential SEPs identify and submit patents that have a high likelihood of being confirmed to be essential upon check. Ideally, owners of potential SEPs would know which of their patents would be confirmed in a check, and submit only those patents with a high likelihood of being confirmed.

According to Bekkers et al. (2020, 2022), different types of experts' assessments coincided with a higher quality essentiality assessments by pools in 75% to 84% of the cases. We thus assess that patent owners' beliefs (prior to conducting specific assessments) about their patents' likelihood to be found essential in such a thorough assessment are accurate in no

more than 75% of the cases.[20] SEP owners' beliefs about the outcome of a less thorough essentiality assessment may be more or less accurate than their beliefs about the outcomes of a more thorough assessment.[21] Based on available evidence, we assess consistency rates between two imperfect essentiality assessments to be lower than 75%.[22]

By investing in improving their own understanding of their own patents' essentiality, patent owners can improve their predictions' accuracy. Nevertheless, even if patent owners are perfectly able to discern non-essential from essential patents (i.e. by investing significant resources, patent owners may reach near-perfect understanding of their patents' *true* essentiality), they still face uncertainty regarding potential random errors made by experts doing the assessment.

Based on these considerations, we can assess the expected outcomes of the essentiality checks of the submitted patents. In the case of patents submitted without any prior selection, the essentiality rate is that of the population of declared SEPs, which we assess to range from 25 to 40%.[23] 49 to 56% of the submitted patents in this group would be confirmed essential.[24] Patents submitted by a patent owner who only submits patents it believes to be essential, but does not carry out costly prior internal essentiality assessment, would have a 75% likelihood of being essential. These patents have a 72% likelihood of being confirmed essential.[25] If patent owners conduct rigorous internal assessments prior to submitting a patent for essentiality check, they may achieve significantly more accurate beliefs about patents' essentiality. We assess that 90% is an upper bound for a realistic accuracy rate of such informed beliefs. 78.5% of such rigorously selected patents would be confirmed essential in a regular essentiality check.[26]

We can use these figures to estimate the number of confirmed SEPs in the portfolios submitted by different types of SEP owners.

Large SEP portfolios (active licensors)

Some, but not all of the portfolios of more than 50 potential SEPs are sufficiently large to include at least 50 patents that the patent owner believes to have a high chance of being confirmed to be essential. With an essentiality rate in the range of 25 to 40%, only portfolios

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[20] It seems implausible that merely based on general subject matter expertise, and without any specific assessment, a company would be able to make more accurate assessments of a patent's essentiality than a senior engineer in academia after an 8 hour assessment; so that we apply the lower bound of the consistency range of experts' assessments to describe the consistency of patent holders' *ex ante* beliefs, prior to conducting any specific assessment.

[21] If both the patent owners and the examiner get it right about 75% of the time, and their errors are uncorrelated, patent owners would correctly predict the outcome of the essentiality check only 62.5% of the time.[21] Of course, different experts' beliefs could be correlated for many reasons, which could lead to inter-expert agreement higher than 75%.

[22] Mallinson (2021) compares two experts' assessments of the essentiality of the same set of patents, and finds a consistency rate of 73%. If experts, after a review of every individual patent, agree on only 73% of the cases, it seems that consistency between one expert's assessment and another party's prior beliefs (absent a specific assessment) should be no higher than 73%.

[23] See SEP Expert Group (2021)

[24] If the true essentiality rate is 25%, 75% of submitted patents in this group are non-essential, and 25% are essential. As non-essential patents have a 38% likelihood of being found essential in a regular check, and essential patents have a 83% likelihood of being confirmed essential, the share of *confirmed* SEPs is 0.75*0.38+0.25*0.83=0.4925. If the true essentiality rate is 40%, the share of confirmed SEPs is 0.6*0.38+0.4*0.83=0.56.

[25] 75% is our assessed upper bound estimate of the accuracy of patent owners' beliefs absent a specific internal assessment. The share of confirmed essential patents follows from 0.25*0.38+0.75*0.83=0.7175; and is consistent with Mallinson's findings about inter-expert agreements between two imperfect assessments.

[26] 0.1*0.38+0.9*0.83=0.785

of at least 125 to 200 potential SEPs are susceptible of including at least 50 actual SEPs. We assess that this is the case for half of the portfolios in this category (i.e. half of the actively licensed portfolios of more than 50 potential SEPs include at least 50 patents with a high likelihood to be confirmed).[27] Other large licensors would include at least some patents with a lower likelihood of being confirmed in order to reach the desired registered portfolio size.[28]

We thus assess that in a scenario in which negative assessments are not published, 68.5% to 70% of the patents submitted by large portfolio owners that actively license their SEPs would be confirmed essential in a regular check.[29] If negative assessments are published, 73 to 74% of the submitted patents from this group will be confirmed.[30]

Large SEP portfolios (others)

Large portfolio owners not actively licensing their patents usually do not seek to actively assert their SEPs in EU courts; they are thus less likely to seek to constitute very large portfolios of confirmed SEPs. As they seek to establish a more limited number of confirmed SEPs, they can limit themselves to submitting patents with the highest likelihood of being confirmed; i.e. they only submit patents that are selected based on their (*ex ante*) likelihood of being confirmed essential. If negative essentiality assessments carry no consequences, these SEP owners would exert little effort, and submit patents based on their existing beliefs; which are consistent with essentiality check outcomes at 72%; i.e. 72% of their submitted patents would be essential. If there are consequences to negative assessments (e.g. because negative assessments are published by the EUIPO, or discoverable in subsequent disputes), we assess that these SEP owners may carry out intermediate efforts, leading to a consistency rate of approx. 75% (i.e. 75% of the lower number of patents submitted for check would be confirmed essential).

[27] In the analysis of Baron and Pohlmann (2022), there are 10 portfolios with more than 200 potential and more than 50 predicted actual SEPs for 5G (out of 18 portfolios with more than 50 potential 5G SEPs).

[28] We assume that in half of these large portfolios, the full contingent of up to 50 patents would be filled with patents selected based on patent owners' beliefs about their essentiality; whereas the other half of the portfolios is partly constrained, so that only half of the contingent can be filled with patents that patent owners believe to have very high chances of being confirmed. 75% of the submitted patents in this group would thus be selected based on patent owners' prior beliefs; whereas 25% of the submitted patents are average potential SEPs, which have an average likelihood of being confirmed. We assess that patent owners' prior beliefs are consistent with the outcome of the assessment in 75% of the cases. If negative assessments are published, patent holders would be more careful, and (1) invest more efforts in scrutinizing patents prior to submitting them for a check, and (2) be less inclined to submit a potential SEP, unless a patent has a higher-than-average likelihood of being confirmed. We thus assume that patents are submitted based on the outcome of internal checks, which are consistent with expert assessments in 78.5% of the cases. We further assume that fewer patent holders would exhaust the cap of 50, and that approx. half of the patents with only average likelihood of being confirmed would be withheld.

[29] 75% of the patents are self-selected based on their likelihood of being confirmed, with intermediate selection effort. Based on our assessment of inter-expert consistency, we assess that 75% of these patents will be confirmed. The remaining 25% of the patents are randomly selected and will be confirmed at the average rate; i.e. 49% if the true essentiality rate is 25%, and 56% if the true essentiality rate is 40%. 0.75*0.75+0.25*0.49=0.685; and 0.75*0.75+0.25*0.56=0.7025.

[30] Of the 25% randomly selected patents, half are withheld, and the 75% selected patents are selected based on beliefs that are consistent with the assessment at somewhat higher rates (78.5%). (0.75*0.785+0.125*0.49)/(0.75+0.125)=0.731; and (0.75*0.785+0.125*0.56)/(0.75+0.125)=0.741.

Smaller SEP portfolios

Small portfolios are unconstrained by the cap. Owners of such smaller portfolios may seek to maximize the number of confirmed SEPs in the database. They would thus submit potential SEPs with little to no prior selection, and their submitted patents would be confirmed essential at the average rates, i.e. 49% if 25% of the potential SEPs are truly essential, and 56% if 40% of the potential SEPs are truly essential. The number of patents submitted by owners of smaller portfolios would be smaller if negative essentiality assessments carry consequences (e.g. are published by the EUIPO, or may become discoverable in other venues); in that case, the rate at which checked patents are confirmed would be higher.

Table A2: Number of patents that would be confirmed essential in different scenarios, by type of portfolio

		True essentiality rate 25%				True essentiality rate 40%			
		negative checks not published		negative checks published		negative checks not published		negative checks published	
	# portfolios	# patents submitted	# patents confirmed	# patents submitted	# patents confirmed	# patents submitted	# patents confirmed	# patents submitted	# patents confirmed
Large Portfolios	50								
(actively licensed out)	30	45	31	40	29	45	32	40	30
(not actively licensed)	20	20	14	15	11	20	14	15	11
Small portfolios (pot. licensed)	150	12	6	10	5	12	7	10	6
Total	200	3,550	2,110	3,000	1,840	3,550	2,290	3,000	2,020

Obviously, each of these estimates is just a best estimate subject to many uncertainties. For the number of portfolios, the number of patents submitted per portfolio, and the share of confirmed patents among submitted patents, there are broad plausible ranges.

We thus estimate that between 3,000 and 3,550 potential SEPs would be submitted for checks, and 1,840 to 2,290 of these submitted patents would be confirmed as SEPs.[31] Once

[31] Strictly speaking, this is the number of confirmed patent-standard observations; i.e. the unique number of patents would be lower. If a patent is confirmed to be essential to both WiFi6 and 5G, it would count as two SEP observations.

again, it bears emphasis that these are *best estimates*, whereas we estimate that there is a large credible range of possible outcomes.

This represents the *stock* of active confirmed SEPs that would be registered in the database at any time. As patents expire or are invalidated, and new licensors appear and incumbent SEP owners exit (or merge), there would be constant renewal of this stock. Most patents would be registered shortly after grant, and registered patents can generally be expected to be renewed until the end of term, the average remaining patent term at time of registration is estimated at about 15 years. New standard generations however appear at a faster rhythm (approx. one new generation every ten years). We thus estimate that approx. 10% of the stock would be renewed annually, for an estimated 184 to 355 new confirmed SEPs being added each year, once the database has been populated. The number of new unique patent families added to the database each year would be lower, perhaps 150 to 250 (the number of unique patents is generally lower than the number of SEP observations, because one patent can be essential to multiple standards within the scope of the register).

The number of checks per year until the steady state has been reached is very difficult to estimate and depends on the rollout of the database. On one hand, the scope of the database is likely to focus on more recent standards generations, and more standards may gradually be added to the scope. On the other hand, in most SEP licensing fields (in particular cellular and WiFi wireless communication), devices usually must be able to connect to different standards generations. A cellular communication device that is equipped to connect to a 5G cellular communication network is usually also equipped to connect to 4G and earlier generation networks. For this reason, also SEP licensing negotiations often span over various standards generations. A database limited to only the most recent standards may thus produce only limited effects on SEP licensing negotiations for a significant period of time (until the legacy standards excluded from the scope of the database are no longer included in the scope of SEP licensing negotiations). In a scenario in which in particular 4G/LTE (and all earlier generations of cellular communication) would be fully excluded from the scope of the database, the size of the database may initially be more limited; but the database would eventually reach its steady state size when licensing negotiations begin to encompass 6G and subsequent generations, and most patents essential to 4G and earlier generations have expired.

A. 2.3.: Appeals

If there is a possibility for patent holders to appeal a negative outcome of the essentiality check, patent holders will do this whenever the value of a positive outcome of the appeal, multiplied by the probability of overturning the negative outcome of the initial examination, exceeds the cost of the appeal. The cost of the appeal is likely to be significantly higher than the cost of the initial check.[32] Nevertheless, there may be a significant likelihood that a negative outcome of a regular essentiality check could be overturned on appeal.

The rate at which negative essentiality assessments can be successfully challenged depends on the initial selection of patents for checks. If potential SEPs are submitted for essentiality checks with limited prior evaluation by patent owners, also patents with a very low probability of being found essential by any subject matter expert may be submitted. Appeals

[32] Note that assumptions regarding the cost of appeal may vary, depending on the appeal system that is being created (see below in Section A3.1).

to the negative assessment of such patents have limited potential to be successful. When patent holders only submit patents after careful scrutiny and selection from a much larger portfolio of potential SEPs, negative essentiality assessments would usually reflect edge cases, in which there is disagreement between different experts' assessments. There is thus a high likelihood that there could also be disagreement between the expert carrying out the initial check and the experts responsible to handle appeals.

Based on these considerations, we can make assessments of the likelihood of appeals to positive and negative assessments in different portfolios. We begin with a scenario in which negative essentiality checks are confidential, and carry no consequences for patent holders other than that the patents may not be added to the register of confirmed SEPs.

Incentives to appeal assessments of individual patents are strongest in the case of small portfolios, as the impact of an individual assessment on a smaller portfolio is larger. This is particularly true of *pivotal* assessments (e.g. the only positive assessment related to a portfolio, or the negative assessment to the strongest potential SEP in a portfolio with no positive assessments – overturning these pivotal assessments on appeal determines whether a patent holder has any patent that can be asserted as SEP in EU courts, and thus may determine whether the portfolio can be actively licensed, and/or significantly affect the value of a license to the portfolio). At the same time, selection is low in this population, i.e. there may be a large share of the negative assessments that are fairly clear-cut. While there is a large plausible range, we thus estimate that about 60% of the negative assessments in this group will be appealed.

Large SEP holders that seek to actively license their SEP portfolios to implementers also have strong incentives to appeal negative essentiality assessments. Their submitted patents were likely selected from larger portfolios based on the patent owner's belief that these patents would be found essential. As these patents underwent initial selection, the likelihood that a negative assessment of these patents can be successfully appealed is considerably higher. We estimate that approx. 75% of the negative assessments in this group may be appealed. Large SEP holders not actively licensing their portfolio have limited incentives to appeal negative assessments; as it is much cheaper for these SEP holders constrained neither by the cap of 50 nor by portfolio size to achieve the desired number of confirmed SEPs in the register by submitting some additional patents for a check. We estimate that 25% of the negative assessments in this group would be appealed.

Our estimates are based on a scenario in which negative assessments are not published. Incentives to appeal negative assessments are exacerbated if there are negative consequences to a negative essentiality assessment (e.g. if the outcome of the negative assessment would be published), as patent owners have a double incentive to appeal a negative initial assessment (first, the incentive to obtain a confirmed SEP, and second, the incentive to erase a negative assessment). Furthermore, in a scenario in which negative assessments are published or otherwise carry negative consequences for the patent owner, submitted patents would be more carefully selected in the first place, increasing the chances that a negative assessment could be successfully appealed.

With only about 210 affirmative essentiality checks being notified in the register every year, there may also be incentives for some (larger) implementers, or organized groups of implementers, to challenge positive essentiality assessments. Our assessments (based on the Essentiality pilot study) assume that false positive assessments are more likely than false negative assessments, so that appealing a positive essentiality assessment is even more likely to be successful than appealing a negative assessment.

Appeals of positive essentiality assessments are particularly viable and potentially rational for pivotal assessments, i.e. positive assessments in portfolios with only very small numbers

of confirmed SEPs (the value of a successful appeal is largest in the case of pivotal patents, and patents from small portfolios of potential SEPs are less likely to undergo rigorous internal selection by the patent owner, so that positive essentiality assessments in this group may have a higher likelihood to be successfully appealed). The patents of large portfolio owners only submitting small shares of their portfolio for checks (most net licensees) are least likely to be subject to appeal (as patent holders can easily "refill" their portfolio of confirmed SEPs, there is little value in appealing a positive assessment of an individual patent).

Based on these considerations, and using the estimated numbers of affirmed and rejected SEPs from the previous section, we can assess the number of appeals to affirmative and negative essentiality checks.

Table A3: Number of appeals in one scenario (essentiality rate 25%, negative checks confidential), by type of portfolio

	negative checks not published				
	# patents submitted	# affirmed	# rejected	# appeals to affirmed	# appeals to rejected
Large portfolios					
(actively licensed out)	1,350	930	420	140	315
(not actively licensed)	400	280	120	42	24
Small portfolios (pot. licensed)	1,800	900	900	270	540
Total	3,550	2,110	1,440	452	879

All these assessments are based on a scenario in which negative assessments carry no consequence, and the "true" essentiality rate in the population of potential SEPs is low (25%). If negative assessments are published, patent holders' incentives to appeal negative essentiality check outcomes are generally increased (as there are increased incentives to appeal, and – because of initial selection – the likelihood of appeals to be successful is also increased); but patent holders also carry out increased prior selection, so that there are fewer negative essentiality checks to be appealed. We estimate that (across all types of portfolios) the average rate of appeals to negative essentiality checks increases from approx. 60% to approx. 75%, if negative outcomes are published or otherwise carry negative consequences. Nevertheless, as we assess that in this scenario patent holders are more careful in selecting the patents for checks, and generally submit fewer patents for essentiality checks, the overall number of appeals is slightly lower than in the scenario in which negative essentiality checks are confidential.

If the "true" essentiality rate in the population of potential SEPs is higher (40%), there are more affirmative and fewer negative essentiality check outcomes. As there are fewer

incentives to appeal affirmative than negative checks, the overall number of appeals in this case is estimated to be lower.[33]

Table A4: Number of appeals in different scenarios

	True essentiality rate 25%		True essentiality rate 40%	
	negative checks confidential	negative checks published	negative checks confidential	negative checks published
Affirmed				
Number affirmed	2,110	1,840	2,290	2,020
Number appeals to affirmed	452	389	501	438
Number affirmed after appeal	1,884	1,589	2,039	1,801
Rejected				
Number rejected	1,440	1,160	1,260	980
Number appeals to rejected	879	868	767	729
Number affirmed after appeal	439	434	383	364
Total number of appeals	1,331	1,257	1,268	1,167
Total number affirmed after appeal	2,323	2,023	2,422	2,165

The likelihood of appeals to be successful is difficult to estimate. While Bekkers et al. (2021) found that 28 to 31% of the negative assessments in their experiment were inconsistent with a supposedly more accurate assessment by pool experts, the likelihood of negative assessments to be susceptible to be overturned upon appeal depends on initial selection – if the average essentiality rate in the population of checked patents is higher, false negative assessments (patents that are actually essential but were found non-essential) constitute a larger share of the total number of negative assessments. By contrast, if many of the patents submitted to check are non-essential, a larger share of the negative assessments are accurate, and will withstand appeal.[34]

In the experiment conducted by Bekkers et al. (2020, 2022), there is no initial selection – the patents used in the experiment were based on pool members' SDO declarations of all their potential SEPs. By contrast, in Policy Option A, most SEP holders would make a prior selection, and submit better-than-average patents for checks. Given the existence of initial selection, the "true" essentiality rate among checked patents is likely to be higher than in the experiment of Bekkers et al. (2020, 2022), so that a larger share of the negative assessments are likely to be false negatives. Furthermore, SEP holders would make a further selection when deciding which assessments to appeal, only appealing decisions with a sufficient likelihood of being overturned. Overall, we estimate that approx. half of the appeals would

[33] Calculations available upon request

[34] In other words, initial selection by patent holders prior to checks may eliminate many relatively clear-cut cases of patents that have a very low likelihood of being confirmed. The consistency rate between experts' assessments in such an experiment, in which potential SEPs are included in the experiment independently of their likelihood of being confirmed, may thus be higher than the consistency rate in a real-world setting, in which such low-likelihood patents would not be submitted for checks, and there are thus fewer "clear-cut" cases for experts to assess.

be successful. Depending on the scenario, about 380 to 440 negative and 195 to 250 positive assessments would thus be overturned.

If appeals are allowed, the number of confirmed SEPs would increase from 1,840-2,110 to approx. 2,000-2,400, reflecting our assessment that there are stronger incentives to appeal negative than positive essentiality check results. In the steady state, after exhaustion of appeals, 200 to 240 new SEP observations would thus be added to the register every year.

A. 2.4.: Validity challenges

Essentiality checks do not address the validity of the checked patents. Nevertheless, singling out a small population of confirmed SEPs among the much larger population of potential SEPs would significantly strengthen incentives for third parties to file oppositions or invalidation actions against these confirmed SEPs.

As only a relatively small share of potential SEPs will be checked and confirmed, the resources that are necessary for invalidation efforts may be better targeted at the relevant (confirmed-essential) patents. Implementers in particular have significant incentives to challenge these patents' validity, as removing confirmed SEPs from the register reduces the likelihood that they face litigation or need a license to the related portfolios. As the register (in this option) is explicitly not an indication of the total number of SEPs, reducing the number of confirmed SEPs in the register does not necessarily reduce the denominator (which otherwise may result in increasing the FRAND value of licenses to the remaining confirmed SEPs).

We currently observe approx. 21 EPO oppositions against potential SEP families per year, in addition to invalidation actions in EU Member States' national courts (25 validity challenges per year at the German Bundespatentgericht, alone) ('Empirical Assessment', Table 15, p. 132). We estimate that these numbers are likely to increase, if validity challenges can be better targeted. With 200 to 240 new SEP observations being added to the register every year, we estimate that the number of new unique patents is even lower (150 to 200). At such low numbers of unique patents, it is plausible that the validity of the majority of the new patents added per year may be challenged, amounting to 75 to 150 challenges per year (meaning that 150 to 180 of the 200 to 240 new SEP observations added per year could be subject to validity challenges).[35]

Success rates of validity challenges vary. At the EPO, on average, roughly one third of oppositions are rejected, one third result in the patent being revoked, and a bit more than one third result in the patent being upheld in amended form.[36] A SEP may or may not lose its essential character by such an amendment (depending on whether the essential claims were revoked or sufficiently narrowed). We assume that approx. half of the empirically observable validity challenges result in a SEP losing its essential character (either by invalidation of the entire patent, or invalidation or significant amendment of its essential claims). Nevertheless, as only less than 5% of patents are currently being challenged, success rates of observed challenges may not be representative. Henkel and Zischka (2019) model selection effects in validity challenges, and find that different types of selection effects largely cancel each other

[35] Recall that the number of unique patents is lower than the number of SEP observations, as individual patents may be essential to multiple standards.

[36] https://www.epo.org/about-us/annual-reports-statistics/annual-report/2017/statistics/searches.html

out. We thus estimate that the 75 to 150 challenges per year may result in approx. 75 to 90 confirmed SEP observations being lost to validity challenges, meaning only 125 to 150 new SEP observations would be added and remain on the register.[37]

A. 2.5.: Renewals

The policy option is estimated to have limited effects on patent maintenance incentives. Even more so than current declared potential SEPs, confirmed SEPs in the register are likely to be renewed to the end of term. Other potential SEPs (not submitted for check) are likely to be renewed at similar rates as current declared potential SEPs, because their function for SEP holders will not have significantly changed (they are not individually discussed or otherwise used in SEP licensing negotiations, but they contribute to constitute larger portfolios of potential SEPs, which may be used to substantiate FRAND licensing offers).

If negative essentiality checks are published, patents submitted for a check but found not to be essential may be renewed at a lower rate. Nevertheless, this concerns a limited number of patents, and would partly be cancelled by further strengthened incentives to renew confirmed SEPs. Overall, we estimate that the policy option has no significant effect on renewal rates.

A. 2.6.: Patent applications

The policy option is estimated to have no significant effect on the number of patent applications. As the policy has no effect on how FRAND rates are determined, it will neither increase nor reduce incentives to inflate patent portfolios by filing numerous patents on marginal inventions ("patent inflation"). Furthermore, as only self-selected potential SEPs are checked, the policy is unlikely to significantly dissuade the filing of "weak" potential SEPs (i.e. patents that have a low likelihood of being found essential if checked) for strategic purposes. Overall, patent propensity (i.e. the number of patent applications for a given number of patentable inventions) is likely to remain largely unchanged.

A. 3.: Direct effects

We can now proceed to assess the *direct effects* of Policy Option A. Direct effects encompass the costs of registrations and checks, other costs (e.g. those related to validity challenges induced by the policy option), and the information that is produced by the checks. Other effects (such as effects of the Policy Option on the efficiency of SEP licensing, innovation incentives, and incentives to implement standards with SEPs) are largely a consequence of these direct effects, we thus refer to these effects as *indirect effects*.

[37] 50% of the 150 to 180 SEP observations that are subject to the 75 to 150 challenges.

A. 3.1.: Direct and indirect costs

Direct costs (Costs of checks and appeals)

We estimate that under the policy option, 3,550 potential SEPs would be submitted for essentiality checks.[38] This is the number of patents submitted for checks in view of constituting the stock of confirmed SEPs alone – once the register has reached its steady state, this stock would be renewed approx. every 10 years, so that in the steady state, approx. 355 potential SEPs would be submitted every year. If negative essentiality assessments are published, companies have reduced incentives to submit patents to a check, and this number is estimated to decline to approx. 3,000; or 300 per year.

There are different data points on which to base the assessment of costs per check. Bekkers et al. (2021) report that the typical fee charged by patent pools for essentiality assessments of a European patent is 5,000-10,000 Euro (page 45). They also report practitioner estimates of potential costs of full assessments. PA Consulting estimated a cost of 5,000-10,000 Euro per patent, whereas CRA estimated the cost of a "medium assessment" to be 4,500 Euro, and the cost of a "full assessment" to be 9,000 Euro. In the pilot study, Bekkers et al. (2021) focused on an assessment in which experts were given 8 hours per patent, roughly consistent with our experts' assessment of essentiality assessment option D (see Section 3.2.3.), "*Claim chart: Specific SEP evaluation plus arguments on mapping, i.e., specific correspondence*". According to our survey, the average cost of such an assessment for the remuneration of the expert alone is 4,159 Euro.

Overall, we estimate a *baseline* cost of 8,000 Euro per essentiality check in the current system, which is within the range of the different estimates. This is our estimate of the total marginal per-patent cost of essentiality checks (excluding any efforts by patent owners to self-select specific patents for checks and following up on the essentiality assessment). It bears emphasis that this is the cost of what we call a *regular* essentiality assessment – i.e. the cost of producing one qualified expert's objective opinion on a patent's essentiality, based on one day of the expert's work, and no involvement of any third parties.

We estimate that once the system is fully established, the per patent cost of essentiality checks may be lower than this *baseline* cost as observable in certain existing contexts. The system creates a demand for 300 to 350 essentiality checks per year. This number is sufficiently low so that the demand can likely be met by the existing pool of qualified experts, so that any incremental effect of the additional demand induced by the policy option on experts' wages can be neglected. At the same time, by creating a standardized methodology for essentiality checks and a roster of credentialed technical experts, the policy option may contribute to somewhat commoditize the task of essentiality assessments. Overall, we assess that 5,000 Euro is a credible estimate for the per patent cost of essentiality assessments, corresponding to a (generous) compensation of experts for their estimated 8 hours of work, and any additional marginal (per patent) cost of operating a system of essentiality checks.

One needs to add to this the costs incurred by patent holders. Patent holders incur several types of costs, incl. administrative costs for preparing the submission and communicating

[38] Obviously, all assessments are subject to significant uncertainty. There is thus a large *credible range* in which the true numbers may fall.

with the EUIPO. Unless claim charts already exist for the submitted patents or would be produced also in the absence of any policy intervention (in the *business-as-usual* scenario, BAU), patent holders also incur the cost of preparing a claim chart to be submitted to the EUIPO (which we estimate to cost 4,000 Euro on average, see section 3.2.3.). Because in this policy option only relatively small numbers of self-selected patents are submitted for checks, we assess that for most of these patents claim charts may already exist or would be produced regardless of the policy option.[39]

In addition to these necessary expenses, patent holders are likely to incur discretionary expenses to increase the chance of a positive outcome (e.g. involve a technical expert to review the claim chart prior to submission, and follow up on the assessment). We would consider parity between the fees of the essentiality check and patent holders' discretionary spendings to be a conservative estimate; bringing the cost of checks to 10k Euro per patent, or 30 to 35 million Euros[40] for the initial stock of potential SEPs alone. This represents a cost of approx. 3-3.5 million Euros per year.

At least some owners of potential SEPs would be selective in identifying and submitting potential SEPs for essentiality checks. These are mostly active SEP licensors with larger portfolios, who already in the BAU scenario are likely to carry out some assessment of their potential SEPs to identify potential SEPs with a higher likelihood of being essential. Some but not all of these companies also have asserted SEPs against alleged unwilling licensees, or have constituted "proud lists" of particularly selected potential SEPs for negotiation purposes. We thus assess that identifying up to 50 potential SEPs for submission to essentiality checks would not be a significant expense for these companies.

We estimate that patent holders would make greater efforts in the initial selection of patents if negative check results are published, or otherwise may carry negative consequences. We estimate that in this scenario patent holders would further assess a total of 10,000 potential SEPs with above-average likelihood of being essential, at an additional cost of 2,000 Euro each (between the cost of a "specific SEP evaluation" and "claim chart"); for a total cost of 20 million Euros, or 2 million Euros per year.

If there is a possibility of appeal, 1,160 to 1,330 of the assessments would be appealed (116 to 133 appeals per year). By analogy to the cost of EPO oppositions, we estimate the total cost of regular appeals at 50,000 Euro per patent, on average, for a total cost of 58 to 66.5 million Euro (approx. 5.8 to 6.65 million Euro per year). Upon instruction from the European Commission, we also consider the cost of a *second opinion*, instead of a full appeal process with testimony by different experts, which merely consists in a re-assessment of the same patent by another expert at the same level of rigor (for a cost of 5,000 Euro per assessment).

We also estimate that the EUIPO would incur a fixed cost of approx. 2 million Euro for setting up the register and the necessary IT infrastructure, and an additional 1 million Euro per year for maintaining the register, training of evaluators, promotion of the system, and general administrative costs.

[39] One important qualification of this assessment is the European nature of the register. Many or most existing claim charts may relate to foreign (in particular US) members of global potential SEP families. For future standards generations, the existence of an EU register may induce sufficient incentives to produce claim charts of EP in lieu of US patent family members; nevertheless, for the existing stock of potential SEPs related to incumbent standards, there may be a larger cost due to the duplication of claim charts (need to produce claim charts for EP patents, where claim charts currently only exist for their US counterpart).

[40] 3,550 potential SEPs submitted for check * 16k Euro

Table A5: Direct and indirect costs of Policy Option A

	True essentiality rate 25%		True essentiality rate 40%	
	negative checks confidential	negative checks published	negative checks confidential	negative checks published
Number of patents checked:	*3,550*	*3,000*	*3,550*	*3,000*
Costs of checks (fees plus patent owners' own costs):	35.55M €	30M €	35.55M €	30M €
Cost of internal assessments to identify patents to be submitted:	0	20M €	0	20M €
EUIPO fixed and annual operating cost:	12M €	12M €	12M €	12M €
Number of appeals:	*1,331*	*1,257*	*1,268*	*1,167*
Cost of appeals:	66.55M €	62.85 M€	63.4M €	58.35M €
Alterantively: cost of *second opinions*:	6.655M €	6.285 M€	6.34M €	5.835M €
Total cost (with full appeals)	114.1M €	124.85M €	110.95M €	120.35M €
Total cost (with *second opinions* only)	54.205M €	48.285M €	53.89M €	47.835M €

If full appeals to essentiality checks are allowed, the total cost of registration and checks is thus approx. 114.1 to 124.85 million Euros (11.4 to 12.5 million Euros per year). With only second opinions, the cost is significantly lower (4.8 to 5.4 million Euros per year). Nevertheless, as we will argue below, in Option A, essentiality checks produce much more valuable information if appeals are allowed – we will thus largely focus on the costs that arise with possibility of full appeal.

Indirect costs

There would be additional costs related to the increased number of validity challenges. We estimate the average cost of a validity challenge in the EU to be 100,000 Euro (approx. 50,000 Euro for EPO opposition, 150,000 Euro for invalidation proceedings at a national patent court). As we estimate that the annual number of challenges related to the validity of potential SEPs will increase from approx. 50 to 75 to 150 per year, this will induce an **annual** additional expense of 2.5 to 10 million Euros (25 to 100 million Euros in total, for the initial stock).

The total annual cost of the policy option is thus estimated at 13.9 to 22.5 million Euros if appeals are allowed, and 7.3 to 15.4 million Euros if only second opinions are offered to appellants.

A. 3.2: Effects on available information

To estimate the effect of essentiality checks on information available to parties of SEP licensing, we will assume that average essentiality rates in the population of potential SEPs are 25-40%, and in the absence of essentiality checks, at least some parties have absolutely no information regarding the essentiality likelihood of individual potential SEPs – i.e. they assign essentiality probabilities of 25-40% to each unchecked potential SEP. This is the probability that stakeholders (implementers) may assign to the likelihood that a patent would be found essential in court, if asserted and rigorously examined.

We can then assess the effect of essentiality checks on stakeholders' beliefs regarding certain key variables – the likelihood that a license is needed, the number of patents in a portfolio that are both valid and essential, and the likelihood of individual patents to be essential.

Information whether a license is needed

Information directly produced by essentiality checks

The Policy Option not only produces information on which patents are essential, but also restricts which patents may be asserted – a patent that is not a confirmed SEP may not be asserted, independently of whether it actually is essential and valid. Confirmed SEPs may be asserted, but uncertainty may persist whether a license is really needed for these patents. A positive assessment does not produce certainty on essentiality. Bekkers et al. (2021) found that 15 out of 21 positive essentiality checks in their pilot were consistent with the more thorough assessment by pools, indicating that 72% of the patents assessed to be essential in a regular essentiality check would be confirmed to be essential in a more thorough assessment (e.g. after assertion). We thus assume checked, confirmed SEP have a probability of 72% to be actually essential – leaving substantial uncertainty. Furthermore, the essentiality check does not address the question of patent validity.

To assess the effect on information regarding whether a license is needed, consider the case of a small portfolio of only 10 potential SEPs. In a "pessimistic" scenario, on average only 25% of the potential SEPs are essential. Essentiality rates are known to vary significantly between different portfolios. We will thus assume that the portfolio has a 50% likelihood of being a "poor quality" portfolio, where each patent has a 10% likelihood of being essential, and a 50% likelihood of being a "high quality" portfolio, where each patent has a 40% likelihood of being essential (consistent with a 25% average probability). Validity rates are unlikely to vary that significantly between different portfolios – we assume that each patent has a 50% likelihood of being found invalid if challenged; and we assume that validity and essentiality are uncorrelated. Using these assumptions, in this pessimistic scenario, a

portfolio of 10 potential SEPs has approx. 35% probability not to include a single patent that is both valid and essential.[41]

Absent essentiality checks, there is thus a significant likelihood that a standard implementer does not need a license to this portfolio, which may have a substantial impact on the difficulty to license this portfolio.

We can now assess the effect of a check. We use data from the essentiality pilot study to estimate Type I and Type II errors. According to this data, actual SEPs have a 75% likelihood of being found essential in a regular, 8-hour essentiality check; whereas potential SEPs that are presumably not essential have a 36% likelihood of being found essential. With these consistency rates, in a "low quality" portfolio, the likelihood of a potential SEP to receive a positive essentiality assessment is 39.9%, whereas in a "high quality" portfolio, the likelihood of a potential SEP to receive a positive essentiality assessment is 51.6%.[42]

With these numbers, for a "low quality" portfolio, the likelihood that no patent is found essential is 0.6%; whereas for the "high quality" portfolio, the likelihood that no patent is found essential is 0.07%.[43] Under these assumptions, the checks would thus have a very low likelihood to fully discard entire portfolios of potential SEPs. There are two reasons for that: first, even if a portfolio does not include a single essential patent, with a false positive rate of 36% per patent, there is a 98.9% likelihood[44] that at least one of these non-essential patents would be mistakenly found to be essential. Second, a sizeable share of the portfolios that do not include a single patent that is both valid and essential do include at least one essential patent – except that this patent would be found invalid if challenged.

The authors of the essentiality pilot study also report that essentiality assessments' consistency rate may increase if claim charts are provided. If claim charts were provided, 30 out of 32 (93.7%) "truly essential" and 13 out of 20 (65%) "truly non-essential" patents were consistently assessed. Using these consistency rates, we find that a patent in a low-quality portfolio has a 40.9%, and a patent in a high-quality portfolio has a 58.5% likelihood of being found essential. While assessments become more accurate, they also become even more overly optimistic regarding the essentiality of potential SEPs (false positives appear to be much more likely than false negatives). In sum, the ability of assessments to correctly weed out portfolios not including a single true SEP is not improved.

As the authors of the essentiality pilot study predict that consistency rates of essentiality checks, if implemented on a large scale, may improve over time, we also estimate a second scenario, in which an actual SEP has a 85% likelihood of being found essential, whereas a potential SEP that is presumably not essential only has an 18% likelihood of being found essential (meaning that error rates of essentiality checks would be cut by a factor of more than two with respect to the pilot study, and errors would become roughly zero-centered). In this scenario, the likelihood that a "low-quality" portfolio of 10 potential SEPs does not include a single patent that would pass the essentiality check rises to 5.9%, and for "high-quality" portfolios, this likelihood rises to 0.3%. On average, under this modified

[41] In a low quality portfolio, each patent has a 10% likelihood to be essential, and 50% likelihood to be valid, i.e. a 5% likelihood to be both valid and essential. Consequently, the likelihood that a low quality portfolio of 10 patents does not include a single patent that is both valid and essential is 1-(1-0.05)^10=0.599. Similarly, a high quality portfolio has a 0.107 likelihood of not including a single such patent. As a portfolio of unknown quality has a 0.5 chance of being of high quality, the likelihood that a portfolio of unknown quality includes not a single patent that is both valid and essential is (0.599+0.107)/2.

[42] In a low quality portfolio, a patent has 10% chance of being essential, and 90% of not being essential. Each patent in a low quality portfolio thus has a 7.5% chance of correctly being found essential, a 32.4% of erroneously being found essential, a 2.5% chance of erroneously being found non-essential, and a 57.6% chance of correctly being found non-essential.

[43] If each patent has a 39.9% chance of being found essential, the likelihood that not a single of 10 patents would be found essential is 1-(1-0.399)^10=0.006148.

[44] 1-(1-0.36)^10

assumption, standard essentiality checks on all potential SEPs thus would thus eliminate approx. 3.1% of the small portfolios (10 potential SEPs) from consideration.

Not all of these 3.1% portfolios are actually correctly eliminated (as there is a 15% chance that a truly essential patent is mistakenly found non-essential during an essentiality check). Eliminating false negative essentiality checks (e.g. by allowing patent owners to appeal negative essentiality assessments) reduces the likelihood that all potential SEPs in a portfolio of 10 receive a negative essentiality assessment to 2.4%. While a portfolio of 10 potential SEPs has a 35% probability not to include a single patent that is both valid and essential, the likelihood that an owner of a portfolio of 10 potential SEPs is correctly barred from asserting any patents as SEPs because not a single patent in the portfolio receives a positive essentiality assessment in a regular essentiality check is thus only 2.4%.

Information produced indirectly through appeals and validity challenges

The essentiality checks themselves thus do not help stakeholders identify a significant number of portfolios of potential SEPs for which a license may not be needed. Crucially, however, the register singles out smaller numbers of potential SEPs that were confirmed essential. If a portfolio of 10 potential SEPs contains no patents that are both valid and essential, it is relatively unlikely that no patent in the portfolio would be assessed essential, but it is very likely that such a portfolio would only include one or two "pivotal" *confirmed* SEPs (i.e. patents that were – correctly or mistakenly – assessed to be essential in a regular check). Such "pivotal" confirmed SEPs would become prime targets for essentiality assessment appeals and/or validity challenges by implementers. The main effect of essentiality checks on smaller portfolios is thus not to correctly identify portfolios not including any truly essential patents, but to sufficiently reduce the number of confirmed SEPs that need to be considered, so that the much more costly appeals and validity challenges can be targeted at the relevant "pivotal" patents.

We estimate that a specialized patent court's invalidation proceedings or EPO opposition produce a much more accurate representation of a patent's likelihood to be valid than the initial grant decision by the patent office. We do not have data from Europe, but in the US, a study has reviewed 73 decisions by the Court of Appeals for the Federal Circuit based upon appeals from Inter Partes Review decisions (Wallach and Darrow, 2016). 61 of these decisions (83%) were fully affirmed, while seven (10%) were affirmed-in-part. Similar to validity decisions on patents more generally, appeals to IPR decisions are not random, and the consistency rate of the IPR decisions that get appealed is not necessarily representative of the consistency rate of all IPR decisions (i.e. the rate at which IPR decisions would be upheld if each IPR decision was appealed). We believe that consistency rates of appealed IPR decisions are rather a lower bound to consistency rates of all IPR decisions. Overall, we estimate that if patents were randomly sampled into a validity re-examination (including EPO opposition and court invalidation proceedings), the outcome of this process would have a 90-95% chance to be upheld upon further challenge.

Under an assumption where appeals and validity challenges result in highly consistent decisions, many (and perhaps most) of the portfolios not including a single patent that is both valid and essential would be correctly filtered out in Policy Option A. Because of the same assumption, false negative assessments are assumed to be correctly weeded out through appeals. The ability of this policy option to achieve this outcome is largely due to appeals and validity challenges, rather than the initial essentiality checks. It is thus crucial for the effectiveness of the policy option that appeals are available, and that also implementers have sufficient incentives to file appeals to positive essentiality assessments and validity

challenges. The effectiveness of the policy option does not reside in the fact that it bars entire portfolios from being asserted, but that it may sufficiently reduce the size of marginal portfolios for such expensive challenges to become viable.

If, returning to the hypothetical portfolio of 10 potential SEPs, we estimate that in the case that not a single of the ten patents is both valid and essential, there is a 50% likelihood that no patent from that portfolio will be positively assessed and remain on the register (i.e. not be challenged, or mistakenly be upheld upon essentiality appeal and/or validity challenge). While there is a 35% chance that a portfolio of 10 potential SEPs does not include a single patent that is both valid and essential, there is thus a 17.5% probability that not a single patent from a small portfolio of 10 potential SEPs can be asserted in EU courts. Approximately half of the portfolios for which implementers do not actually need a license are thus correctly weeded out.

This effect is also beneficial to the owners of patents that are actually valid and essential. In case at least one patent from a portfolio of 10 potential SEPs is confirmed and included in the register, the likelihood that an implementer needs a license to that portfolio (i.e. the patent owner would be able to successfully assert at least one patent from the portfolio) increases from 65% to 78.8%.[45] It may thus become somewhat easier for owners of such small SEP portfolios to license their patents.

Information regarding the number of SEPs in a portfolio

The Policy Option has limited effects on information regarding the number of true SEPs in different portfolios. In particular, the number of potential SEPs that may be submitted for checks is capped at 50, so that the policy cannot produce information on the actual size of larger portfolios. While all portfolios of confirmed SEPs are subject to selection, i.e. patent owners are free to decide which of their patents to submit for a check, some owners of smaller portfolios may use the register as an opportunity to signal portfolio size (and rely on the number of confirmed SEPs in justifying their licensing offers). Nevertheless, in the absence of credible information on the size of the denominator, or the actual portfolio size of most other SEP owners, even improved information about one patent owner's number of true SEPs is of limited use.

In addition, any information on numbers of confirmed SEPs in such small portfolios is subject to significant assessment uncertainty. In our example of a portfolio of 10 potential SEPs, a "high quality" portfolio on expectation received 5, whereas a "low quality" portfolio on expectation received 4 positive essentiality assessments. Of course, there is large variation around these expected values – including scenarios in which the low quality portfolio receives a larger number of confirmed SEPs. More accurate assessments are only produced through appeals and validity challenges, which – in our assessment – would largely be reserved to pivotal patents.

[45] There is a 35% chance that the portfolio does not include a single patent that is both valid and essential; and in half of such cases (17.5% overall probability), not a single confirmed SEPs would remain on the register (after exhaustion of all appeals and validity challenges). The ex post probability of a portfolio of 10 potential SEPs to include at least one valid and essential patent, *conditional upon including at least one confirmed SEP*, is thus 0.65/(1-0.175)=0.788. This is the average increase; the actual increase will depend on how many patents from the portfolio would be confirmed, and how many patents survive a validity challenge. Some portfolios will thus be considerably strengthened, i.e. it is becoming apparent that there is a very high likelihood that implementers need a license from these portfolios. For other smaller portfolios, the effect is ambiguous, as the fact that some individual patents are confirmed and thus strengthened is compensated by the fact that other patents are not confirmed, and the number of potential SEPs that could be asserted thus declines.

For individual patents included in the registry, the likelihood to be both valid and essential has significantly increased. Ex ante, stakeholders without any private information may assign the population averages to the likelihood that a patent is valid (which we estimate at 50%) and essential (25 to 40%). The ex ante likelihood of individual patents to be both valid and essential is thus 12.5 to 20%.[46] Patents included in the registry have significantly higher likelihoods to be valid and essential. Conditional upon a positive essentiality assessment, randomly selected potential SEPs have a 75% likelihood to be found essential in a more rigorous assessment. Most confirmed SEPs in the register are however not randomly selected, but selected by SEP holders from much larger portfolios. We may thus assign a 80% likelihood to these confirmed SEPs to be found essential if challenged. Furthermore, approx. 20% of the confirmed SEPs in the database underwent appeal (either to an initial positive or negative assessment). If we assign a 90% likelihood to such (more rigorous) appeals decisions to be upheld, the average likelihood of confirmed SEPs to be essential increases to 82%.

Crucially, we also estimate that the validity of 75% of the patents included in the register is challenged. If we assign a 95% likelihood to a patent whose validity was upheld in a challenge to withstand further challenges (consistent with Wallach and Darrow's data on Federal Circuit appeal court decisions adjudicating appeals to inter partes review decisions), the average likelihood of a patent in the registry to be valid increases to 83.75%. The average likelihood of patents in the registry to be both valid and essential thus increases to 68.7%, a significant improvement over the ex ante situation. While only a relatively small number of patents are checked and confirmed, at least for these patents, uncertainty regarding their essentiality (and, indirectly, validity) is substantially reduced.

A. 4.: Indirect effects

A. 4.1.: Effects on SEP licensing

Effects on SEP licensing negotiations

SEP licensing negotiations may potentially be impacted through three different mechanisms: first, and most immediately, the policy option may produce information that stakeholders would otherwise have to produce during the conduct of bilateral negotiations. Second, parties of SEP licensing negotiations may have the possibility to use more ample information than they currently use. Third, as SEP licensing negotiations often take place in the shadow of litigation, any effects of the policy option on SEP litigation also indirectly affect SEP licensing negotiations.

While we found negotiation costs difficult to estimate, we estimated that technical discussions of individual patents are a common and substantial cost factor in many SEP

[46] Assuming, as we do throughout, that essentiality and validity probabilities are independently distributed.

licensing negotiations (see section 6.2.3. of 'Empirical Assessment'), in particular bilateral negotiations between large SEP owners and large implementers. Also, the total volume of estimated licensing negotiation costs is generally large enough for even marginal improvements to create substantial cost savings.

There is a relatively clear rationale why the essentiality checks created by the policy option may be more cost-efficient than existing practices of essentiality assessments. First, there is a potential for wasteful duplication of similar assessments by different implementers. SEP holders may discuss the same set of potential SEPs in bilateral negotiations with different implementers. It is common that SEP holders disclose detailed technical information, such as claim charts, under the protection of non-disclosure agreements (NDA). Subsequent technical discussions may thus similarly be protected by NDA. Technical analyses conducted by experts paid by one implementer may thus not be available to a different implementer in its bilateral negotiation with the same SEP owner, potentially leading to wasteful duplication. Alternatively, at least some implementers may also participate in bilateral negotiations with only limited technical information on the set of patents under discussion.

Second, while technical experts have an incentive to conduct reasonably objective analyses in order to preserve their reputation, they also have an incentive to favor the position of the stakeholder paying for their analysis. During bilateral negotiations, both sides may employ different experts, and there may be large inconsistencies between the different experts' assessments, which partly reflect the different incentives of experts working for opposing sides. Generally, a process involving two experts with opposing vested interests may be better at revealing accurate information than a process involving only one neutral expert, but it is bound to be more expensive.

Overall, the process thus has the potential to generate efficiency gains, especially if the set of patents that is assessed under the policy option significantly overlaps with the set of patents that would be assessed in the absence of the policy option in bilateral negotiations; or otherwise obviates the need for these privately conducted assessments.

Under Policy Option A, we assess that this overlap is reasonably large – most patents that patent holders would choose to discuss in bilateral negotiations would be included in the set of patents that patent holders submit for essentiality checks and registration. The number of patents checked under the policy option is likely to be larger than the number of patents that would otherwise be assessed in bilateral negotiations.[47] Nevertheless, because one single objective assessment may replace two opposing parties' experts' assessments, and because there is less duplication of efforts between different negotiations, the total amount of effort on essentiality checking must not necessarily increase. While highly uncertain, we consider that it is plausible that the cost of the essentiality checks conducted for the register may be fully compensated by the (potential) cost savings related to essentiality assessments during bilateral negotiations.

One significant qualification for this assessment is the European nature of the register, and the global focus of SEP licensing negotiations. According to our interviews with technical experts, most commonly, technical assessments of potential SEPs in the context of SEP licensing negotiations involve US and/or EP patents. The register would however be populated exclusively with checked and confirmed European (EP or national) patents. Substantial cost savings in bilateral negotiations may only be produced if checks on EP members of a global potential SEP family can substitute for checks of their US counterpart,

[47] According to the technical experts we interviewed, the number of patents discussed in negotiations is usually not larger than 15.

which may otherwise be conducted within the context of SEP licensing negotiations. Whether this is plausible is probably dependent on context – in particular in a context in which disputes may need to be resolved in court, parties may wish to discuss also US patents, as these are the patents that may be asserted in US courts.

Effects on SEP litigation

The information produced by the checks may have some effect on SEP litigation. Most directly, the policy impacts those portfolios of potential SEPs for which no single member is confirmed essential (or every confirmed patent is invalidated). It would no longer be possible to assert such portfolios in EU courts. There have been SEP litigations in EU courts that resulted in every asserted patent being found invalid and/or non-infringed.[48] Presumably, many of these litigations would no longer take place under Policy Option A.

In addition, some (especially small) portfolios have a significant likelihood not to include a single patent that is both valid and essential. Implementers may genuinely be unsure whether they need a license to such a portfolio, and litigation is a legitimate tool for resolving this uncertainty. These portfolios would also be significantly impacted by the policy if some of the patents in the portfolio are confirmed and included in the register. By increasing the likelihood that implementers need a license to portfolios including confirmed SEPs, the policy option may lead to some of these licenses being negotiated without the need for litigation.

These immediate effects of the policy option on SEP litigation focus on marginal portfolios of few potential SEPs, which only constitute a small share of estimated SEP litigation costs. The effect of the policy option on the overall volume of litigation is uncertain and depends on the broader consequences of a positive assessment. Many challenges to the validity and essentiality of individual potential SEPs arise in the course of disputes over licenses to larger portfolios. In these cases, there is limited genuine uncertainty whether a license is needed, and court assessments of the validity and/or essentiality of non-randomly selected individual patents-in-suit produce only very limited information on the quality of the overall portfolio. These strategic challenges are part of the negotiation process and may help an implementer obtain concessions in ongoing negotiations and disputes, or discourage other, more resource-strapped SEP holders from also asserting their patents against an implementer that has demonstrated its willingness to mount costly defenses.[49]

The overall impact of the policy on the volume of litigation thus not only depends on what information the policy option provides regarding the necessity to license, but also on the effect of the policy option on litigation strategies more broadly. On one hand, if courts apply a presumption that patents that are included in an EU register of confirmed SEPs are truly essential, they may require implementers seeking to be considered willing licensees to engage with the substance of SEP owners' licensing offers without requiring further explanations and examinations of the essentiality of individual patents-in-suit.[50] In this case,

[48] E.g. Conversant Wireless v LG Electronics

[49] At the social level, challenges to individual patents' validity or essentiality by alleged infringers may contribute to a general level of scrutiny of patent quality, and complement the scrutiny effect of patent examination. See Schankerman and Schuett (2022) for a comprehensive welfare discussion. For the purposes of this Impact Assessment, we do not seek to comment on the social welfare implications of different company strategies in litigation, but simply to assess the effect of the policy option on the costs arising in SEP litigation.

[50] Courts may e.g. consider that implementers had their chance to appeal the patent's essentiality assessment after the patent was confirmed and added to the register.

the complexity of litigations may decrease, as there may be more limited technical assessments in court. There may also be fewer litigations in SEP licensing disputes more generally, as some implementers may prefer signing a license if the policy option partly reduces the cost of assertion of SEPs in court for holders of confirmed SEPs.[51]

On the other hand, by capping the number of potential SEPs that owners of large portfolios of potential SEPs may submit to a check, and restricting assertion of non-registered patents, the policy option provides a strategic advantage to implementers. Implementers seeking to challenge individual patents-in-suit as part of complex SEP licensing disputes can use the register to gain advance notice against which patents to defend. Furthermore, the essentiality assessments and potential appeals and validity challenges produce significant additional information and arguments on the technical merits of these patents, which accused infringers may use in court. Whether, on balance, the option restricts strategic challenges to individual patents-in-suit thus depends on whether the presumption of essentiality generated by a positive assessment carries sufficient weight to outweigh these strategic effects.

Overall, any impacts of the policy option on SEP litigation costs would be negligible if the effect of the policy is limited to SEP litigation in EU courts. In our estimates, SEP litigation costs in the EU account for significantly less than 10% of total SEP litigation costs in the world. Furthermore, more than half of the estimated SEP litigation costs in the EU are attributable to invalidations and EPO oppositions, which we estimate to increase, rather than decrease under the Policy Option. What share of the remaining estimated approx. 6M Euros in annual SEP litigation costs in EU courts may be saved is difficult to estimate, but estimated cost savings of more than 25% would appear optimistic (for total cost savings of approx. 1.5M Euros).

The effect of the policy option on SEP litigation in foreign courts is difficult to predict. Foreign courts may take notice of a patent's confirmation and registration in an EU database, but they would probably not extend a presumption of essentiality to foreign counterparts of confirmed EP patents or restrict the assertion of foreign counterparts of potential SEPs not registered in an EU database. Large SEP holders may choose to assert patents other than the counterparts of EP patents registered in the EU database in foreign courts, in order to preserve the strategic advantages of surprise and information asymmetry regarding the patents' characteristics. While the essentiality checks may thus also have some effects on assertion of these patents in foreign courts, these effects would be certainly more limited and more indirect than the effects on EU courts.

There is also a possibility of a displacement effect, whereby owners of potential SEPs barred from asserting their patents in the EU (or restricted in their choice of which patents to assert) may give preference to foreign venues. Such displacements may often benefit the UK and the US, which are among the other litigation venues commonly chosen by SEP holders. As patent litigation in these alternative venues is approx. 10 times more expensive per case than in the EU, even a small displacement effect may fully outweigh any potential cost savings from a decline in SEP litigation in EU courts.

[51] Reducing the cost of assertion may also motivate SEP holders to broaden the number of implementers against which to assert their (confirmed) SEPs. While the increased number of assertions may result in an increase in the overall volume of SEP litigation, the relative litigiousness of SEP licensing negotiations (i.e. the likelihood of any given negotiation to result in litigation) may still decrease.

Overall, we estimate that the policy option has ambiguous effects on SEP litigation costs; but in any case, SEP litigation costs susceptible of being substantially impacted by the policy are too small for these effects to be decisive.

Effects on bargaining positions

The policy option eliminates several strategic advantages that SEP holders currently hold. First, it restricts SEP holders' choice which potential SEPs to assert against individual implementers, thus making assertions more predictable, and reducing flexibility. Furthermore, SEP holders currently often benefit from information asymmetries regarding the technical characteristics of patents under discussion in bilateral negotiations, as one implementer has limited or no access to the technical information produced during bilateral negotiations between the same SEP holder and another implementer, whereas SEP holders may use such technical assessments in multiple bilateral negotiations. Overall, an information structure in which one side (SEP holders) may use and re-use technical information in multiple negotiations, whereas the other side (implementers) is not allowed to share this information with each other, is likely to be strategically beneficial to SEP holders. Replacing (or partly replacing) this system with a system in which assessments are centrally produced and registered in a transparent register open to inspection eliminates this strategic advantage.

As explained above, how the policy option would impact the overall balance of bargaining powers depends on the practical effect of the "presumption of essentiality" generated by a positive essentiality assessment. The mere signal that an objective expert has deemed a particular patent to be standard-essential is certainly not sufficient to compensate SEP holders for the loss of aforementioned strategic advantages. This is consistent with the empirical observation that a purely voluntary system of central essentiality checks (such as the Japanese *Hantei* system) generates little interest among SEP holders. This may be different in a system in which patents receiving positive essentiality assessments (and a fortiori, confirmed SEPs that survived appeals and validity challenges) benefit from significant advantages in the process of SEP litigation (e.g. significantly increased burden on implementers to show willingness to license).

A. 4.2.: Effects on innovation

The effect of Policy Option A on innovation is uncertain, but probably limited. Generally, three different mechanisms could produce an effect of essentiality checks on innovation incentives:

First, a policy intervention creating a system of essentiality checks may shift bargaining powers between SEP holders and standard implementers in SEP licensing negotiations, thus affecting the profits of SEP licensors and licensees, and ultimately impacting the returns on contributions to standards development. Generally, reducing the return on patents is likely associated with decreased innovation incentives; but theoretically, shifting the balance of bargaining powers in favor of implementers could also produce positive innovation effects.[52]

[52] If in the current situation SEP holders' royalty demands stifle implementers' product-driven contributions to a larger extent than they encourage patent-driven contributions by net licensors, reducing SEP holders' bargaining position may increase total innovation incentives.

Empirically, there is a lack of high-quality evidence on the general effect of SEP licensing and FRAND royalty levels on aggregate innovation incentives. Rosa (2022) predicts that eliminating FRAND royalties would reduce contributions to standards development by 18%. Whatever shift in bargaining powers in SEP licensing negotiations may be produced by a policy of essentiality checks would likely be less dramatic than eliminating FRAND royalties altogether; nevertheless, on balance, a shift in favor of implementers (in particular large implementers who may make strategic use of the register and the produced information) would likely have a chilling effect on aggregate contribution incentives. As discussed, depending on courts' implementation of the presumption of essentiality that should be associated with a positive essentiality assessment, the policy option may also preserve the current balance of bargaining powers, or even strengthen the position of SEP holders.

Second, essentiality checks may accentuate the difference between the returns to essential and non-essential patents; thus increasing SEP holders' efforts to produce truly essential patents. In an unpublished theoretical analysis, Wipusanawan and Schuett (2022) argue that increasing the differential between the value of essential and non-essential patents increases potential SEP owners' incentives to contribute to standards development. In their model, this effect could be welfare-decreasing if equilibrium contribution incentives are socially excessive. Policy Option A would however only produce significant differential effects for small portfolios (between those that do and those that do not receive any positive essentiality assessments). Quantitatively, the contributions made by owners of such marginal portfolios account for only a small share of the total number of contributions to standards development. We thus need not investigate in detail potential (complex) effects of essentiality checks on innovation transmitted via the greater differentiation between returns on higher and lower quality small portfolios, as these effects are anyway likely to be of modest importance.

Third, essentiality checks may be costly, while increasing or decreasing the cost of SEP licensing negotiations. The balance of these effects determines whether essentiality checks add to or reduce the transaction cost of SEP licensing, which acts like a tax on both licensors and licensees. Overall, as SEP licensing generates royalty payments of approx. 18bn Euro per year, worldwide, the costs and potential cost savings of essentiality checks would change SEP holders' revenues (and implementers licensing costs) by only about 0.1%. These costs are too modest to plausibly produce significant effects on global incentives to innovate in technology standards.

Overall, how the policy option would affect innovation crucially depends on how the policy affects the bargaining position between SEP holders (licensors) and implementers (licensees). If the policy is overall neutral with respect to the distribution of profits between licensors and licensees (because the effect of the presumption of essentiality conferred by a positive essentiality check is exactly sufficient to compensate SEP holders for the strategic costs of mandatory essentiality checks), innovation incentives would be largely unchanged. If, however, the policy does affect the balance of bargaining positions, the effect of this redistribution on innovation incentives is likely to outweigh any other effects of the policy.

A. 4.3.: Effects on standard implementation

The policy would affect implementation incentives through a variety of mechanisms.

Similar to innovation incentives, implementation incentives may be affected by a shift in bargaining power between licensors and licensees. As discussed, the policy option offers

implementers a variety of strategic advantages (e.g. ability to predict against which patents to defend themselves). Holding investments in standards development constant, shifts of bargaining power in favor of implementers may encourage standard implementation. As such shifts however also have the potential to discourage contributions to standards development, the net effect on standard implementation incentives is ambiguous.

As discussed, the shift in bargaining powers in favor of licensees may be offset by the practical consequences of a presumption of essentiality generated by a positive essentiality check. Assuming that the value of this presumption of essentiality would be sufficient to largely preserve the overall balance of bargaining powers between SEP holders and implementers, and thus the overall royalty level, any effect of the policy on implementation incentives would be limited.

Furthermore, similar to contribution incentives, implementation incentives are affected by transaction costs in SEP licensing. As already argued before, effects of Policy Option A on overall transaction costs in SEP licensing are however too marginal to produce significant effects on innovation or implementation decisions.

Finally, essentiality checks may provide implementers with earlier information about future SEP licensing conditions, thus assisting implementers with an assessment of the future bill of materials. In Policy Option A, the most relevant information produced by the checks is the information about the number of portfolios to which an implementer may need a license. Nevertheless, as Policy Option A produces little information that may be used in the determination of FRAND rates, the overall contribution of Policy Option A to implementers' ability to predict their future total SEP licensing costs remains limited.

A. 4.4.: Systemic effects

The policy option would create a register of approx. 2,400 confirmed SEPs. This register can be used for different purposes, beyond the immediate application in SEP licensing negotiations. In particular, the database may be used for research purposes, and/or to train machine learning algorithms to recognize "true" SEPs among larger populations of potential SEPs. These methods are expected to significantly improve over the next years, and the policy option may further contribute to this evolution. The causal effects of improved ML approaches to essentiality determinations are complex, but potentially significant.

A. *5.: To summarize*:

Policy Option A creates a system of essentiality checks of modest scope (approx. 300-350 checks per year), limited to smaller numbers of self-selected patents for each portfolio. The small number of confirmed SEPs in the register funnels resources for appeals and validity challenges towards a small number of pivotal patents. Rather than expanding the resources that society already allocates to essentiality assessments, the policy option would re-allocate these resources towards those patents that are most relevant and make the results of these essentiality assessments more widely available (thus also limiting wasteful duplications).

Whether these efficiency gains translate into social welfare gains depends on whether the policy option preserves or upends the balance of bargaining powers between SEP holders

and implementers in SEP licensing negotiations. The policy option is capable of producing net benefits (mostly related to potentially significant cost savings in the process of bilateral negotiations over high-value SEP licenses). The policy however also has the potential to shift bargaining powers in SEP licensing negotiations. The direction of this shift is difficult to assess, and depends in particular on the practical consequences of the "presumption of essentiality" generated by the essentiality check. The consequences of such a shift in bargaining powers (in either direction) may plausibly outweigh the cost savings produced by the policy. Whether such a shift is welfare-improving depends on whether current distributions of bargaining powers and royalty levels are considered adequate.

2. OPTION B: CHECKS OF ALL POTENTIAL SEPS

B. 1.: Explanation of policy option:

B. 1.1.: General presentation

A register of checked and confirmed European SEPs is created. SEP holders submit self-selected potential SEPs along with high level claim chart for essentiality checks. Upon a positive essentiality evaluation, the SEP is included in the database along with an indication of the relevant patent claim and technical specification (with version and section numbers). SEP licensing is expected to be based on these registered and confirmed SEPs. Assertion of SEPs in EU courts is limited to registered and confirmed SEPs.

The policy option aims to create a database of confirmed SEPs in support of SEP licensing negotiations. The database is intended to be used during negotiations for the evaluation of a certain SEP license; e.g. parties to SEP licensing negotiations may count the number of confirmed SEPs included in different firms' portfolios, and/or compare the characteristics of different firms' confirmed SEPs.

NB: Option B generally encompasses Option A; i.e. all patents that are checked in Option A will also be checked in Option B, but the number of checked patents in Option B will not be limited to 50 per company. The assessment below takes account of the additional essentiality checks.

B. 1.2.: List of scenarios

The implementation of the database (i.e. how patent holders choose to populate the database) strongly depends on how the database will be used. Use of the database in turn is likely to depend on how the database is populated. There are thus *multiple equilibria* – it is possible

that the database will be very widely used in global SEP licensing negotiations, in particular for FRAND determinations, in which case SEP holders will have strong incentives to populate the database and submit comprehensive portfolios of potential SEPs for check and registration. In this case, the database will provide meaningful information on confirmed SEPs. It is also possible that the database will not be used significantly in SEP licensing negotiations, in which case there are no incentives for patent holders to incur the expense of checking large numbers of potential SEPs. As coverage of the database in that case will be very incomplete, it will be further disregarded in the conduct of most SEP licensing negotiations.

Preferred scenario:

The numbers of confirmed SEPs in the database will be available to parties of SEP licensing negotiations, as well as third parties participating in the resolution of SEP licensing disputes. *Some* SEP holders and *some* implementers will refer to the numbers of confirmed SEPs in the database in support of their FRAND licensing offers. Other SEP holders and implementers will dispute the relevance of these counts. In cases in which FRAND rates are determined by third parties, the number of confirmed SEPs in the database may be one potential input to a FRAND determination, which is usually based on a variety of data points. Courts and other third parties, especially outside the EU, differ in the extent to which their FRAND determinations place weight on the number of confirmed SEPs in the EU database.

For robustness, we also consider three alternative scenarios.

Alternative scenario B1:

The database will have significant influence on global SEP licensing negotiations. In particular, global FRAND rates will often be derived from an aggregate royalty for a standard, where apportionment is based on the number of confirmed SEPs in the register, potentially subject to adjustments for certain readily observable characteristics.

Alternative scenario B2:

The database will have very significant influence on licensing negotiations related to the use of SEPs in the EU. FRAND rates for the EU will often be derived from an aggregate royalty for a standard, where apportionment is based on the number of confirmed SEPs in the register, potentially subject to adjustments for certain readily observable characteristics. FRAND rates for the rest of the world will continue to be determined through a variety of other methodologies.

Alternative scenario B3:

The numbers of confirmed SEPs in the database will be widely reported, but have a limited and highly uneven influence on global SEP licensing negotiations. Those parties that stand to benefit from a determination of FRAND rates based on the numbers of confirmed SEPs in the EU database may expand references to these numbers in their FRAND licensing offer, but other parties will routinely dispute the relevance of these counts. The register will have

limited influence on actual FRAND rates as determined by courts or through bilateral negotiations.

2.2. B.2.: Implementation

B. 2.1: Number of patents submitted for check

Preferred scenario

Independently of the meaning that stakeholders assign to the information available from the database, patent holders have the same legal incentive as in Option A to submit a certain number of patents for checks in order to preserve a credible threat of assertion. In contrast to Option A, there is no cap on the number of patents that patent holders may wish to submit. The holders of the 50 large portfolios that were potentially constrained by the cap in Option A thus have the option to submit more than 50 patents, which may be advantageous independently of the effect of the register on FRAND determinations, even for the sole purpose of constituting a portfolio of assertable patents.

While patent holders can usually only assert a limited number of patents in court (usually no more than 15), including a larger number of potentially assertable patents in the register has several benefits for patent owners: it reduces the likelihood that patents are challenged (or positive essentiality assessments appealed); it makes it more difficult for potential infringers to anticipate which patents may be asserted against them, preserving a strategic advantage of the patent owner in litigation; and it dispenses patent holders of the need to carefully scrutinize their portfolio for patents with higher likelihood to be confirmed, and potentially appeal negative assessments.[53]

In all scenarios, patent holders thus submit at least those patents that they submit in Option A for the purpose of potential assertion; and the 30 active licensors of large portfolios that were constrained by the cap in Option A now may submit significantly larger numbers of patents, with less prior scrutiny and lower rates of appeal. These confirmed SEPs would also include those individual patents that may be discussed in detail in licensing negotiations.

Beyond these sets of self-selected SEPs, in Option B, there is the additional incentive that the register of confirmed SEPs may produce information on the overall number of actual SEPs in the portfolio, to support valuation of licenses to SEP holders' entire portfolios. While in Option A, the cap of 50 checks per portfolio specifically precluded the use of the database to assess the total number of SEPs for a standard or in a large portfolio, the database may now be used to count confirmed SEPs, and to investigate their observable characteristics. The weight that stakeholders place on this information determines patent holders' incentives to populate the database; at the same time, the extent to which patent holders are incentivized to populate the database with comprehensive and meaningful information determines its use. Because of this circularity, plausible scenarios for the

[53] i.e. submitting large numbers of potential SEPs may be a lower cost methodology of populating the register than carefully selecting individual patents

number of patents that patent holders may wish to submit, as well as the efforts they put in this submission, may span a very large range.

At minima, the new system for essentiality checks may substitute for existing checks of similar quality. One SEP licensing environment in which potential SEPs that patent holders seek to license are already often checked for essentiality is licensing through pools – some, but not all pools appoint technical experts to assess the essentiality of every potential SEP family that a patent holder seeks to include in the pool; and the number of a firm's confirmed SEPs in the pool are usually a significant and often the most important factor in determining how the pool's royalty revenue is shared among pool members. Some pools may rely on the essentiality checks under the EU system for the purpose of royalty sharing instead of appointing their own experts, whereas other pools may prefer different methodologies, or US-patent-based checks.

Some licensors also refer to the number of potential SEPs in their portfolio in substantiating their FRAND licensing offers in bilateral negotiations. At least some of these licensors may choose to build a large portfolio of confirmed SEPs in an EU register to which they can refer in order to substantiate their view of their fair share of the aggregate royalty for SEPs covering a particular standard. This is likely to be an "all-or-nothing" strategy – a patent owner that chooses to refer to its number of confirmed SEPs in the register in order to create a favorable impression of its patent portfolio would seek to maximize its number of confirmed SEPs; a company that has submitted significantly less than its total portfolio of potential SEPs for essentiality checks would not refer to the number of its confirmed SEPs in the register as evidence of the strength of its portfolio.

Heterogeneity in firms' efforts to populate the database may strengthen the incentives of some firms to populate the database. If some large SEP holders decline to use the register as a signal of portfolio size and strength, other SEP holders may create an inflated impression of their share in the standard by maximizing their number of confirmed SEPs in the register. If e.g. the owners of half of the potential SEPs for a standard do not participate in the "race" to create the largest portfolio of confirmed SEPs, a company that actually owns 5% of the SEPs for a standard may use the register to sustain a claim that it owns 10%. If the number of firms participating in populating the database increases, these extra incentives weaken.

At least some SEP holders are likely to fundamentally disagree with the notion that their share in the number of confirmed SEPs (even if adjusted for countable patent characteristics) could provide a fair representation of the value of their portfolio. Unless these companies can be compelled to peg their FRAND licensing offers to the number and readily observable characteristics of their confirmed SEPs in the register, coverage of the database (beyond the relatively small set of patents to be potentially asserted in EU courts) is bound to be uneven.

We assess that only a share of the SEP holders actively licensing their patents to implementers would use the register to signal the size of their portfolio. Many of these participating SEP holders however would submit very large numbers of potential SEPs (several hundreds or thousands) to be checked. The use of the register as a signal of portfolio strength would be particularly attractive to SEP holders owning large numbers of potential SEPs (relative to other metrics of the relevance of their technical contribution), and it would further incentivize companies to inflate their patent portfolios by filing additional applications. Also some small SEP licensors would be incentivized to use the register, even if they do not plan to assert their patents in EU courts (e.g. for the purpose of licensing through patent pools).

Alternative scenarios

Scenarios B1 and B2

In the preferred scenario, a significant number of SEP licensors would discount the register as an indication of the strength of their overall SEP portfolio. In alternative scenarios B1 and B2, the information available from the database would have significant effects on FRAND determinations for all SEP owners' portfolios, – e.g. courts or other third parties may use the register when making binding FRAND determinations, or require SEP licensors to formulate FRAND licensing offers that are compatible with the share of confirmed SEPs that they own in the EU register. In an extreme case, FRAND rates are determined in numerical proportionality to the number (and potentially weighted by observable characteristics) of confirmed SEPs, whereas patents that were not checked or checked and not confirmed to be essential play no role in the valuation of SEP licenses. In Scenario B1, this effect is applicable to SEP holders' worldwide FRAND licensing offers, whereas in Scenario B2, the effect of the EU register of confirmed SEPs would be limited to FRAND rates for licensed use of SEPs within the EU.

If worldwide FRAND royalty rates were to be proportional to the number of confirmed SEPs, the average value of a positive essentiality assessment would be approx. 6 to 10M Euro (1 to 1.7M Euro if the effect of the checks is limited to the EU).[54] Given the large value of a positive assessment and the low cost of the check, it is difficult to see how any patent holder would ever decide to withhold a potential SEP from a check, even if the likelihood of the patent being confirmed is low. While this is clearly an extreme (and somewhat hypothetical) example, it is clear that in a scenario in which the number of confirmed SEPs in the register becomes a significant input to the determination of EU-wide (and a fortiori global) FRAND rates, there would be strong incentives for patent holders to populate the database with as many patents as possible.

Incentives to over-submit potential SEPs are further exacerbated as patent holders are uncertain which of their patents are essential, and an examiner may (erroneously) confirm the patent's essentiality even if a more thorough check would indicate that the patent is actually non-essential, etc. The cost of erring on the side of being overly conservative (withholding a patent that may have had a chance with a particularly lenient examiner) is many times larger than the cost of being overly optimistic; and the low payoff of identifying some outlier patents that are so irrelevant to the standard that there is not even a 1% chance of the patent being confirmed hardly justifies the substantial expense of scrutinizing the firm's entire portfolio.

It is thus plausible that if FRAND rates are based on the number and readily observable characteristics of confirmed SEPs in the register, all or almost all potential SEPs related to the standards included in the scope of the database would be submitted for a check. Furthermore, increased use of counts of confirmed SEPs for the determination of FRAND royalty terms produces incentives to file for additional patents, or to (over-)declare additional patents as potential SEPs. Empirical evidence related to pool licensing strongly suggests that

[54] We estimate that there currently are approx. 60,000 potential SEP families ('Empirical Assessment', Appendix 1), generating approx. 18bn Euro annual royalty revenue (Galetovic et al., 2018), for an average 300k Euro per patent family. If, on average, a potential SEP family will generate significant royalties for approx. 10 years, the net present value of a potential SEP family early in life would be approx. 2.5M Euro. If FRAND royalties are determined by apportionment among confirmed SEPs only, and 25 to 40% of the potential SEPs are confirmed essential, the average NPV of these confirmed SEP families would be 6 to 10M Euros (whereas non-confirmed potential SEPs have no value). Proportional to the EU's share in world GDP, we estimate that approx. one sixth of that value is attributable to the licensed use of SEPs within the EU.

SEP licensing environments in which entire portfolios are checked for essentiality to support FRAND determinations by numerical proportionality to patent counts exacerbate patent inflation (Baron and Delcamp, 2015; Baron and Pohlmann, 2012). We therefore expect that in this Scenario, the portfolios of patents submitted for check may be even larger than currently observable portfolios of potential SEPs related to the standards included in the scope of the database.

We assess that there are currently approx. 60,000 families of potential SEPs with an EP or national EU member (see 'Empirical Assessment', Appendix 1). Many of these patents are essential to existing standards that may not be included in a database aimed at supporting future SEP licensing negotiations – nevertheless, if anything, the current stock of currently active and relevant SEPs is an underestimate of the future stock of active and relevant SEPs, as the number of new patents being added to the stack of relevant potential SEPs every year significantly exceeds the number of patents exiting that stock (because of lapse, expiration, or loss of relevance of the underlying standard). For these reasons, we estimate that 60,000 potential SEPs is a reasonable estimate of the baseline steady state number of potential SEPs subject to check. With the additional patent applications resulting from further increased patent propensity, this baseline number may even further increase (while acknowledging significant uncertainty regarding the magnitude of this effect, we estimate that a 20% increase to 72,000 is plausible).

Scenario B3

In Scenario B3, the register has no significant impact on the determination of FRAND rates. Nevertheless, there are two main effects why the number of submitted patents in Scenario B3 is higher than the approx. 3,550 patents submitted for checks in Option A: first, large SEP portfolio owners are no longer constrained by the cap of 50, and some active licensors may choose to constitute larger portfolios of assertable SEPs for litigation strategy reasons. Second, the EUIPO system takes over some or most of the essentiality checks currently carried out by pools' experts – a relatively large number of additional smaller SEP portfolios may thus be checked, where the SEP portfolio owner has no intention of ever asserting a potential SEP in an EU court, buy may submit small numbers of confirmed SEPs to a pool program to collect some royalty revenue. We thus assess that compared to Option A, there would be a larger number of small portfolios, and a greater number of patents submitted from the actively licensed and large SEP portfolios.

Overview

Table B1: Number of patents submitted for checks by portfolio, in different scenarios

	Number patents	Number portfolios
Preferred Scenario	**20,000-30,000**	**450**
Large portfolios	15,000-22,000	50
(actively licensed)		30
- *Using the register as signal of size*	*10,000-15,000*	*10-15*
- *Not using the register as signal of size*	*1,500-2,000*	*15-20*
(net licensees)	3,000-5,000	20
Small portfolios	5,000-8,000	400
Alternative Scenarios B1&B2	**72,000**	**>700**
Large portfolios	42,000	60
(actively licensed)	27,000	30
(net licensees)	15,000	30
Smaller portfolios	30,000	>600
Alternative Scenario B3	**6,500**	**350**
Large portfolios	3,500	50
(actively licensed)	3,000	30
(net licensees)	500	20
Small portfolios	3,000	300

B. 2.2.: Which patents are submitted for checks?

Overall, in all scenarios, patent holders' incentives to carefully scrutinize their patents prior to submission for an essentiality check are greatly reduced.

Preferred Scenario

In the preferred scenario, some patent holders will seek to populate the register with as many confirmed SEPs as possible; whereas other patent holders merely seek to populate the register with a sufficient number of confirmed SEPs to maintain a credible threat of assertion in EU courts. As the cost of an essentiality check (5,000 Euro) is small, and the consistency rates between different experts' assessments is relatively low (72 to 75%); neither type of patent holder has strong incentives to significantly scrutinize their patents prior to submitting them for a check.

Large SEP holders using the register to signal portfolio size, and smaller SEP licensors, have no incentives to withhold any potential SEPs from the register (if they participate, they are likely to participate with their entire portfolio of potential SEPs). Essentiality rates in their portfolios of submitted patents would mirror those in the population of potential SEPs, which we estimate at 25-40%. Given the rates of false positive and false negative assessments from Bekkers et al. (2021), we thus estimate confirmation rates of 49 to 56% in these portfolios.

Large portfolio owners not using the register as a signal of portfolio size only submit a share of their larger portfolios. Nevertheless, they submit larger number of patents than in Option A, and compared to Option A, their incentives to scrutinize patents prior to check are diminished by the possibility to submit larger numbers of patents. While larger than in the other portfolios, confirmation rates in these portfolios are thus bound to be lower than in the same portfolios in Option A. We assess that 55-60% of the patents they submit would be confirmed.

Alternative Scenarios

In Scenarios B1 and B2, the value of a positive essentiality check is many times larger than the cost of the assessment. Only patents with an extremely low likelihood of being found essential may thus plausibly be withheld from essentiality checks.[55]

In Scenario B3, no stakeholder makes significant use of the register to determine the value of SEP licenses. By comparison to policy option A, in this scenario, the only difference is to lift the cap on the number of patents that patent holders may submit for essentiality checks in order to constitute a portfolio of confirmed SEPs assertable in EU courts. The policy thus removes incentives from patent holders to conduct their own internal assessments prior to submitting their patents for the limited number of permissible checks, inducing patent owners to submit patents based on prior beliefs without internal assessments (consistent at 55-60%). Participating owners of small portfolios are likely to submit their entire portfolios.

Overall, given the limited incentives for patent holders to conduct internal assessments prior to selecting potential SEPs for essentiality checks, patents submitted for essentiality checks are not significantly more likely to be essential than the average essentiality rate among potential SEPs.

[55] With a net present value of a confirmed SEP family between 1 and 10 million Euros, and a cost of the essentiality check of 10,000 Euro, even a probability of being confirmed of 1% would be sufficient to incentivize a patent holder to submit a potential SEP for a check.

Table B2: Number of confirmed SEPs by type of portfolios, in different scenarios

	Number checked patents	Share confirmed	Number confirmed SEPs	
			Essentiality rate 25%	Essentiality rate 40%
Preferred Scenario	**20,000-30,000**		**9,825-15,120**	**11,100-17,080**
Large portfolios	15,000-22,000		7,375-11,200	8,300-12,600
(actively licensed)				
- *Using the register as signal of size*	*10,000-15,000*	49-56*%*	*4,900-7,350*	*5,600-8,400*
- *Not using the register as signal of size*	*1,500-2,000*	*55-60%*	*825-1,100*	*900-1,200*
(net licensees)	3,000-5,000	55-60%	1,650-2,750	1,800-3,000
Small portfolios	5,000-8,000	49-56%	2,450-3,920	2,800-4,480
Alternative Scenarios B1&B2	**72,000**	**49-56%**	**35,280**	**40,320**
Large portfolios	42,000	49-56%	20,580	23,520
(actively licensed)	27,000	49-56%	13,230	15,120
(net licensees)	15,000	49-56%	7,350	8,400
Smaller portfolios	30,000	49-56%	14,700	16,800
Alternative Scenario B3	**6,500**		**3,395**	**3,780**
Large portfolios	3,500	55-60%	1,925	2,100
(actively licensed)	3,000	55-60%	1,650	1,800
(net licensees)	500	55-60%	275	300
Small portfolios	3,000	49-56%	1,470	1,680

B. 2.3.: Appeal

Preferred scenario

If there is a possibility for patent holders to appeal a negative outcome of the essentiality check, patent holders will do this whenever the value of a positive outcome of the appeal, multiplied by the probability of overturning the negative outcome of the initial examination, exceeds the cost of the appeal.

Patent owners seeking to maximize their counts of confirmed SEPs for purposes of FRAND determinations are likely to appeal most negative assessments (as every overturned negative assessment adds to their number of confirmed SEPs, and any potential effect on FRAND

rates is likely to outweigh the cost of appeal).[56] We assess that small and large portfolio owners using the register as a signal of portfolio size would appeal approx. 75% of the negative assessments.

For large SEP owners not using the register as signal of size, the number of appeals is difficult to estimate. Compared to Option A, they receive a significantly larger number of negative assessments. Nevertheless, their incentives to fight for every individual confirmed SEPs are diminished, as the cap of 50 maximum submitted patents has been lifted. We estimate that these SEP owners appeal much lower shares, approx. 25%, of the negative assessments that they receive.

In Option A, we estimated a number of appeals by implementers to affirmative essentiality assessments. Many of these appeals concentrate on pivotal SEPs, which determine whether or not a license is needed for a particular portfolio. While patent holders submit much larger numbers of less selected potential SEPs in Option B, and there is thus a larger number of positive assessments that are susceptible of being reversed in appeal, the number of pivotal SEPs does not significantly increase. Implementers have little incentives to appeal the additional confirmed SEPs added to the register in Option B; especially the additional patents submitted by the owners of large portfolios that are now unconstrained by the cap.

Potentially, other SEP holders seeking to increase their own share of the confirmed SEPs for a standard may issue appeals against other SEP holders' confirmed SEPs; nevertheless, experience from patent pools suggests that such appeals are uncommon. Overall, we estimate that the *rate* at which positive essentiality assessments are appealed significantly decreases in the number of confirmed SEPs in the database. To an even larger extent, appeals to affirmative assessments focus on smaller portfolios (of which there are more in Option B than in Option A); as the overall level of scrutiny of the patents that are part of larger portfolios is lower in Option B, in which potentially very large numbers of patents from the same portfolio may be registered.

Table B3: Number of appeals (assuming average essentiality rate of 25%)

	Number affirmative checks	Appeals to affirmed	Number negative checks	Appeals to rejected
Preferred Scenario	**9,825-15,120**	**750-950**	**10,175-14,880**	6,245-9,586
Large portfolios	7,375-11,200	350	7,625-10,800	4,332-6,526
(actively licensed)				
- *Using the register as signal of size*	*4,900-7,350*	*250*	*5,100-7,650*	3,825-5,738
- *Not using the register as signal of size*	*825-1,100*	*50*	*675-900*	169-225
(net licensees)	1,650-2,750	50	1,350-2,250	338-563
Small portfolios	2,450-3,920	400-600	2,550-4,080	1,913-3,060

[56] As an alternative benchmark, one can only observe that the cost of appeal is much lower than the total cost of patent protection for the SEP familly (application, grant and renewal fees). If the patent owner considers that the potential SEP family is worth the cost of patent protection, it is also worth the cost of essentiality assessment, including appeal.

Alternative scenarios

When the number of confirmed SEPs is generally used in global or EU-wide FRAND determinations (Scenarios B1&B2), all SEP owners are incentivized to appeal most (75%) negative essentiality assessments. If the register is generally not used in FRAND determinations (Scenario B3), the number of appeals is similar to Option A – while patent holders submit larger number of (less selected) patents, and thus receive substantially larger numbers of negative assessments, their incentives to fight for confirmations of individual SEPs are reduced by the fact that they can submit any number of potential SEPs for a check.

B. 2.4.: Validity challenges

While essentiality checks may attenuate uncertainty regarding the essentiality of potential SEPs, they will not re-assess the validity of these patents. In the preferred scenario (assuming an average essentiality rate of 25% in the population of potential SEPs), we estimate that 9,825-15,120 potential SEPs would be confirmed upon initial check (related to the initial stock alone). Successful appeals to affirmative checks would remove 375 to 475 of these affirmative outcomes; whereas successful appeals to negative checks would add approx. 3,100 to 4,800 further affirmations. 12,600 to 19,500 confirmed SEP observations would thus be created for the initial stock; if we assume (as we do throughout) that the stock is renewed every ten years, 1,260 to 1,950 confirmed SEP observations are added to the register every year. While these SEP observations would related to a somewhat smaller number of different patents (as one patent may be confirmed essential to multiple standards), the number of new patents being added to the register every year is still likely to reach or exceed 1,000. Challenging the validity of these patents would require expanding the currently observed number of validity challenges to potential SEPs by a factor of 20 to 30 – this does not seem plausible. In contrast to Option A, we thus assess that the number of patents on the register is too large to attract targeted challenges to all or most registered patents. Most confirmed SEPs will thus remain on the register without being challenged.[57]

Compared to the status quo, incentives for third parties to file oppositions or invalidation actions against potential SEPs could nevertheless be somewhat strengthened. As the essentiality checks will somewhat winnow the population of potential SEPs, and help identify pivotal SEPs in smaller portfolios, the resources that are necessary for invalidation efforts may be better targeted at some particularly relevant (confirmed essential) patents. We thus estimate that the number of validity challenges to potential SEPs would increase from the current approx. 50 challenges per year to 75-100 challenges per year.

B. 2.5.: Renewals

Patent owners submitting their entire portfolios of potential SEPs to essentiality checks may benefit from the essentiality assessments to better identify which patents to renew. In

[57] Which is precisely the reason why SEP holders may seek to expand their portfolios of assertable confirmed SEPs beyond the cap of 50

particular, patent owners may expand their number of patent applications (see below), and subsequently only maintain those patents confirmed and included in the register. In the preferred scenario, this effect is limited to the patent owners using the register as a signal of portfolio size, and even these patent holders may choose to maintain part of their non-confirmed potential SEPs, as the EU register is only one among various inputs into the valuation of their portfolio.

In the preferred scenario (once again assuming an average essentiality rate of 25% in the population), we estimate that approx. 10,170-14,880 potential SEPs submitted by SEP holders receive a negative essentiality assessment. After the significant number of appeals to negative assessments, 7,000 to 9,000 potential SEP observations are likely to be definitely assessed non-essential, accounting for approx. 5,000-8,000 different patent families.

Declared potential SEPs are currently maintained at much larger rates than other, otherwise comparable patents (see e.g. Baron and Pohlmann, 2018). This indicates that the status of potential SEP is an incentive for patent owners to maintain their patents at higher-than-average rates. Therefore, we estimate that SEP holders allow approx. 50% of the non-confirmed patents to lapse early (bringing renewal rates in the population of non-confirmed SEPs in line with average renewal rates). Conservatively, we estimate the remaining maintenance cost of EP patents at the time of essentiality assessment at approx. 20,000 Euro per patent.[58] In the preferred scenario, we estimate that the effect of the EU register of confirmed SEPs is largely confined to maintenance decisions for EP patents. Allowing 2,500-4,000 patents to lapse early results in maintenance fee savings of approx. 50 to 80 million Euros for the owners of these non-confirmed SEPs.

In Scenarios B1 and B2, SEP holders will be required by negotiating parties and third parties to base their SEP licensing offers on the number and observable characteristics of confirmed SEPs in the register. Thus, while any other patents may be included in a licensing offer, only patents that have been assessed and whose essentiality has been confirmed contribute to generate royalty revenue from standard implementers (or, in the case of cross-licensing, to offset royalty demands from licensors). In this case, incentives to renew patents that have not been confirmed are even more significantly reduced. Incentives to renew patents confirmed to be essential are increased with respect to the status quo; however, currently observable renewal rates for potential SEPs are already very high, and only a small share of potential SEPs related to active standards is allowed to lapse. Therefore, increased non-renewal of non-confirmed potential SEPs is very likely to significantly outweigh increased renewal of confirmed SEPs. In Scenario B1, the outcome of European essentiality checks impact worldwide SEP royalty rates, so that renewal rates are affected for all family members of the assessed patents. In Scenario B2, the effects of the EU register is limited to the EU, so that only renewal rates for EP patents would be significantly affected.

In Scenarios B1 and B2, approx. 31,700 to 36,700 patents submitted for essentiality check receive a negative assessment. After the very substantial number of appeals, perhaps 20,000 to 25,000 SEP observations are definitely eliminated, accounting for 16,000 to 20,000 different patents (each representative of a different patent family). We assess that SEP holders would allow a majority (75%) of the patents in these families to lapse early, resulting in reduced rates of maintenance related to 12,000 to 15,000 different patent families. In

[58] For an EP patent application registered in four EPO member countries, or for a future unitary patent, the maintenance cost for the remaining patent life (assuming that the essentiality check occurs after grant, and approx. 5 years after application date) is approx. 40k Euro. The average European patent is allowed to lapse after less than 10 years after application, but declared SEPs are maintained at significantly higher rates. Assuming that in the BAU scenario declared SEPs lapse on average 15 to 20 years after application, the maintenance fee savings from allowing patents to lapse immediately after check would be 15k to 40k Euro. https://www.epo.org/applying/european/unitary/unitary-patent/cost.html At least in the beginning, the register will be populated with national patents based on EP applications, rather than unitary patents, and most declared SEPs are registered in more than four EPO member countries. In this case, the maintenance fees saved by patent owners (and thus revenues lost to patent offices) will be even more significant.

Scenario B2, allowing 12,000 to 15,000 European patents to lapse results in maintenance fee savings of 240 to 300 million Euros for SEP holders.

In Scenario B1, SEP holders may also allow a significant share of the foreign counterparts to the rejected EP patents to lapse early.[59] , resulting in failure to maintain patents related to 8,000 to 10,000 different worldwide patent families. Conservatively estimating remaining maintenance fees related to the non-European members of these families at 30,000 Euro, this results in another 240 to 300 million Euros maintenance fee savings for the owners of these non-confirmed potential SEPs.

It is important to understand that SEP holders' maintenance fee savings are not cost savings at the social level – by the time these renewal decisions are made, the patent offices have already incurred all costs related to the examination of these patents. Allowing significant numbers of granted patents to lapse earlier thus results in a net revenue loss for patent offices, without appurtenant savings in actual examination expenses. Patent offices may need to compensate these losses in revenue; e.g. by reducing services or increasing fees for the general population of users of the patent system (applicants, parties filing an opposition, etc.). We thus assess that the cost of patent offices' net losses of revenue will be borne by the general population of users of the patent system.

B. 2.6.: Patent applications

According to IPlytics data, there has been a five-fold increase in the cumulative number of declared potential SEPs in just 10 years (2010-2020, see 'Empirical Assessment', Figure 4). Families of these declared potential SEPs include significantly more than 250,000 patent applications. The cost of patent prosecution related to these applications, i.e. the total of all costs related to the examination of patent applications by patent offices, is very substantial. Conservatively, we estimate the average social cost of examination at 40,000 Euro per application.[60]

The filing and examination of the existing stock of declared potential SEPs has thus likely produced costs in the order of 10bn Euro. The costs related to the examination of potentially standard-essential patent applications by patent offices thus substantially outweighs any costs that may plausibly be *directly* attributed to a possible system of essentiality checks. If a system of essentiality checks for potential SEPs has the potential to influence patenting incentives, these indirect effects (i.e. induced increases or decreases in the number of patent applications to be processed by patent offices) are thus potentially substantial, and cannot be ignored in an assessment of the overall impacts of the system of essentiality checks.

[59] By assumption, in Scenario B1, there would be numerical proportionality to the number of confirmed SEPs in the register in the determination of *worldwide* FRAND royalty rates. While the probability of such an outcome to arise is low, if it nevertheless does arise, it certainly seems plausible that non-confirmation of potential SEPs would have a significant effect on incentives to renew foreign patents.

[60] The social cost of patent prosecution includes at least the costs of the patent office, and the costs of patent attorneys and other service providers assisting the patent applicant. Application and grant fees charged by patent offices are transfers, not social costs. Application and grant fees also do not fully cover the patent offices' cost of examination, as patent offices earn a large portion (more than 50% in the case of the EPO) of their revenue from maintenance fees. A better measure of the social cost of examination per application is the total annual budget of a patent office divided by the number of applications processed by the office per year. The EPO e.g. processes somewhat below 200,000 applications per year on a yearly budget of somewhat more than 2bn Euro, so that the total per-application cost of prosecution (including search, processing, etc.) is estimated at approx. 10,000 Euro. According to van Pottelsberghe de la Potterie and Mejer (2010), the average cost of external services per application was 21,120 Euro in 2008 (equivalent to 27,667 Euro in 2023). Internal efforts by the applicant further add to the social cost of patenting; so that 40,000 Euro per application is very likely a conservative estimate.

Essentiality checks may affect the number of patent applications through at least two different mechanisms. First, in the current system, patent holders may self-declare any patent to be potentially standard-essential. Some companies may *over-declare* potential SEPs for strategic reasons, e.g. to produce an inflated representation of the actual size and value of their SEP portfolio. To the extent that numbers of self-declared potential SEPs have any effect on the rates at which these companies are able to license their patents, the possibility to over-declare patents as potential SEPs produces incentives to file additional patent applications (as even evidently non-essential patents may be relied upon to boost the count of declared potential SEPs). A system of essentiality checks may thus have the effect to reduce patenting incentives, as the incentives to file applications that have a very low likelihood of being confirmed standard-essential would be reduced.

Second, essentiality checks may increase the propensity of the parties of SEP licensing negotiations (and of third parties charged with determining a FRAND rate for a SEP license) to rely on *patent counts* as a method for evaluating portfolios. While some parties may be reluctant to assign weight to counts of self-declared potential SEPs, these same parties may assign greater weight to counts of confirmed SEPs. Essentiality checks may thus increase the incentives to file larger numbers of applications, as even patents of marginal significance (which may otherwise not be worth the cost of patent protection) may gain significant value, as long as they have a positive likelihood of being confirmed standard-essential. Patent holders may also have a possibility obtain larger numbers of patents for the same set of patentable inventions.

The balance of these different effects is difficult to predict, and likely to depend on the Scenario. In the Preferred Scenario, only those patent owners who choose to assign weight to the number of confirmed SEPs as an indication of the value of their portfolio would use the register in this way. These are likely companies that already are more likely to rely on counts of patents in their portfolio to justify their licensing offers. Offering these companies the opportunity to further document the number of confirmed SEPs in their portfolio is thus not likely to substantially change their patenting incentives.

In Alternative Scenarios B1 and B2; negotiating parties and third parties more systematically rely on counts of confirmed SEPs for FRAND determinations. Even those patent owners who would not voluntarily choose to use counts of confirmed SEPs as a measure of the value of their portfolio are compelled to document the strength of their portfolio using counts of confirmed SEPs in the register. Available empirical evidence from the creation of patent pools suggests that creating a licensing model in which royalty rates are distributed proportionally to the number of confirmed SEPs increases incentives to file for additional patents, which outweigh a potential decline in incentives to file and declare patent applications unlikely to be found essential upon check (Baron and Pohlmann, 2012; Baron and Delcamp, 2015).

It is impossible to reliably quantify the potential magnitude of the resulting increase in the number of patent applications. We estimate that a 20% increase in patent applications is a realistic, albeit conservative estimate.[61] In alternative scenarios B1 and B2, in addition to the existing stock of 60,000 potential SEPs, 12,000 additional patent applications are thus filed. Assuming, as we do throughout, that the stock of potential SEPs is renewed every ten years, additional patents related to 1,200 new families would thus be filed every year. Also, the number of necessary essentiality checks would increase to 72,000.

[61] An increase in the number of applications at this level would still result in patent holders' patent portfolio size to decrease, because of incentives to let a significant share of the patents not confirmed to be essential lapse. Furthermore, empirical evidence by Baron and Pohlmann (2012) and Baron and Delcamp (2015) suggests that much larger shares of the number of patents included into patent pools may result from such "patent inflation".

In the preferred scenario and Scenario B2, additional patent filing incentives would be largely limited to EP patents. In Scenario B1, in which the EU register has an impact on global FRAND rate determinations, the policy would induce increased incentives to file additional patents both in Europe and in other patent systems.

2.3. B.3.: Direct effects

B. 3.1.: Costs of registration and checks and other costs

Preferred scenario

In the preferred scenario, an estimated 20,000-30,000 patents are submitted for checks, for a total cost (including fees and patent owners' discretionary expenses) of 200 to 300 million Euros. Approx. 7,000 to 10,500 of these initial assessments will be appealed, for a cost of 350 to 525 million Euros. This cost reduces to 35 to 52.5 million Euros, if instead of full appeals, only *second opinions* by another expert are available. Most SEP holders will reduce efforts in the scrutiny of their patents prior to submission for checks, resulting in lower costs for internal assessments compared to Option A (approx. 10 million Euros).

For most of the additional patents submitted in Option B (i.e. excluding those that would also be submitted under Option A), claim charts cannot be expected to exist or to be produced even in the absence of the policy option. At 4,000 Euro per claim chart (see 'Challenges' Table 8, p. 36), we assess a total cost for these 15,000 to 25,000 additional claim charts of 60 to 100 million Euros. We also estimate that the EUIPO's fixed and annual costs of creating and maintaining the significantly increased database would be larger compared to Option A (for a set-up cost of 3 million and an annual operating cost of 1.5 million Euros).

Table B4: Direct and indirect costs of Policy Option B, Preferred Scenario

Costs	Costs to patent holders	Costs to implementers	Costs to EPO/NPOs/EUIPO	Social cost
Registration and checks	200-300 M €			200-300 M €
EUIPO costs			18 M €	18 M €
Internal assessment	10 M €			10 M €
Claim charts	60-100 M €			60-100 M €
*Appeals**	*325-480 M €*	*25-45 M €*		*350-525 M €*
Validity challenges	12.5-25 M €	12.5-25 M €		25-50 M €
Non-renewal of rejected SEPs	-80 to -50 M €		50-80 M €	0
Total cost	**527.5-865M€**	**37.5-70 M€**	**68-98 M€**	**660M-983M €**
Annual cost	**52.75-86.5M€**	**3.75-7 M€**	**6.8-9.8 M€**	**66-98.3 M €**
alternatively Cost of 2nd opinions	*32.5-48 M €*	*2.5-4.5 M €*		*35-52.5 M €*
Total cost	***235-433M €***	***15-29.5 M €***	**68-98 M€**	***338-530.5M €***
Annual cost	***23.5-43.3 M€***	***1.5-2.95 M €***	**6.8-9.8 M€**	***33.8-53.05M€***

Scenario B1

In Scenario B1, an estimated 72,000 patents are submitted for checks, for a total cost (including fees and patent owners' discretionary expenses) of 720 million Euros. 24,350 to 29,000 of these checks would be appealed, for a total cost of 1.2175 to 1.375 bn Euros. Alternatively, if only second assessments, but no full-fledged appeal processes are available, the cost of these re-examinations would be 121.75 to 137.5 million Euros.

SEP holders will make no significant efforts in the scrutiny of their patents prior to submission for checks. For most of the additional patents submitted in Option B (i.e. excluding those that would also be submitted under Option A), claim charts cannot be expected to exist or to be produced even in the absence of the policy option. At 4,000 per claim chart (see 'Empirical Assessment',), we assess a total cost for these 67,000 additional claim charts of 268 million Euros.

We also estimate that the EUIPO's fixed and annual costs of creating and maintaining the very significantly increased database would be much larger compared to Option A (for a set-up cost of 5 million and an annual operating cost of 2 million Euros).

We also estimate the number of patent applications to increase by 12,000 additional EP applications, and foreign counterparts. Conservatively, we assess the total social cost of each

additional EP patent at 40,000 Euro (including patent office costs, costs of external services, and internal costs of the applicant), and another 40,000 Euro for the totality of each patent family's foreign members (also equally split between attorney fees and patent office costs). Similar to before (see *Renewals*), we estimate that potential SEPs are overall maintained at higher rates than average patents, and thus constitute a source of net revenue for patent offices. We estimate that the patent office fees paid by owners of potential SEPs (including application, grant, and renewal fees at the EPO and national offices) average 40k Euro per EP patent, whereas the cost of examination per patent is closer to 15,000 Euro, so that patent applicants' total cost is 65k Euro per patent, and patent offices' net revenue related to these patents is 25k Euro per patent.

Non-renewal of rejected patents results in maintenance fee savings for SEP holders of 480 to 600 million Euros.

The 25 to 50 additional validity challenges *per year* cost on average 100k Euro per challenge, for a total additional cost of 25 to 50 million Euros over ten years (equally shared by implementers and patent holders).

Table B5: Direct and indirect costs of Policy Option B, Alternative Scenario B1

Costs	Costs to patent holders	Costs to implementers	Costs to EPO/NPOs/EUIPO	Social cost
Registration and checks	1.152 bn €			1.152 bn €
EUIPO costs			25 M €	25 M €
Claim charts	268 M €			60-100 M €
*Appeals**	*1.1875-1.375bn €*	*30-75 M €*		*1.2175-1.375bn €*
Validity challenges	12.5-25 M €	12.5-25 M €		25-50 M €
Additional patent applications	1.56bn €		-(600 M €)	996 M €
Non-renewal of rejected SEPs	-(480-600 M €)		480-600 M €	0
Total cost	**3.58-3.9 bn €**	**42.5-100 M €**	**-95M to 25M€**	**3.6795-3.902 bn €**
Annual cost	**358-390 M €**	**4.25-10 M €**	**-9.5 - 2.5 M€**	**367.95-390.2 M €**
alternatively				
2nd opinions	*118.75-137.5 M€*	*3-7.5 M €*		*121.75-137.5 M€*
Total cost	**2.511-2.662 bn €**	**15.5-32.5 M €**	**-95M to 25M€**	**2.379-2.461 bn €**
Annual cost	**251-266.2 M €**	**1.55-3.25 M €**	**-9.5 - 2.5 M€**	**237.9-246.1 M €**

Scenario B2

In Scenario B2, an estimated 72,000 patents are submitted for checks, for a total cost (including fees and patent owners' discretionary expenses) of 720 million Euros. 24,350 to 29,000 of these checks would be appealed, for a total cost of 1.2175 to 1.375 bn Euros (122 to 137.5 million Euros, if instead of full appeals only *second opinions* are available to appellants).

We estimate that in this scenario SEP holders will make no significant efforts in the scrutiny of their patents prior to submission for checks. For most of the additional patents submitted in Option B (i.e. excluding those that would also be submitted under Option A), claim charts cannot be expected to exist or to be produced even in the absence of the policy option. At 4,000 per claim chart, we assess a total cost for these 67,000 additional claim charts of 268 million Euros.

We also estimate that the EUIPO's fixed and annual costs of creating and maintaining the very significantly increased database would be much larger compared to Option A (for a set-up cost of 5 million and an annual operating cost of 2 million Euros).

We also estimate the number of patent applications to increase by 12,000 additional EP applications. We assess the total social cost of each additional EP patent at 40,000 Euro. Similar to before, we estimate a total fee (including application, grant, and renewal fees at the EPO and national offices) of 40k Euro per EP patent, so that patent applicants' total cost is 65k Euro per patent, and patent offices' net revenue related to these patents is 25k Euro per patent. Non-renewal of rejected patents results in maintenance fee savings for SEP holders of 240 to 300 million Euros.

The 25 to 50 additional validity challenges *per year* cost on average 100k Euro per challenge, for a total additional cost of 25 to 50 million Euros over ten years (equally shared by implementers and patent holders).

Table B6: Direct and indirect costs of Policy Option B, Alternative Scenario B2

Costs	Costs to patent holders	Costs to implementers	Costs to EPO/NPOs/EUIPO	Social cost
Registration and checks	720 M €			720 M €
EUIPO costs			25 M €	25 M €
Claim charts	268 M €			268 M €
*Appeals**	*1.1875-1.375bn €*	*30-75 M €*		*1.2175-1.375bn €*
Validity challenges	12.5-25 M €	12.5-25 M €		25-50 M €
Additional patent applications	780 M €		-(300 M €)	480 M €
Non-renewal of rejected SEPs	-(240-300 M €)		240-300 M €	0
Total cost	**3.1-3.36 bn €**	**42.5-100 M €**	**90-145 M €**	**3.0795-3.302 bn €**
Annual cost	**310-336 M €**	**4.25-10 M €**	**9-14.5 M €**	**307.95-330.2 M €**
alternatively				
2nd opinions	*118.75-137.5 M €*	*3-7.5 M €*		*121.75-137.5 M €*
Total cost	**1.599-1.691 bn €**	**15.5-22.5 M €**	**90-145 M €**	**1.640-1.681 bn €**
Annual cost	**159.9-169.1 M €**	**1.55-2.25 M €**	**9-14.5 M €**	**164-168.1 M €**

Scenario B3

In Scenario B2, an estimated 6,500 patents are submitted for checks, for a total cost (including fees and patent owners' discretionary expenses) of 104 M Euros. 1,750 to 1,850 of these checks would be appealed, for a total cost of 87.5 to 92.5 M Euros. Similar to Option A, SEP holders will invest 20 million Euros to scrutinize their patents prior to submission for checks. For most of the additional patents submitted in Option B (i.e. excluding those that would also be submitted under Option A), claim charts cannot be expected to exist or to be produced even in the absence of the policy option. At 4,000 per claim chart (per our experts' estimates), we assess a total cost for these 1,500 additional claim charts of 6 million Euros.

We also estimate that the EUIPO's fixed and annual costs of creating and maintaining the database would be similar to Option A (for a set-up cost of 2 million and an annual operating cost of 1 million Euros).

We estimate that the number of patent applications and renewal rates for potential SEPs would not change.

The 25 to 50 additional validity challenges *per year* cost on average 100k Euro per challenge, for a total additional cost of 25 to 50 million Euros over ten years (equally shared by implementers and patent holders).

Table B7: Direct and indirect costs of Policy Option B, Alternative Scenario B3

Costs	Costs to patent holders	Costs to implementers	Costs to EPO/NPOs/EUIPO	Social cost
Registration and checks	104 M €			104 M €
EUIPO costs			12 M €	12 M €
Internal assessment	20 M €			20 M €
Claim charts	6 M €			6 M €
*Appeals**	*65-70 M €*	*22.5 M €*		*87.5-92.5 M €*
Validity challenges	12.5-25 M €	12.5-25 M €		25-50 M €
Total cost	**207.5-225 M €**	**35-47.5 M €**	**12 M €**	**254.5-284.5 M €**
Annual cost	**20.75-22.5 M €**	**3.5-4.75 M €**	**1.2 M €**	**25.45-28.45 M €**
alternatively				
2nd opinions	*6.5-7 M €*	*2.25 M €*		*8.75-9.25 M €*
Total cost	**149-162 M €**	**14.75-27.25M€**	**12 M €**	**175.75-208.25 M €**
Annual cost	**14.9-16.2 M €**	**1.475-2.725M€**	**1.2 M €**	**17.6-20.825 M €**

B. 3.2.: Effects on available information

We can again assess the effect of essentiality checks on stakeholders' beliefs regarding certain key variables – the likelihood that a license is needed, the number of patents in a portfolio that are both valid and essential, and the likelihood of individual patents to be essential.

Information whether a license is needed

In each scenario of Option B, checks, appeals, and validity challenges regarding pivotal potential SEPs from small portfolios likely to be asserted in EU courts are similar to Option A. As these checks and appeals are largely driven by the potential for these patents to be asserted, rather their use in patent counting for FRAND determinations, Option B has limited

effects on the information that essentiality checks produce regarding whether a license is needed to a certain portfolio. Similar to Option A, essentiality checks may correctly filter out approx. half of the portfolios not including a single patent that is both valid and essential. The average likelihood that a license is needed for one of the remaining smaller portfolios thus increases; even though the effects on individual portfolios vary depending on the number of potential SEPs that are confirmed.

Crucially, the ability of the policy option to produce this information (and to avoid erroneously eliminating portfolios including truly essential patents) hinges on the availability of appeal. Nevertheless, appeals are a significant factor in driving up the cost of Policy Option B, and weaken rather than strengthen the ability of the policy option to produce accurate information on the *share* of truly essential patents in different portfolios. At the same time, a modified version of Policy Option B, in which appeals are not available, would produce much less reliable information on the essentiality of individual patents, and would fail to produce reliable information on the portfolios from which implementers need a license.

Information regarding the number of true SEPs in different portfolios

The ability of Policy Option B to produce useful information on the number of true SEPs in different portfolios varies between scenarios. In the preferred scenario, there is significant heterogeneity between firms' incentives and strategies in populating the database. The register includes both SEP holders that have populated the database with a small number of self-selected patents, and SEP holders that have tried to maximize their number of confirmed SEPs. The user of the database thus cannot distinguish between firms whose true number of SEPs is low, and firms lacking incentives to populate the database.

Even if the database provides reliable information on the number of true SEPs in *some* portfolios (portfolios of those companies who seek to have their full portfolio of SEPs registered), the database fails to produce relevant reference points (the total number of SEPs for the standard, or the number of SEPs in relevant competitors' portfolios). Overall, in the preferred scenario, the register does produce information on the number of true SEPs in *some* portfolios; nevertheless, in most circumstances, the usefulness of this information remains limited.

If – as in alternative Scenarios B1 and B2 – SEP holders are compelled to populate the database with large numbers of SEPs (e.g. because FRAND rates are commonly determined by reference to the number and observable characteristics of confirmed SEPs in the database), the information on counts of true SEPs that is available from the register becomes more representative.

One persistent limitation on this type of information is over-confirmation bias. Because false positive assessments appear to be more common than false negative assessments, the number of confirmed SEPs would systematically be larger than the number of actual, true SEPs in firms' portfolios. This bias only partly cancels out when estimating relative portfolio sizes of different firms. Over-confirmation bias favors firms with larger numbers of lower quality SEPs. This bias would be exacerbated if there is a possibility to appeal essentiality checks, as patent holders have significantly stronger incentives to appeal negative assessments of their own patents than third parties' incentives to appeal positive assessments. While appeals are bound to improve the average prediction accuracy of assessments on a patent-by-patent

basis, they increase bias in the determination of different firms' shares in the number of true SEPs for a standard.

Precision in the determination of firms' "true" numbers of SEPs also depend on firms' numbers of potential SEPs submitted for checks. Under the assumption that essentiality checks (other than being overly optimistic) are not biased between different firms, estimates of firms' true numbers of SEPs become more accurate in larger portfolios, as Type I and Type II errors partly cancel out. Nevertheless, this only works for large portfolios; for small portfolios, there is significant imprecision in the determination of true numbers of SEPs, resulting from the large error rate in the assessment of individual patents.

In the essentiality pilot study (Bekkers et al., 2021), the likelihood of a patent to be essential, conditional upon being found essential, was 75%.[62] With a validity rate of 0.5, the conditional likelihood of a confirmed SEP to be both valid and essential is thus 0.375. At these rates, if two firms have 10 confirmed SEPs each, each firm has a 95% likelihood to hold no more than 3.5 times more truly essential, valid SEPs than the other firm. If both firms hold 100 confirmed SEPs each, each firm has a 95% likelihood to hold no more than 35% more truly essential and valid SEPs than the other firm.

Because of the residual uncertainty regarding the essentiality of confirmed SEPs, and uncertainty regarding patent validity (which the checks don't address), counts of confirmed SEPs in smaller portfolios remain subject to large margins of error. Nevertheless, for the largest portfolios (those with more than 100 confirmed SEPs), counts of confirmed SEPs may potentially be a reliable indication of the number of true valid SEPs in the portfolio. These ranges assume absence of systematic bias in the determination of essentiality. As we have identified at least one likely source of bias (over-confirmation bias, which disadvantages portfolios of higher quality), residual uncertainty after checks is likely to be larger.

Provided that one is willing to use counts of patents that are both valid and essential as a relevant indicator of the value of a portfolio, Policy Option B may provide such information for larger portfolios with acceptable confidence intervals, but only in scenarios in which all (or close to all) relevant SEP holders are compelled to massively populate the register in view of maximizing their count of confirmed SEPs. This information on counts of confirmed SEPs in large portfolios thus comes at a substantial cost.

Information regarding essentiality and validity of individual patents

The effect of Policy Option B on the likelihood of individual patents included in the registry to be both valid and essential also depends on the Scenarios, but overall is more limited than in Option A. We again consider the *ex ante* likelihood of individual patents to be both valid and essential to range from 12.5 to 20%.

Patents included in the registry have significantly higher likelihoods to be valid and essential. Conditional upon a positive essentiality assessment, randomly selected potential SEPs have a 75% likelihood to be found essential in a more rigorous assessment. The likelihood of pre-selected, confirmed SEPs to be truly essential is even higher. Compared to Policy Option A, where the cap of 50 patents per company and standard forces SEP holders to make a

[62] 53 out of the 70 patents that were experimentally assessed essential were presumably truly essential.

selection, self-selection by patent owners prior to essentiality checks is estimated to be more limited (especially in Scenarios B1 and B2).

Furthermore, a smaller share of essentiality assessments (and a much smaller share of *positive* assessments) is subject to appeal. If we assume that SEPs confirmed in an initial assessment have a 75% likelihood to be essential, estimate that approx. 10% of the confirmed SEPs in the database underwent appeal (either to an initial positive or negative assessment), and again assign a 90% likelihood to such (more rigorous) appeals decisions to be upheld, the average likelihood of confirmed SEPs to be essential increases to 76.5%. Crucially, in Policy Option B only a small minority of the registered patents are challenged for validity (10% in the preferred scenario). With a 95% likelihood to a patent whose validity was upheld in a challenge to withstand further challenges, the average likelihood of a confirmed SEP in the registry to be valid is 54.5% (assuming that 50% is the average likelihood for a patent to be valid). The average likelihood of patents in the registry to be both valid and essential thus is 41.7% - still an improvement over the ex ante situation, but much less than the 68.7% achieved in Policy Option A, where the smaller number of patents in the registry is more exposed to appeals and validity challenges.

2.4. B.4.: Indirect effects

B. 4.1.: Effects on licensing costs and delays

The effect of Policy Option B on SEP licensing negotiations is contingent on how the database is used – in particular, whether (as in the preferred scenario) reference to the database in support of FRAND licensing positions remains optional and one input among various; or – as in alternative Scenarios B1 and B2 – all relevant SEP holders may be induced to peg their FRAND licensing offers to the number and readily observable (countable) characteristics of their confirmed SEPs.

Preferred scenario

The availability of a non-binding source of information on the number of confirmed SEPs may have two effects on SEP licensing negotiations: first, the availability of a database of confirmed SEPs may affect *how* parties of SEP licensing negotiations procure information on (estimated) counts of confirmed SEPs in cases in which they already do this. In particular, numbers of confirmed SEPs from the database (presumably publicly available at no charge) may be used instead of reports available for a fee from commercial providers. In some cases, the availability of a database of confirmed SEPs will also make it unnecessary for parties of SEP licensing negotiations to conduct their own (costly) assessments of larger samples or portfolios of potential SEPs.

Information from the database of confirmed SEPs may partly or fully replace these other sources of information. It is common, and good practice, to use and cross-check different sources of information. Commercial providers may offer information not available from the EU database, in particular information on non-EU SEPs.

The (partial) crowding out of commercially provided information by the EU database will have different implications. Commercial providers may lower their prices to face the new competition. Commercial providers may also extend their offering of analyses that are not competing with the EU database, such as analytics of patents' quality (commercial and technical relevance) and likelihood to be found valid if challenged. It may also become easier to compare different commercial providers' estimates with an authoritative and transparent benchmark, further increasing pressure to enhance the overall quality and transparency of commercial reports.

This first effect of the database thus entails a reduction in the cost, and improvement in the quality, of existing uses of counts or estimated counts of true SEPs.

Second, the availability of the new database will create new uses of counts of confirmed SEPs, i.e. some parties who currently do not use information on SEP counts will begin using this information if relatively reliable counts are available free-of-charge.

This may entail use by courts, arbitrators, conciliators, or other third parties; as well as use by parties in regular SEP licensing negotiations. The new use of counts of confirmed SEPs may arise in situations in which there currently is no information on confirmed SEPs at all (e.g. cases in which the consistency of an individual SEP license's terms with a reasonable aggregate royalty is not examined for lack of information on the relative portfolio strength); as well as in situations in which currently only one party has access to information on estimated counts of confirmed SEPs (asymmetric information).

Cost savings related to existing uses of SEP counts

The first effect is perhaps easier to estimate, because cost savings in the existing use of essentiality checks represent a fraction of currently arising costs. While this is in principle an objective empirical magnitude, it is impossible to observe. Reports on the estimated number of true SEPs per portfolio are produced by a variety of companies. Some providers of such estimates are larger consulting companies, for which producing and distributing assessments of the number of SEPs is only one among many commercial activities. Many essentiality checks are performed by independent experts or smaller companies that do not publish any financial reports. It is thus impossible to estimate the resources currently employed to these activities.

Perhaps the largest potential cost savings resulting from a database of confirmed SEPs are related to patent pools that are limited to checked and confirmed SEPs. Some pool licensing administrators appoint technical experts to conduct essentiality checks of every patent submitted by aspiring pool members for potential inclusion into the pool licensing program. Merges and Mattioli (2017) e.g. estimate that the cost of these essentiality checks related to the MPEG Audio pool represented 5,250,000 USD, about two thirds of the total set-up cost of this pool.

The policy option may not fully dispense pool administrators of the need to appoint their own experts.[63] At the least, pools may choose to restrict their own scrutiny to confirmed SEPs from the database, thus reducing the workload for their own experts.

[63] Bekkers et al. (2021) use the checks performed by these experts as higher quality benchmark against which they compare the pilot checks, indicating that the pools' experts' checks are potentially more thorough. Pools may also require information on non-EU SEPs, or apply different criteria or standards of examination than those practiced by the EU essentiality checks.

While there is a number of larger pools currently in operation that conduct essentiality checks for every potential SEP to be included in the licensing program, not all pools are limited to specifically identified (and checked) patents. Nevertheless, licensing administrators for larger pools such as Avanci, while not checking the essentiality of every potential SEP that pool members may own, also carry out technical assessments of larger numbers of patents. Also in this context, a EU database of confirmed SEPs may offer some potential cost savings.

A total of more than 70 SEP-related patent pools have been created over the last 30 years. While some pool licensing administrators indicate that they have requested expert assessments for each patent family included in the pool, other administrators carry out essentiality checks of sampled patents, or otherwise assess essentiality rates in larger portfolios using lower cost alternatives to thorough checks of every individual patent. We thus estimate that 5 million Euro is an upper bound estimate to the average expense by pools related to essentiality checks, bringing the total estimated expense in this respect to 350 million Euros over 30 years (of which only a fraction may have been saved if a EU database of confirmed SEPs had been available).

Cost savings from essentiality checks in the context of litigation in the EU are mostly related to the essentiality of selected patents-in-suit. Significant cost savings in litigation resulting from the fact that not only those patents eligible for assertion in EU courts, but entire portfolios have been checked for essentiality, are only plausible outside the EU. We are not aware of a case in the EU (excluding UK) in which the court heard or assessed evidence regarding the (estimated) number of true SEPs owned by different companies.

There were at least four cases in which foreign courts have estimated the total number of SEPs for a standard. In two of these cases (Microsoft v Motorala and In re Innovatio), courts merely used an approximate assessment of the number of potential SEPs, without requiring or reviewing essentiality checks for that purpose. In Unwired Planet v Huawei, the judge accepted experts' use of essentiality rates from existing studies. Random samples were checked for essentiality in order to produce estimates of essentiality rates in at least one decision, TCL v Ericsson. These assessments probably significantly contributed to the cost of the dispute. A EU database of confirmed SEPs may have eliminated the perceived need for these costly assessments – the foreign court that adjudicated these disputes could perhaps have accepted counts of confirmed SEPs in a EU database (with some adjustments, using information on the foreign counterparts on the checked European patents) as a reasonable approximation of firms' shares in global SEP portfolios.

We estimate that potential cost savings that a EU database of confirmed SEPs may produce for such litigations in foreign courts approximate about 0.5 to 1 million EUR per case (rough estimate, based on the assumption that part, but not all of the expenses related to counts of SEPs by portfolio could have been saved). It is difficult to foresee how many more cases there will be in the future in which estimated counts of true SEPs play such a prominent role. Presumably, if adjudications of patent counts were to ever become a regular occurrence, there would be redundancy between different cases (assessments from previous disputes could be re-used), mitigating somewhat the potential for cost savings.

Outside litigation, we estimate that it is unlikely that there currently are large-scale essentiality checks on large portfolios of potential SEPs taking place during SEP licensing negotiations. Instead, parties of SEP licensing negotiations are likely to use lower cost indications of how many patents in larger portfolios are likely to actually be essential, such as commercially available reports, expert opinions, technical or scientific studies, and indications of portfolio strength based on observable characteristics.

The total worldwide expense for these technical assessments is likely in the tens of millions EUR per year (potentially growing to the hundreds of millions), and some part of that

expense may be saved if there was a EU database of confirmed SEPs.[64] Nevertheless, as the EU SEP database would be limited to EU SEPs, and subject to self-selection and over-confirmation bias, complementary sources of information on the true number of SEPs would continue to be produced and used. Furthermore, commercial reports, technical studies, and software solutions are not limited to estimated counts of SEPs by firm, but may also provide e.g. indications of other dimensions of technical merit. The share of the current expense on patent analytics related to potential SEPs (commercial reports, technical studies, etc.) that could really be saved is thus difficult to estimate, but unlikely to exceed a few million EUR per year.[65]

Overall, the potential for cost savings related to existing uses of information on SEP *counts* is real, but somewhat limited. Overall, we estimate that approx. 10-20 million EUR per year could be saved (excluding the cost savings from essentiality assessments related to individual patents under discussion in SEP Licensing negotiations or litigation).

Expanded use of SEP counts

In addition to cost savings related to existing uses of (estimated) counts of confirmed SEPs, the policy option may expand the range of these uses. Parties would only elect to make these additional uses if there is a net benefit to these new uses. These net benefits from the additional uses need to be added to the cost savings related to existing uses in order to estimate the overall benefits of the policy.

For many purposes, the net benefits of currently unrealized uses of counts of confirmed SEPs are constrained by the price of existing commercial solutions: presumably, stakeholders that currently do not make use of this type of information have a relatively low valuation for this information (i.e. their willingness-to-pay for this information is below the price currently charged by commercial providers). Commercial reports on counts of confirmed SEPs are available for several thousand Euros. Potential users of this type of information are primarily the (potential) implementers of standardized technology subject to potential SEPs.[66] Some such standards (AVC, WiFi, Bluetooth…) are implemented by several thousand companies, and an even larger number of companies may have at least contemplated the use of such standards in their products.

Only a fraction of these (potential) implementers are ever actively engaged in SEP licensing negotiations, and it is plausible that a significant share of these implementers currently does not purchase any information on assessed numbers of true SEPs. For most of these companies, this is a rational decision – using this information would require significant complementary background knowledge, and in light of the low cost of some SEP licenses (e.g. pool licenses for AVC), and the low likelihood of assertion of most SEPs against small

[64] The global patent analytics market is projected to grow from 907.6 million USD in 2022 to 2,099.3 USD million by 2029. We estimate that the share of that market related to (potential) SEPs is a high single digit percentage, in line with the share of (potential) SEPs in patent litigation counts and estimated patent royalty flows. https://www.fortunebusinessinsights.com/patent-analytics-market-102774

[65] More generally, the strategic value of patent analytics may be primarily driven by information that is held only by some parties, thus giving these parties a strategic advantage. Free availability of data on confirmed SEPs thus could lead to a displacement effect, whereby companies would continue to purchase and use expensive, and exclusive, patent analytics from commercial providers, covering other aspects not available from publicly available sources. It could also lead to a situation in which the demand for costly patent analytics collapses, as no negotiating party can gain an advantage by accessing crucial information unobservable to the other party.

[66] Other potential users are spread throughout the economy, such as investors, strategic consultants, journalists, etc. It is impossible to quantify the benefits of providing these numerous marginal stakeholders with improved information of indirect and overall limited relevance to their purposes.

implementers, the cost of acquiring this knowledge may often not be justified. Nevertheless, it is plausible that there are larger numbers of implementers for which this information would have some value (albeit not enough value to justify the purchase of commercial reports at the current price). Overall, there may be hundreds or a few thousand stakeholders (primarily smaller companies) who currently do not use information on counts of confirmed SEPs, but for whom such information would produce some benefits (of up to a few thousand EUR per user, per year). The total value of this expanded commercial use of SEP information thus may total up to 10-20 million EUR per year.

Overall, the potential benefit of a new source of information on the number of true SEPs in different portfolios may be significant, but would be unlikely to exceed the range of 20-40 million Euro per year, unless there is a significant *qualitative* change in the use of SEP information (e.g. the availability of a database of confirmed SEPs may change the dominant interpretation of SEP holders' FRAND obligation by EU courts). If EU courts e.g. more routinely checked the consistency of individual SEP owners' licensing offers with a reasonable aggregate royalty burden for implementers (using the EU database of confirmed SEPs for estimating relative portfolio strengths), such assessments may become much more common during SEP licensing negotiations. In this case, there may be significantly expanded use of information on (estimated) counts of confirmed SEPs, and current use of such information may be of limited informativeness to assess the extent and the social value of future use.

Nevertheless, such a significant qualitative change in the use of counts of confirmed or presumed SEPs is only plausible if a new source of information provides encompassing and reasonably accurate information on SEP counts in different portfolios. A register subject to selection and over-confirmation bias, which is limited to certain portfolios, would be unlikely to trigger such a regime change.

Information on individual patents

Unlike discussions of entire portfolios or populations of potential SEPs, discussions of the essentiality and validity of individual patents are very common in the technical phase of SEP licensing negotiations, and SEP litigation. The use and value of the information provided in the register on the large number of included confirmed SEPs is difficult to estimate. Nevertheless, we estimate that the vast majority of patents that would be individually discussed in licensing negotiations or disputes would also be checked and registered in Option A; and in Option B, the larger number of patents in the registry means that appeals and validity challenges are less focused on those patents that will subsequently be relevant in licensing negotiations or litigation contexts, so that there is actually less information being produced on these individual patents. Therefore, while still potentially significant, the benefits of the information on individual patents produced in Option B are somewhat smaller than in Option A.

Overall, while Policy Option B produces information on a larger number of patents, and produces information on the total size and characteristics of some SEP portfolios that is not available in Option A, in the preferred scenario, the value of this additional information is insufficient to compensate for the higher cost of Policy Option B compared to A, as well as the loss of scrutiny of individual patents.

Scenario B1

In Scenario B1, the produced information on the size and characteristics of SEP portfolios has the potential to produce much larger benefits, as – by assumption – the EU register of confirmed SEPs would significantly impact the determination of global FRAND rates. The register would provide a publicly observable indication of portfolio size. If this indication becomes a standard in worldwide SEP licensing negotiations, and FRAND rates would generally be determined proportionally to the observable portfolio sizes, this would have the potential to eliminate much of the existing uncertainty regarding the FRAND terms of licenses to confirmed SEP portfolios. As a consequence, the part of SEP licensing costs, delays, and disputes that is related to the FRAND value of a SEP license may be significantly reduced. In the case of licenses to large portfolios of potential SEPs, disagreements over the FRAND rate constitute the main source of such transactions costs. The cost and delays of licensing large portfolios of potential SEPs may thus be significantly reduced.

It bears emphasis that this effect is *not* attributable to the value of the information produced by essentiality checks, i.e. the fact that uncertainty regarding the number of truly essential patents has been reduced. Any policy that ties FRAND rates to a publicly observable empirical magnitude (whether relevant to the "true" value of a SEP portfolio or not) would have the same effect. In a scenario in which FRAND rates are not negotiated, but follow mechanically from a count of confirmed patents in a register (or counts of any other publicly observable, countable things), the transaction cost of negotiating FRAND rates is greatly reduced.

It is important to keep in mind that transaction costs are only one dimension of the efficiency of SEP licensing. Other dimensions, such as the opportunity for SEP licensing negotiations to result in mutually beneficial idiosyncratic provisions, would similarly be eliminated by a mechanical determination of FRAND rates based on counts of confirmed SEPs.

The policy may increase or reduce delays in SEP licensing. Currently, SEP licensing takes place at an intermediate stage – after a standard has been published, but while very large numbers of potential SEPs are still pending applications. If SEP licensing only takes place after all patents have been granted and checked, SEP licenses will be concluded at a significantly later stage than is currently the case. It is possible however that an aggregate royalty would be determined, and apportionment of the rates is subsequently adjusted for numbers of confirmed SEPs added to the register on a rolling basis. Under this scenario, the policy does not necessarily create a delay in SEP licensing, and may even reduce currently observable SEP licensing delays.

Whether the policy results in royalty rates that are economically more efficient than the rates emerging from bilateral licensing (e.g. create strong innovation incentives without stifling incentives for standard implementation) is empirically very difficult to assess. Overall, there is little reason to believe that the policy option would result in economically efficient prices. First, whether FRAND terms would be apportioned from an economically efficient aggregate royalty is unclear, and depends on the specific process through which this aggregate rate would be determined. Second, the relationship between patent counts and the actual relative value of a SEP portfolio is tenuous, at best.

Currently, determining FRAND rates by apportioning an aggregate royalty among SEP holders in numerical proportionality to their numbers of confirmed SEPs is mostly reserved to circumstances in which potential transaction costs are large compared to the per unit economic value of SEP licenses. In these circumstances, the relatively small value of SEP licenses does not justify the relatively important cost of "getting the price right" (determining

licensing terms that are economically efficient, and appropriate for the idiosyncratic situations of the parties of each license).

In this scenario B1, this process for SEP licensing would be generalized. This change has the potential to dramatically modify the overall efficiency of SEP licensing; nevertheless, the existing evidence is not fully conclusive as to whether these potentially large modifications would improve or worsen the efficiency of SEP licensing.

Given that, in this scenario, the policy option would fundamentally transform a core aspect of global SEP licensing, any potential effects on the efficiency of SEP licensing are likely to outweigh the potential costs or transaction costs savings resulting from the policy. Unfortunately, these potentially significant effects are also highly unpredictable.

Overall, Scenario B1 is predicated on a radical change in the way FRAND rates for global SEP licenses are determined. Enforcing proportionality between FRAND rates and publicly observable counts of confirmed SEPs in an EU database is likely to significantly reduce transaction costs in SEP licensing, but may also significantly diminish the value of these licenses, and the effectiveness of the economic incentives that are produced. These effects are very difficult to predict. While it cannot be ruled out that Scenario B1 would result in welfare improvements, it is certainly a high-risk policy option. Ultimately, it may not be necessary to fully assess the effects of Policy Option B in Scenario B1, as this scenario is also very unlikely – the EU simply lacks the means to force foreign courts and decision makers to enforce FRAND rates that are proportional to information available from an EU register.

Scenario B2

In light of the limited means of the EU to influence FRAND determinations by non-European decision makers, it may be more realistic to expect that a (comprehensive) EU register of checked and confirmed European SEPs would very significantly impact the determination of FRAND rates for the use of SEPs within the EU; while FRAND determinations for uses in other parts of the world would continue to follow different methodologies.

In this scenario, SEP licensing (which currently takes place on a global scale) will be split in at least two geographical blocks – FRAND licensing terms for the EU will need to be calculated separately from FRAND licensing terms for the rest of the World. Even if the new system for determining FRAND rates for the EU should be relatively low cost, the transaction costs under the EU system are added to, rather than replace the existing transaction costs related to the negotiation of global SEP licenses.

Because of this feature, the overall royalty burden for standard implementers becomes less, rather than more predictable due to the policy option. Furthermore, the policy option is bound to increase delays until implementers have secured all necessary licenses (as breaking up global SEP licenses in at least two different licenses along geographical lines means that implementers only have secured all necessary licenses once both processes are completed).

In this scenario, the policy option creates significant upfront costs, while further increasing transaction costs in SEP licensing. Even if the determination of FRAND licensing terms through numerical proportionality should turn out to be economically more efficient than existing processes for the determination of FRAND terms in the SEP licensing market

(which is dubitable), these potential benefits would be unlikely to outweigh the significant costs of the policy – as only about 20% of the SEP licensing revenue are attributable to the use of SEPs in Europe, the policy may only impact a small share of the SEP royalty determination.

Scenario B3

In alternative Scenario B3, the register would have no significant influence on FRAND determinations. The only significant difference with Policy Option A is that the cap of 50 potential SEPs that may be submitted for checks has been lifted. As explained, this distinction produces no benefits, but diminishes the value of the register. In Scenario B3, policy option B is thus clearly dominated by Policy Option A.

2.5. *B.5.: To summarize*

In Policy Option B, a larger (and potentially much larger) number of potential SEPs is checked. Compared to Policy Option A, Policy Option B produces much larger costs, but also has the potential to produce two additional benefits: information on the essentiality of every potential SEP, and information on the number of potential SEPs in different firms' portfolios. For this information to be representative and useful, the policy option requires systematic participation from all owners of potential SEPs, to minimize self-selection bias. If essentiality checks are limited to only some firms' self-selected potential SEPs, the register provides little reassurance to implementers seeking information on their overall exposure, and has limited potential to be useful in FRAND determinations.

If all firms submit all their potential SEPs for essentiality checks, the total cost of the policy option would reach several hundred million Euro per year. It is difficult to identify specific cost savings that the policy may plausibly produce within the current framework for SEP licensing that would justify such costs.

For such a significant expense on essentiality checks to potentially be justified, the availability of counts of confirmed SEPs would need to fundamentally transform the process of SEP licensing; thus eliminating a significant share of costs that are assessed to arise in the current process of SEP licensing. It is impossible to fully assess whether such a transformation would be welfare-enhancing. It does however appear that such an assessment is not necessary, as the ability of an EU register to fundamentally transform the way SEP licenses are being evaluated and negotiated would be geographically confined to the EU. Licenses for the use of global SEP portfolios outside the EU would need to be negotiated separately; and regulators in other world regions may decide to also put forward their own preferred methods for evaluating SEP licenses. Such a bifurcation of SEP licensing processes has no realistic potential to be efficiency-enhancing.

3. OPTION C: CHECKS OF SELF-SELECTED AND RANDOMLY SAMPLED POTENTIAL SEPS

3.1. C.1. Description of Policy Options

C. 1.1.: General Description

A register of potential SEPs is created, including technical information of varying detail on these patents (e.g. the number of the relevant claim, and the technical specifications, and versions and sections thereof, to which the patent is potentially essential). Owners of potential SEPs may register any patent they believe to be (potentially) essential to a standard, along with the required information.

Patent owners may submit up to 50 self-selected potential SEPs along with high level claim charts for essentiality checks. Results of affirmative essentiality checks shall be indicated in the register. Only registered *and confirmed* SEPs may be asserted *as SEPs* in EU courts.

In addition, the EUIPO defines (short) lists of *standards* for which (approximate) numbers of SEPs per company should be assessed based on samples. The EUIPO draws random samples from the potential SEPs included in the register. Patent holders are informed which of their patents were sampled and are invited to submit claim charts to support an essentiality check. If a patent is randomly selected that had already been checked based on patent owners' own request, the results of the previous essentiality check may be used. After checks of the sampled patents, the EUIPO publishes a report with the assessed numbers of SEPs by company. If a randomly selected patent is confirmed to be essential, the information that the patent was found to be essential is added to the register.

C. 1.2.: List of scenarios

The number and identity of potential SEPs in the register, as well as the EUIPO's assessment of the number of true SEPs in different firms' portfolios (based on samples drawn from the second register), will be available to parties of SEP licensing negotiations, as well as third parties participating in the resolution of SEP licensing disputes. As in Option B, there is a variety of scenarios how this information may be used. For the most part, we focus on the *Preferred Scenario*: Some SEP holders and some implementers will refer to these numbers in support of their FRAND licensing offers. Other SEP holders and implementers will dispute the relevance of these numbers. In cases in which FRAND rates are determined by third parties, the EUIPO's assessed numbers of true SEPs in different firms' portfolios may be one potential input to a determination usually based on a variety of data points. Different courts and other third parties differ in the extent to which their FRAND determinations place weight on the EUIPO's estimates.

Scenarios for Option C (within the Preferred Scenario) differ in the way the information produced *by sampling* will be used - in essence, the willingness of stakeholders to use assessed rates that are subject to statistical uncertainties. First (Scenario C1), stakeholders may wish to use the sampling estimates as *reliable evidence* (rather than merely an indication) for the relative number of SEPs in a firm's portfolio; i.e. elect to only rely on

information that is established with high levels of confidence. Some sources of uncertainty (e.g. random sampling error) can be quantified, and a confidence interval can be calculated – indicating e.g. that there is a 95% likelihood that Firm A's essentiality rate is anywhere between 20 and 50%. If stakeholders require such high levels of statistical confidence, large samples need to be drawn and checked to produce confidence intervals that are sufficiently small to be useful.

Second, (Scenario C2) stakeholders may use estimates based on samples (that can be small) to provide *one* objective indication of the number of essential patents in different portfolios. The average essentiality rate in a randomly drawn sample (no matter how small) provides an *unbiased* estimate of the essentiality rate in a population. While subject to significant uncertainty, sampling estimates based on small numbers of higher quality checks on randomly selected patents from every portfolio would likely still constitute one of the best publicly available indications of the number of SEPs in different portfolios, and may be used as such.

Third (Scenario C3), sampling may be used to create discipline in firms' behavior in populating the register. In this scenario, firms are "rewarded" for populating the register with accurate information; and a firm may compromise its bargaining position by submitting a larger number of potential SEPs to the register that are subsequently found not to be essential in random checks. If this penalty is large enough, firms would be incentivized to rigorously examine their own patents prior to submitting them to the register; so that the register provides a reasonable indication of the population of actual SEPs. The number of checks necessary to uphold this discipline is not necessarily very large, as confidence intervals around the sample estimates are largely irrelevant – nevertheless, the policy option requires firms to carry out costly internal assessments.

In each of the options, there are two types of checks – those prompted by a request from the patent holder, and those prompted by random sampling. There is the possibility to also use the outcomes of checks requested by the patent owner for the purpose of determining firms' average number of SEPs. In the case of many of the smaller portfolios, the overlap between both sets is large: most potential SEPs that would be randomly sampled for checks would also be self-selected for a check by the owner. In the case of the 50 larger portfolios, however, only a small portion (perhaps 5-10% on average) of the entire portfolio would have been checked in compliance with Option A. There is thus only a 5% to 10% chance that a randomly sampled patent already has an essentiality assessment that could be used. The additional checks under Option C (compared to A) thus largely relate to these 50 larger portfolios. Under Options C1 and C3, checking an additional 50 randomly selected patents from each of these portfolios may provide a sufficient indication of essentiality rates in the portfolio. If stakeholders however require essentiality estimates with conventional statistical confidence levels (e.g. 90 or 95%); much larger samples would need to be drawn.

3.2. C.2.: Implementation

C. 2.1.: Size of samples

Compared to Options A and B, Option C would entail a number of additional implementation decisions. In particular, for those patents that are randomly selected for essentiality checks, a specific sampling methodology will need to be defined; which specifies in particular (1) the number of patents to be checked, and (2) the selection of patents to be checked. Patents

could e.g. be randomly drawn from the entire register of potential SEPs (so that also the distribution of sampled patents over portfolios is random); or random samples could be drawn within each portfolio. If random samples are drawn from each portfolio, the methodology would need to define how many patents to randomly draw from each portfolio (as a function of the number of registered potential SEPs in each portfolio).

Based on discussions with the Commission, we assume that the methodology will entail drawing random samples within each portfolio.[67] The size of the samples that would need to be drawn from each portfolio to assess essentiality rates in different portfolios depends on the size of the portfolios, the desired level of statistical confidence (e.g. 90, 95, or 99% confidence), the desired precision of the estimate (i.e. the maximum size of confidence intervals that are considered acceptable), and the estimated accuracy of the assessment of individual sampled patents.

Generally, larger samples are needed to make assessments with higher levels of confidence and greater precision (i.e. smaller confidence intervals). Random sampling error is compounded by assessment errors, i.e. the (partly random and partly systematic) errors that occur in the assessment of individual potential SEPs. While systematic error (bias) persists independently of sample size, random assessment errors are zero-centered, i.e. false positive and false negative *random* errors tend to cancel out as sample sizes grow larger. Nevertheless, in smaller samples, the balance of false positive and false negative random assessment errors may fall within a sizeable range. Larger sample sizes thus increase the precision of essentiality rate predictions because they (1) reduce sampling error (i.e. the error that may occur because the true essentiality rate in the sample is different from the true essentiality rate in the portfolio), and because they (2) reduce the random part of assessment error (i.e. the error that occurs because examiners make a larger number of false positive than false negative random assessment errors, or vice versa).

Based on these considerations, a sampling methodology could prescribe very different sample sizes, depending on the intended specific use of the information that is produced.

In *Scenario C1*, sampling would be intended to produce an estimate of the essentiality rate within each portfolio that is both precise and highly reliable, i.e. that is characterized by small confidence intervals at 95% or even 99% levels of confidence. The confidence intervals would need to reflect not only the uncertainty created by sampling errors, but also the uncertainty attributable to random assessment errors (which is exacerbated if smaller samples are assessed).[68]

As a preliminary matter, it is clear that under these circumstances, assessment of essentiality rates would necessarily be limited to the largest portfolios of potential SEPs. For illustration, consider a hypothetical portfolio of 100 potential SEPs, 50 of which are truly essential. If we assume that experts' assessment of the essentiality of these potential SEPs are accurate in 80% of the cases, and assessment errors are zero-centered (unbiased), assessed essentiality rates for this portfolio have a 95% likelihood to fall within a range from 42 to 58%, even if the entire portfolio of 100 potential SEPs is checked. Given that essentiality assessments of individual patents are themselves inherently uncertain, producing precise and reliable

[67] We do note that drawing one random sample from the entire population of registered SEPs to determine the average essentiality rate in the population would provide a cost-effective assessment of the total number of SEPs related to a standard; which could be used as a denominator to determine the share that a portfolio with a known number of SEPs represents in the total. Essentiality rates within individual portfolios thus would only need to be assessed (separately) if the need arises, e.g. in a case of dispute.

[68] Non-random assessment errors persist independently of sample size.

estimates for average essentiality rates requires a larger number of checks, and thus is only possible for large portfolios.[69]

For larger portfolios, the size of the samples that would need to be drawn increases in the size of the portfolios for which essentiality rates need to be assessed, but as portfolios grow larger, the share of the patents that needs to be checked decreases. If (hypothetically) the true essentiality rate in the population is 50%, and the desired precision is characterized by a margin of error of 5% at a 95% confidence level, 278 patents need to be checked for a portfolio of 1,000; whereas 323 patents need to be checked for a portfolio of 2,000 potential SEPs, to account for sampling error alone. Nevertheless, with 80% assessment accuracy, these samples are still too small to produce estimates of the desired precision. Assume that the essentiality rate in a portfolio of 1,000 patents was 50%. Even if the rate of essential patents in a sample of 278 patents randomly drawn from this portfolio is exactly 50% (i.e. there is no sampling error), an assessment based on essentiality checks with 80% accuracy would have a 95% likelihood to fall in a range between approx. 45% and 55%. Assuming 80% assessment accuracy, and an average 50% essentiality rate in the population, approx. 800 patents from each portfolio would need to be checked so that assessments of the essentiality rate in the sample have a 95% likelihood to fall within a 5% margin of error around the true essentiality rate in the sample.[70]

These illustrative examples largely coincide with the analysis by Mallinson (2022), who calculates that sample sizes of several thousand patents may be needed to produce reliable and precise estimates of essentiality rates in different portfolios.

In *Scenario C2*, smaller samples would be drawn. The precise criteria for sampling would need to be defined, based on estimates of the accuracy of individual assessments, the estimated average essentiality rate in the population, the accepted margin of error, and the desired level of statistical confidence. For the purpose of this assessment, we will assume that for portfolios of less than 100 potential SEPs, close to all patents will be checked, whereas the size of samples drawn from larger portfolios will range from 100 to 200 patents.

In this Scenario, the assessment will fail to produce estimates of essentiality rates in individual portfolios that are both very precise and highly reliable (i.e. subject to small margins of error at high levels of confidence). Nevertheless, as long as there is absence of systematic error in the assessment of individual patents, this sampling methodology will produce (1) a precise and reliable assessment of the average essentiality rate in the population ("the denominator"); (2) assessments of essentiality rates in individual (larger) portfolios that may rule out extreme discrepancies between different parties' views of the essentiality rate within a portfolio (such as those observed in currently observable FRAND disputes); (3) objective and defensible approximate indications of the essentiality rates in different portfolios that willing parties of an agreement *may choose* to rely on.

(1) Even if only 100-200 patents are checked from every larger portfolio, while all or most patents are checked within smaller portfolios, the total number of checks of potential SEPs for a standard is sufficiently large so that the average essentiality rate in the overall

[69] Assuming, once again, that assessment errors are zero-centered. If assessment errors are not zero-centered (i.e. there is systematic bias), by definition, reliable estimates of essentiality rates in different portfolios can never be produced, irrespective of portfolio size.

[70] At samples of such size, sampling error is no longer a substantial concern.

population, and thus the total number of SEPs for a standard, can be assessed with high precision and statistical confidence.[71]

(2) In court cases, divergences between parties' views over the number of SEPs in a portfolio or the total number of SEPs are rarely the only or primary source of disagreement over the FRAND rate for a SEP license. Nevertheless, in the rare cases in which courts have adjudicated on different parties' divergent proposed patent counts, these divergences were substantial (see 'Empirical Assessment', Table A6 in the Appendix). In Unwired Planet v. Huawei or In re Innovatio, licensors' and licensees' views of the total number of SEPs related to the relevant standards differed by a factor ranging from 3 to 6. In other words, divergences between parties' views of how many patents are essential in empirically observable SEP licensing disputes are even larger than the margins of error (at high levels of statistical confidence) of assessments that are based on samples of 100-200 patents.[72]

That is, while imprecise by any absolute standard, assessments on the basis of samples of that size would be sufficiently precise to have a significant effect on empirically observable disputes over counts of (assessed) SEPs. The fact that all court cases in which SEP counts played a determinant role involved such widely diverging views regarding the number of true SEPs does not necessarily mean that lesser disagreements within the margin of error of small-sample-based assessments (e.g. essentiality rates varying between 40 and 60%) may not cause substantial disagreement; but it does suggest that such disagreements would not be sufficiently pronounced to be the main point of contention between parties in disputes.

(3) Indicators that may be useful in SEP licensing contexts do not necessarily need to rise to the level of scientifically established evidence of the true value of a SEP portfolio. Willing parties of SEP licensing agreements *may choose* to use a variety of benchmarks and indicators.[73] None of the usually available indicators provides credible scientific evidence of the true value of a SEP portfolio that would fulfill the standards of precision and reliability that are conventional for scientific publications (such as 95% confidence intervals). Rather, indicators may be chosen because they are widely available in a timely manner, provide information that is relevant (i.e. plausibly related to the value of the SEP portfolio), objective, robust (not susceptible of being easily manipulated), and easy to use.[74] A variety of indicators may fulfill these criteria, and no party is bound to adhere to any particular criterion, but indicators can be useful for willing parties to a negotiation to resolve their differences and regulate their relationship in a reasoned and transparent fashion.

The question whether assessed numbers of SEPs in different portfolios – established through essentiality checks of samples of 100-200 patents – would be considered useful indicators for such purposes does not hinge on whether these assessments reflect the true number of SEPs in a portfolio with high precision and 95% statistical confidence, but how these assessed numbers compare to other indicators that are available as a practical matter. While an assessed count of SEPs, with an essentiality rate established based on a sample of 100-

[71] Provided absence of systematic assessment error, self-selection bias, and other sources of uncertainty that are independent of sample size

[72] In our hypothetical example above, in a sample of 100 potential SEPs, the essentiality of which is assessed with an assessment accuracy of 80%, and which is randomly drawn from a large portfolio (more than 1,000 potential SEPs), may indicate with 95% confidence that the essentiality rate within that portfolio falls within a range from approx. 40 to 60%.

[73] Avanci e.g. distributes royalty revenue among pool members according to a royalty distribution scheme that awards "points" for "evaluated essential patents" (up to 150), "other licensing revenue", "standards contributions", and "licensing or enforcement support". https://www.justice.gov/atr/page/file/1298626/download

[74] See SEP Expoert Group (2021), Annex 8.

200 randomly drawn patents, has a substantial margin of error,[75] it compares favorably with some other indicators currently used in amicable licensing contexts.[76]

Also noteworthy are the incentives that the use of an indicator in SEP licensing may produce.[77] The incentive properties of determining FRAND rates based on a sampling-based estimate of the true number of SEPs in a firm's portfolio are very similar to the incentive properties of using a count based on checking all potential SEPs in the portfolio: in both cases, a firm seeking to maximize its royalty revenue would be incentivized to maximize its number of true SEPs.[78]

In Scenarios C1 and C2, random essentiality checks produce information on the number of true SEPs x_e by providing an estimate of the rate of true SEPs among registered potential SEPs; so that the estimated number of true SEPs $\widehat{x_e}$ can be estimated by multiplying the estimated essentiality rate $\widehat{r_e}$ with the number of registered potential SEPs x_p (by portfolio or by standard or both); i.e. $\widehat{x_e} = \widehat{r_e} * x_p$.

By contrast, in *Scenario C3*, checks of randomly sampled patents are conducted to incentivize firms to only register potential SEPs that have a high likelihood of being actually essential. In order to achieve this, there needs to be a sufficient "penalty" for registering non-essential patents, i.e. the allocation of royalty revenue between portfolios needs to give greater weight to the assessed essentiality share than to the number of potential SEPs; i.e. $\widetilde{x_e} = \widehat{r_e}^{\alpha} * x_p$, where $\alpha > 1$.

Consider a hypothetical example in which sampling-based assessments are used to divide royalties between two firms; where firm A has registered 1,000 potential SEPs, and firm B has registered 2,000 potential SEPs. After essentiality checks are conducted on randomly drawn samples from both portfolios, it is concluded that 40% of the patents registered by firm A, and 20% of the patents registered by firm B, are truly essential. While $\widehat{x_{e_A}} = \widehat{x_{e_B}} = 200$, Scenario C3 requires that $\widetilde{x_{e_A}} > \widetilde{x_{e_B}}$, i.e. firm A, which has registered fewer non-essential patents, may reap a larger share of the revenue. Knowing that registering non-essential patents will reduce their prospective royalty revenue, all firms are incentivized to scrutinize their own patents prior to registering patents as potential SEPs.

Scenario C3 could be implemented with samples of any size, including by checking every registered potential SEP.[79] The accuracy of the information that can be derived from the

[75] which, at least as far as sampling error is concerned, can be specifically calculated

[76] See e.g. Baron (2019) on the use of contribution counts.

[77] Using counts of self-declared SEPs for royalty sharing agreements e.g. generates incentives for over-disclosure (Baron and Delcamp, 2015), whereas using counts of SDO contributions generates incentives for companies to flood SDO working groups with meaningless submissions (see Baron, 2019).

[78] Consider the hypothetical example of a firm that owns 10 potential SEPs, one of which is essential. If all 10 potential SEPs are assessed, with probability p=1, the firm will earn licensing revenue according to its correctly assessed number of true SEPs (1); if only one patent is randomly drawn to assess the firm's share of true SEPs, there is a probability p=0.9 that the firm will earn licensing revenue according to an assessed number of true SEPs of 0, and probability p=0.1 that the firm will earn licensing revenue according to an assessed number of true SEPs of 10. If there is a linear relationship between assessed number of SEPs and licensing revenue, the *expected* revenue from licensing the portfolio of 10 potential SEPs thus does not depend on the extent of random sampling error in assessing the share of essential patents in the portfolio; as incentives are driven by expected revenue (ex ante to the assessment), sampling error has no significant effect on firms' innovation and patenting incentives. Random assessment error and – a fortiori – systematic bias in essentiality checks however have the potential to produce perverse incentives; e.g. random assessment error has the effect of insufficiently discriminating between essential and non-essential patents, and thus fails to fully eliminate firms' incentives to over-declare potential SEPs.

[79] The policy option would remain notably different from Policy Option B, as the use of checks to curb over-registration results in significantly lower numbers of patents being registered.

register here does not hinge on the size of the samples based on which $\widehat{r_e}$ is estimated,[80] but rather on the strength of the incentives for patent owners to scrutinize their own patents (i.e. the size of α); as well as patent owners' ability to correctly identify patents that would be found essential if checked. Estimates based on very small samples would (in principle) deliver the same incentives for companies to only register patents with a high likelihood of being confirmed; nevertheless, the inherent uncertainty of checks in small samples may limit the acceptance of the estimates, and thus reduce the likelihood that they may produce sufficient incentives. For the purpose of this assessment, we will assume that samples would be of similar size as in Scenario C2.

C. 2.2.: Number of patents submitted for registration

Similar to policy option B, patent owners have two different sets of incentives to submit patents for registration: first, as in all options A through C, patent owners may self-select a number of potential SEPs (up to 50) for the purpose of constituting a portfolio of confirmed SEPs that may be asserted in EU courts. Second, patent owners may register a potentially large number of additional potential SEPs as an indication of the strength of their portfolio, which they may rely on in SEP licensing negotiations.

With respect to the larger number of additional potential SEPs (beyond the up to 50 patents self-selected by patent owners for essentiality checks), and similar to Policy Option B, there is a large variety of different scenarios how patent holders may choose to populate the register. All or the vast majority of owners of potential SEPs may choose to populate the register with comprehensive information about their portfolios; in which case the register would have the potential to produce information of high quality that would be widely respected (in turn bolstering firms' incentives to populate the register); if several or even most of the relevant owners of potential SEPs discount the register as an unreliable or otherwise irrelevant source of information, information on SEP counts from the register is incomplete and unrepresentative (giving further reasons to owners of potential SEPs to discount the register as a significant source of information).

Compared with Policy Option B, patent holders' incentives to submit patents in the different variants of Option C may potentially differ because of two reasons: the cost of registration is lower, and the information that the register is capable of producing may be different.

In *Scenario C1,* essentiality rates are determined only for the largest portfolios (as sample sizes in this variant need to be large, all except the largest portfolios are too small for sampling-based estimates). Whether owners of smaller portfolios choose to register additional potential SEPs (beyond those that they self-selected for checks) is largely irrelevant, as these additional registered potential SEPs will not be checked. For these portfolios, the register would largely be duplicative of existing SDO declaration databases, and can be populated at very low cost; it would however also produce no significant additional benefit, and be largely discounted as a relevant source of additional information.

For a small number of portfolios with several hundred or even thousand potential SEPs, samples could be drawn to determine essentiality rates at high levels of statistical

[80] Also in this case, incentives are a function of *expected* revenue, which is not affected by sampling error.

confidence.[81] Compared to Option B, especially for the largest portfolios, sampling several hundred potential SEPs instead of checking all patents offers potentially significant cost savings, while delivering substantially the same information on the number of true SEPs in the porfolio. Nevertheless, as there are only few portfolios of that size, and the heavy focus on statistical confidence requires that even in these portfolios a significant share of the patents are checked, overall potential cost savings are somewhat limited.

The fundamental assessment underlying Option B thus also applies to Option C1: producing precise estimates (at high levels of statistical confidence) of the essentiality rate in a large portfolio requires that a very substantial portion of each portfolio is checked. Given the cost of such checks, *within the preferred scenario*, where companies remain free to decide whether they wish to rely on their (estimated) number of confirmed SEPs to justify their licensing offers, at least some owners of large portfolios would not register their entire portfolios. This self-selection bias, which contributes to generate an inflated representation of the relative size of the portfolios of firms fully using the register, is a much bigger concern for the usefulness of estimated counts of confirmed SEPs than sampling error and random assessment errors.

Furthermore, if samples as large as 800 patents would need to be checked from each portfolio of potential SEPs, 16,000 checks would need to be carried out to estimate the number of confirmed SEPs in the 20 largest portfolios. The cost of such a large number of additional checks, for the only purpose of estimating the number of confirmed SEPs in 20 portfolios could only potentially be justified if this information (i.e. the number of confirmed SEPs in a portfolio) had a decisive effect on SEP licensing disputes– i.e. companies would be *bound* to use SEP counts in formulating SEP licensing offers. In other words, Scenario C1, similar to Policy Option B, is only viable if the creation of the register or accompanying regulatory measures fundamentally transform the process of SEP licensing.

Scenario C2 requires much lower numbers of checks. As owners of larger portfolios incur the costs of checks for only a small fraction of the patents they register, the cost of registering potential SEPs for patent owners is thus substantially lower than in Option B. At the same time, the information that the policy option is capable of producing is less precise, limiting the purposes for which the register may be used. Scenario C2 does not have the potential to fundamentally transform global SEP licensing norms, as parties in SEP licensing disputes could not plausibly be bound to estimates of essentiality rates subject to significant uncertainties. Nevertheless, Scenario C2 has the potential to produce objective (albeit not authoritative) information on the number of SEPs in different portfolios at a cost that is sufficiently low so that potential cost savings from supplementing or supplanting existing sources of information on essentiality may justify this expense.

In Scenario C2, broad participation in populating the register thus does not hinge on a possible fundamental transformation of global SEP licensing norms. While it is still likely that owners of potential SEPs differ in their extent of participation, thus leading to self-selection bias that undermines the representativeness and comprehensiveness of the information that may be produced; there is at least a distinct possibility that there would be broad participation by owners of potential SEPs (as little effort is required from owners of potential SEPs to populate the register with large numbers of potential SEPs, only a small share of which would need to be checked).

[81] More precisely, the results are immune to sampling error and random assessment errors at high levels of statistical confidence. Similar to Option B, the results remain vulnerable to systematic bias.

Scenario C3 also requires lower numbers of checks; nevertheless, it is not a low-cost option for participating owners of potential SEPs (at least compared to Scenario C2). As registering patents that are subsequently found not to be essential may have adverse consequences for owners of potential SEPs, these firms would need to carefully scrutinize their own patents prior to registering. It is certainly plausible that patent owners have superior knowledge or access to lower cost expertise regarding the essentiality of their potential SEPs. Scenario C3 thus provides for a cost-effective mechanism of assessing large portfolios of potential SEPs, as the vast majority of these assessments would be carried out internally by firms. While the cost of internal assessments of individual patents is plausibly lower than the cost of external essentiality checks; these internal assessments are nevertheless costly, and having to carefully scrutinize all their potential SEPs prior to registration is likely to represent a significant cost for patent owners. In terms of costs, Scenario C3 thus likely represents a middle ground between Scenarios C1 and C2. While the system is cheaper than in Scenario C1, it still requires that the register produces significant effects on global SEP licensing to justify the costs, and to ensure that incentives to participate in the system (and to invest efforts in populating the register with meaningful information) are sufficiently widely shared among firms.

C. 2.3.: Number of checks

The number of checks that would need to be carried out depends on the number of potential SEPs that patent owners register, and on the specific sampling methodology. As explained above, there is considerable uncertainty regarding both these factors; and there are many different and equally plausible scenarios.

In all scenarios, as in Option A, patent owners would at least submit approx. 3,500 potential SEPs for the purpose of constituting portfolios of patents that may be asserted as potential SEPs in EU courts.

Beyond these patents (that would all be checked), in Scenario C1, owners of smaller portfolios may or may not register additional potential SEPs, but no assessment of the estimated number of confirmed SEPs in these portfolios can be made at the required levels of confidence. Therefore additional checks are only carried out in a small number of large portfolios. Assuming that assessment accuracy may improve over time (see Bekkers et al., 2021), sample sizes of approx. 500 patents may be sufficient and necessary to produce estimates that are both precise and robust to sampling error and random assessment error at high levels of statistical confidence. There are perhaps 10-20 portfolios of that size. As it would only make sense to carry out such thorough checks in a very small number of portfolios if the information thus produced had a substantial impact on the licensing of these portfolios, we can rule out significant self-selection bias, and assume that all owners of these large portfolios would be compelled to submit all their potential SEPs, so that 4,750 to 9,500 additional checks would be carried out.[82]

In Scenario C2, registration is cheap and requires little effort from owners of potential SEPs; it is thus plausible that full participation by patent owners may be the most likely scenario. In contrast to Option B and Scenario C1, Scenario C2 does not require a fundamental transformation of SEP licensing norms - any additional incentives to inflate patent counts by

[82] The random samples may include some of the 50 potential SEPs self-selected by their owners for a check. As the samples may represent approx. 50% of the total number of potential SEPs in these large portfolios, there would be approx. 25 patents on average that would be randomly sampled, and for which an essentiality check has already been carried out.

filing additional applications that may exist would be weaker than in these other options. We will assume that the existing population of 60,000 potential SEPs would be registered (56,500 of which not self-selected by their owners for checks). To ensure that significant portions of potential SEPs in smaller portfolios, and samples of 100-200 potential SEPs from the largest portfolios, are checked, 15 to 20% of the registered SEPs may need to be checked (9,000 to 14,400 checks). Especially in the smaller portfolios, there is significant overlap between the patents self-selected by their owners, and the patents selected for the purpose of determining essentiality rates; so that 7,000 to 12,000 additional checks may need to be carried out. The number of checks is not directly comparable to Scenario C1, as in Scenario C1 checks are limited to only 10-20 portfolios, whereas in Scenario C2 the somewhat larger number of checks is distributed over hundreds of portfolios.

In Scenario C3, owners of potential SEPs would be more selective in submitting potential SEPs for registration. We assess that approx. 25-40% of the patents in the stock of potential SEPs are actually essential. With the observed levels of assessment error, 49-56% of the potential SEPs would be found essential in regular checks. Owners of potential SEPs cannot predict with certainty which of their patents would be found essential if checked, but – assuming that the policy option is capable of incentivizing an appropriate amount of scrutiny – they may be equally eager to avoid Type I and Type II errors. Based on these considerations, it appears plausible that patent owners would submit approx. 50% of their potential SEPs (30,000 to 35,000 registrations). There is no specific number of checks that would need to be conducted; in line with Scenario C2, samples of 100-200 patents may be drawn from larger portfolios for an objective indication of essentiality shares in different portfolios. As these samples are now drawn from smaller portfolios, the number of necessary checks would be somewhat smaller (4,500 to 7,000 additional checks)

Even more so than in Options A and B, these numbers are subject to significant uncertainties, as there is a wide range of plausible scenarios how the policy may unfold.

C. 2.4.: Appeals

In all Scenarios of Option C, owners of potential SEPs may make two different decisions: (1) a decision to submit self-selected potential SEPs for essentiality checks. If confirmed in the check, these patents may be registered as confirmed SEPs, and may be asserted as SEPs in EU courts; and (2) a decision to register additional potential SEPs; only a randomly drawn fraction of which will be checked. There are thus checks on two sets of potential SEPs, which result from different forms of selection: potential SEPs that were self-selected for checks by their owners, and potential SEPs that were randomly sampled to be checked.

Patent owners' incentives to appeal negative essentiality checks, and the value of the information potentially produced by such appeals, differs significantly between these two sets of patents. Negative essentiality assessments of patents self-selected by their owners should be subject to appeal, as these negative checks have the effect to restrict patent owners from asserting their patent as SEP in EU courts. As explained in the assessment of Option A, appeals to essentiality assessments of these selected patents (both by the owners of these patents, and appeals to affirmative assessments by third parties) have the potential to significantly improve the information that the register provides about the likelihood that a license is needed to a certain portfolio for the purpose of implementing a standard.

By contrast, allowing for appeals to the assessments of randomly sampled patents produces few benefits, and significant costs – appeals are likely to correct a significant share of random

assessment error, which is a relatively benign and unconsequential error for purposes of assessing firms' relative portfolio size (false positive and false negative random errors tend to cancel each other out). Appeals are however likely to exacerbate, rather than correct over-confirmation bias, as negative assessments are significantly more likely to be appealed. By selectively eliminating some random errors and increasing bias, appeals increase the overall percentage of potential SEPs that are correctly assessed, but make the assessments of firms' relative portfolio sizes *less* reliable.[83]

Not allowing for appeals to the assessments of randomly sampled patents, while allowing appeals to patents self-selected by patent owners, implies that appeals must not be considered when incorporating essentiality assessments of self-selected potential SEPs in the assessment of a firm's essentiality share. Consider an example in which a firm registers 500 potential SEPs and self-selects 50 of these patents for essentiality checks. A random sample of 100 patents is drawn from the firm's 500 potential SEPs to assess its number of SEPs, including 10 of the patents that the firm had self-selected for checks. The assessment of the firm's number of true SEPs is valid only if all 100 sampled patents are checked using the same method; meaning that the 10 patents would either have to be checked again (ignoring the result of the outcome of the checks requested by the patent owner); or only the outcome of the initial regular assessment of these patents may be used (ignoring the outcome of any possible appeal to this outcome).[84]

C. 2.5.: Validity challenges / renewals

In *Scenarios C1 and C2*, the policy impact has no significant impact on patent owners' renewal decisions, or third parties' incentives to challenge patents' validity (beyond the significant effect on validity challenges to confirmed SEPs in the first register). The population of potential SEPs has not been winnowed – while there is information indicating that only a certain share a firm's potential SEPs are actually essential, there is no information (outside of the randomly drawn sample) *which* of these patents are essential. The firm would thus need to maintain the whole population of potential SEPs to preserve its portfolio size of assessed true SEPs. Similarly, challenging the validity of individual patents (incl. patents in the randomly drawn sample) has only a very small effect on the assessed size of the firm's portfolio of true SEPs – as the policy option only indicates how many, but does not identify which potential SEPs are actually essential, it does not help other firms make more targeted use of their resources for the purposes of challenging patent validity.

In *Scenario C3*, the policy would somewhat winnow the population of potential SEPs. The number of patents in the register is still too large to invite for challenges to each individual patent on the register. We thus assess that the database has a limited effect on *average* incentives to challenge the validity of assessed SEPs. The smallest portfolios and pivotal patents are least affected by sampling (because these patents are most likely to have been

[83] Assessments of essentiality rates in a randomly drawn sample are a valid estimator of the essentiality rate in a portfolio. If subsamples of these samples are non-randomly selected for further verification, over-turning one type of error with much greater likelihood than the opposite type of error, the assessed essentiality rate in the sample ceases to be a valid estimator of the essentiality rate in the portfolio. Sampling estimates are imprecise and potentially inaccurate for two reasons: sampling error, and assessment error. Sampling error is random and zero-centered by definition. Assessment error may comprise both random and non-random (systematic) types of errors. By definition, the random component of assessment error is zero-centered, i.e. converges to zero as samples get larger. Appeals to a number of non-randomly selected assessments (presumably primarily to negative assessments) would eliminate a larger share of one of the two types of errors; so that also the random component of assessment error is no longer zero-centered. In other words, selective appeals generate an additional source of bias.

[84] Using the corrected information from appeals may make the overall determination more wrong, if different methods and standards of examination are applied to different subsets of the sampled patents – i.e. it is better to make mistakes with the same probability for all patents, rather than correcting mistakes for some, but not all sampled patents based on non-random selection.

checked for the first register of assertable confirmed SEPs). Overall, the policy has thus no significant effect on the likelihood of patents' validity to be challenged.

Owners of potential SEPs have significant incentives to scrutinize their own portfolios and to identify patents that they no longer think are essential. These patents, upon not being included in the register, may lose some or even most of their value. Patent owners have significantly reduced incentives to renew these patents (at least with respect to the European family members of these patent families).[85]

C. 2.6.: Patent applications

We have assumed that Scenario C1 would only be implemented if there is comprehensive participation from all the owners of major portfolios of potential SEPs. Such a scenario would require that all major SEP owners choose to refer to counts of confirmed SEPs to document the size and value of their portfolios.[86] Such increased reliance by patent owners on counts of confirmed SEPs may induce additional incentives to file patent applications. Consistent with Option B, we assess an increase of 20% per portfolio; nevertheless, here, this effect is confined to the participating largest portfolios. As these largest portfolios may comprise approx. half of the potential SEPs in the existing stock, a total increase in the number of patent applications by 10% may seem prima facie plausible (i.e. additional applications related to 6,000 additional SEP families, or 600 additional families per year).

Scenario C2 does not require, and does not seem consistent with, a fundamental transformation of SEP licensing norms. It is a low cost policy option, that may offer affordable, yet imprecise, estimates of the number of SEPs in different portfolios. This information may be useful in certain circumstances, without binding parties to particular valuation method for SEP licenses. Consequently, the option may have limited if any effects on patenting incentives.

Scenario C3 may or may not be implemented as part of a more fundamental transformation of SEP licensing norms. For the prospect of random checks to significantly discipline firms' registration incentives, all relevant owners of potential SEPs need to place sufficient weight on the outcome of the checks. At the same time, the cost of the checks in this option is much lower than in Option B; so that the option may also be viable without a fundamental shift towards patent counting as primary method for evaluating SEP licenses. Furthermore, the option has the potential to produce not only information on the number of SEPs in different portfolios, but to also indicate *which* patents have a higher likelihood of being essential (thus potentially also supporting valuation methods other than patent counting). Overall, if the policy induces additional incentives to file patent applications, these incentives would likely be muted.

[85] Currently, potential SEPs declared and registered in SDO databases are renewed at much higher rates than other, comparable patents. It is plausible that patents no longer considered to be potentially essential would at least lose this advantage over other patents, and be renewed at similar rates to other patents.

[86] This is particularly true for Scenario C1, compared to Option B or Scenario C3, as policy Option C here is tailored to produce information on patent counts, without producing information on the essentiality of all individual patents. The only context in which such information may be used is patent counting.

3.3. C.3.: Direct effects

C. 3.1.: Direct and indirect costs

All estimated costs are in addition to the costs accrued for the first register (unchanged with respect to Option A).

In Scenario C1, 4,750 to 9,500 additional checks (beyond those of potential SEPs self-selected by their owners) would be necessary for the policy option to produce information on the estimated number of confirmed SEPs in only the largest portfolios. With a total cost of 10,000 EUR per check (5,000 for the check, 5,000 for firms' elective expenses in follow-up), the cost of these checks would be approx. 47.5 to 95 million EUR. Patent owners would need to produce claim charts for the randomly sampled patents, as for most of these patents, claim charts cannot be assumed to exist (with a cost of approx. 4,000 EUR per claim chart, this may result in an additional cost of 19 to 38 million EUR).

The EUIPO would spend approx. 1 million EUR on sampling methodology and the statistical analysis of the sampled check results, and firms would spend an additional total 5 to 8 million on consultants discussing and interpreting the outcome of the checks.

Potentially the most significant cost of the policy option is indirect: as owners of large portfolios of potential SEPs would increasingly rely on counts of confirmed SEPs to demonstrate the value of their portfolios, there may be a significant cost of 240 million Euros related to the filing of 6,000 additional EP applications (and, in a scenario in which worldwide SEP licensing and FRAND determination norms are affected, another 240 million Euros for their foreign counterparts).

The cost of the additional checks under policy option C in Scenario C1 may thus total 72.5 to 142 million EUR; plus 240 to 480 million Euros attributable to increased patenting incentives. Once the initial stock is constituted, 10% of these costs would arise every year related to the renewal of the stock (7.25 to 14.2 million EUR per year in direct costs, and 24 to 48 million Euros per year in indirect costs).

In Scenario C2, an additional 7,000 to 12,000 checks (beyond those of potential SEPs self-selected by their owners) would be conducted. With a total cost of 10,000 EUR per check; the cost of these checks would be approx. 70 to 120 million EUR. Again, patent owners make no significant effort in scrutinizing and selecting potential SEPs for registration, but would need to produce claim charts for the randomly sampled patents, for an additional cost of 28 to 48 million EUR. The EUIPO would again spend approx. 1 million EUR on sampling methodology and the statistical analysis of the sampled check results, and firms would spend an additional total 5 to 8 million on consultants discussing and interpreting the outcome of the checks.

The cost of the policy option in Scenario C2 may thus total 104 to 177 million EUR (10.4 to 17.7 million Euro per year, after constitution of the initial stock).

In Scenario C3, 4,500 to 7,000 additional checks would be conducted, for a cost of 45 to 70 million Euros for the checks, and 18 to 28 million Euros for producing the necessary claim charts. Patent owners would need to incur significant expenses on internal assessments of their potential SEPs prior to registration. In line with our assessment of Option A, we estimate the cost of these assessments at approx. 2,000 Euro per patent, and that the majority of potential SEPs would need to be thus assessed. We assess that 50,000 additional internal assessments would be carried out, for a total cost of 100 million Euro.

The EUIPO would again spend approx. 1 million EUR on sampling methodology and the statistical analysis of the sampled check results, and firms would spend an additional total 5 to 8 million on consultants discussing and interpreting the outcome of the checks.

The policy may be implemented as part of an increased shift to apportionment methods using counts of confirmed SEPs for FRAND determinations. In this case, there may be incentives to file applications related to an additional 6,000 to 12,000 potential SEP families; for a total cost of 240 to 480 million Euros (480 to 960 million Euros, if the transformation of SEP licensing practices is global, rather than confined to the EU).

The direct costs of the policy option in Scenario C2 may thus total 169 to 207 million EUR (16.9 to 20.7 million Euro per year, after constitution of the initial stock). Much larger indirect costs (240 to 960 million Euros, or 24 to 96 million Euros per year) may arise if the policy option contributes to exacerbate patenting incentives as part of firms' efforts of boosting SEP counts.

C. 3.2.: Effect on available information

In *Scenario C1*, the number of SEPs in the largest portfolios would be assessed at very similar levels of precision and confidence than in Option B (the samples are sufficiently large so that sampling error is a negligible source of uncertainty; the much larger source of remaining uncertainty is systematic assessment error [such as over-confirmation bias], which Option C1 shares with Option B).

Unlike Option B, Option C (in Scenario C1) may not produce information about the essentiality of every potential SEP. Nevertheless, it produces this information for up to 50 potential SEPs self-selected by their owners, and for a very large number of additional patents in some very large portfolios.

If the option is modified to also call for checks to all or close to all potential SEPs in smaller portfolios, the information produced by the option – but also its cost – becomes overall comparable to Option B.

Not opening the majority of essentiality assessments (excluding the checks of patents selected by their owners) to appeal is a major source of cost savings compared to Option B. In terms of information, this feature means that the information regarding the essentiality of individual patents is *less reliable*, whereas the information regarding the estimated number of SEPs in a portfolio is *less susceptible to bias* in Option C1 than Option B.

In *Scenario C2*, the much more limited number of additional checks produce more limited additional information. In particular, it produces estimates of firms' numbers of SEPs that are statistically valid (unbiased), but imprecise. Information on the essentiality of individual patents is produced only for a relatively small number of patents (beyond those self-selected for checks by their owners).

In *Scenario C3*, the bulk of the information is produced by firms' internal assessments of the essentiality of their own patents, while checks primarily serve to incentivize patent owners to register meaningful information. It seems plausible that patent owners, after an internal

assessment, may be able to determine whether a potential SEP is essential with a precision that is similar to the one achieved by a regular check. Provided that there are sufficient incentives to conduct meaningful internal assessments and register only those patents that indeed have a high likelihood of being confirmed, the policy option produces the same information as Policy Option B, albeit at a significantly lower cost (because it relies on firms' internal, rather than external assessments).

3.4. C.4.: Indirect effects

C. 4.1.: Effects on licensing costs and delays

The effects of the essentiality checks of up to 50 selected potential SEPs per portfolio are assessed above (see Option A). These effects largely carry through, so that we focus here on the effects on SEP licensing that may be produced by additional essentiality checks on randomly sampled patents.

The assessment of these additional checks is similar to our assessment in Option B: within the current SEP licensing process, we have assessed that providing a new source of information on the number of SEPs in different portfolios may produce up to 10-20 million Euros per year in cost savings (savings of costs that currently arise from different parties' efforts to determine these numbers); and another 10-20 million Euros benefits per year attributable to the expanded use of such information (i.e. uses for which a positive demand exists, but that currently cannot be met at the prices at which this information is available).

These estimated cost savings and benefits are certainly an upper bound to the cost savings and benefits that may be produced by the sampling-based methods in C1 and C2, and C3, as each of these methods produces information that is more limited (in different regards) than Policy Option B. The information produced in C1 is limited in two respects: it covers much smaller numbers of portfolios, and it only produces estimates of the counts of SEPs in large portfolios, as opposed to indicating for each patent whether it may be essential.

The information produced in C2 potentially covers all portfolios, but is substantially less precise, limiting the scope of its potential use; nevertheless, even this information compares favorably to other types of information on essentiality rates in different portfolios that is currently publicly available, and currently used in SEP licensing and litigation contexts.[87]

The information produced in C3 is substantially similar to the information produced in Option B.

Overall, within the existing processes for SEP licensing, estimates of the number of SEPs in different portfolios may produce cost savings and other benefits of approx.. 20 to 40 million Euros per year in Scenario C3, and somewhat lower benefits in Scenarios C1 and C2.

Nevertheless, without an increased emphasis on patent counting in the evaluation of SEP portfolios, there would be little reason to conduct thousands of checks to produce estimates

[87] In Unwired Planet v Huawei, the Court e.g. accepted studies on essentiality rates in 2G and 3G as acceptable indications of essentiality rates in 4G. The potential errors resulting in Scenario C2 from sampling and random assessment error are certainly less severe than the potential errors from the type of approximations that decision makers are currently willing to make in order to determine or approximate essentiality rates.

of the count of confirmed SEPs in a small number of large portfolios. Such an increased emphasis on patent counts may induce significant indirect costs. Furthermore, within the current SEP licensing practices, essentiality checks may not be able to produce the disciplining effect required to incentivize firms to conduct meaningful internal assessments. Scenario C2, a low cost but imprecise estimation of number of SEPs in different portfolios based on a limited number of checks, seems to be the only viable option that does not require a more fundamental shift in SEP licensing and valuation practices.

Similar to Option B, there is a difficult-to-estimate potential for high-precision estimates of firms' number of true SEPs to transform SEP licensing negotiations in more fundamental ways. EU courts that are currently not inclined to determine FRAND rates may become more willing to do so if the number of SEPs in different portfolios can be reliably estimated. FRAND rates may more often be determined by apportionment of a reasonable aggregate royalty based on estimated relative numbers of true SEPs. Implementers may become more willing to challenge licensing offers that are difficult to reconcile with a firm's assessed share in the total number of SEPs, and more willing to accept licensing offers that are justified based on objective criteria, including (assessed) counts of SEPs. All of these effects are theoretically plausible; but there are also significant arguments why such significant effects may fail to materialize.

Among the different variants of Policy Option C, only Options C1 and C3 have the potential to produce such significant transformative effects, as negotiating parties cannot be reasonably bound to approximate estimations of firms' essentiality rates.

It is also difficult to assess the overall welfare implications of such effects, should they arise – e.g. potential cost savings in negotiations (especially for low-value licenses) because of increased availability of a low cost methodology for the determination of FRAND terms, but also potential losses in the efficiency of SEP licensing due to increased reliance on a metric with limited relevance for an accurate valuation of a patent license.

While the welfare effects of a worldwide transformation of SEP licensing norms and FRAND determination practices is difficult to assess, such a worldwide transformation also appears relatively unlikely. Compared to Policy Option B, the ability of an EU register to fundamentally transform global norms of SEP Licensing and FRAND determinations appear even more questionable in Option C, where an EU institution needs to make specific methodological decisions, such as a sampling methodology. Overall, similar to Option B, it seems more realistic to assume that any transformative effects of the policy would be limited to the EU, whereas SEP licensing and FRAND determination practices in other World regions may remain unchanged, or become influenced by foreign regulators' attempts to offer their own suggested basis for FRAND determinations. Such a splintering of currently global SEP licensing practices is unlikely to be efficiency-enhancing.

C. 4.2.: Effects on innovation/standard implementation incentives

Given the incremental nature of the effects of the register on SEP licensing negotiations in the most likely scenario, any potential effects on innovation and implementation decisions (related e.g. marginally increased reliance on numerical proportionality in the determination of FRAND rates, or somewhat increased visibility regarding total aggregate royalty burdens for implementers) are very indirect, and likely to be small.

3.5. C.5.: To summarize

Essentiality checks in randomly drawn samples are an appealing alternative to checking all potential SEPs in different portfolios.

Relying on random checks to incentivize firms to conduct their own assessments of potential SEPs (Scenario C3) may produce information that is comparable to the information produced by comprehensive checks of all potential SEPs. If essentiality checks are introduced in the context of a broader transformation of SEP licensing or evaluation practices, Scenario C3 may be the most cost-effective policy option for achieving the information that would be required for such transformation. Nevertheless, as we have previously assessed for Option B, the overall welfare effects of such a transformation are difficult to assess. Furthermore, the ability of an EU register to transform worldwide SEP licensing practices may be limited, so that a European system of essentiality checks may further fragmentation in SEP licensing rather than promoting efficiency.

Within the current framework for SEP Licensing, a low cost system of essentiality checks (based on a limited number of checks on randomly sampled patents) may produce information that, while falling short of fundamentally transforming the way that SEP licenses are negotiated, may usefully complement the existing (spotty) publicly available information on the essentiality of potential SEPs. This approximate information may be particularly useful in low-value transactions, which do not justify significant expenses on more thorough technical expertise. Furthermore, while estimates of the number of SEPs in any individual portfolio would be imprecise, the total number of SEPs per standard could be estimated with high precision and statistical confidence, potentially providing the denominator that negotiating parties may use in conjunction with additional checks that would need to be conducted within a particular portfolio to determine the numerator.

4. OVERALL ASSESSMENT

We have assessed three different policy options for creating a system of essentiality checks: (1) checking only small numbers of potential SEPs within each portfolio, self-selected by their owners to demonstrate that they own SEPs; (2) checking all potential SEPs to determine which and how many patents in each portfolio are essential; and (3) checking random samples to estimate counts of SEPs in different portfolios, in addition to checking a smaller number of patents self-selected by their owners. The different policy options may produce different types of information: information whether a given portfolio contains any patent that is essential, information whether a particular patent is essential, information how many patents in a portfolio are essential.

Overall, different policy options may plausibly produce benefits that outweigh the costs. In particular, conducting high quality essentiality checks on small numbers of self-selected patents may significantly simplify technical discussions in bilateral SEP licensing negotiations, and reduce the need for SEP litigation. In this context, accuracy in the assessment of individual patents is very important. As regular essentiality checks are prone to yield inconsistent results, it is thus important that a significant share of both affirmative and negative essentiality checks are subject to appeals, in order to ensure reliable and consistent information.

Furthermore, a smaller number of essentiality checks in randomly drawn samples may be used to periodically estimate the overall number of SEPs related to different standards, as

well as producing approximate estimates of the number of SEPs in different portfolios. Heavy emphasis on the statistical confidence intervals around these estimates seems unwarranted: sampling error and random assessment error, which may be attenuated by increasing sample size, are plausibly lesser concerns compared with different sources of systematic error (such as over-confirmation bias), which persist regardless of portfolio size. In any event, the number of (confirmed) SEPs in a portfolio is a noisy indicator of portfolio value; and it is not clear why significant resources should be spent to measure a noisy signal with great precision.

The cost of checking the essentiality of every potential SEP (beyond the smaller number of patents habitually discussed in bilateral negotiations) could only plausibly be justified if information on the number of confirmed SEPs in different portfolios would be used much more often to determine FRAND rates for SEP licenses. Whether such an increased reliance on counting confirmed SEPs for FRAND determinations improves the economic efficiency of SEP licensing is difficult to assess. In any event, it seems implausible that a European register of confirmed European SEPs could produce a worldwide shift in SEP licensing and FRAND determination practices. If the system leads to bifurcation in global SEP licensing negotiations, it may not be conducive to greater transparency and efficiency.

While it is thus uncertain whether the use of essentiality checks to facilitate counts of confirmed SEPs for the purpose of FRAND determinations is efficiency-enhancing, even for these purposes, checking the essentiality of all potential SEPs may not be necessary. Relying on random checks to discipline firms' declaration behavior and incentivize firms to carry out internal assessments (which are presumable less costly, but not necessarily less accurate than regular checks carried out by external experts) may be a cost-effective alternative to produce substantially the same information that could be produced through comprehensive checks of all potential SEPs.

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6. APPENDIX

True essentiality rate 25%

	If negative checks are confidential					If negative checks are public				
	Share subject to selection	Essentiality rate among selected	Essentiality rate among others	Essentiality rate	Confirmation rate	Share subject to selection	Essentiality rate among selected	Essentiality rate among others	Essentiality rate	Confirmation rate
Large portfolios										
(actively licensed)	0.75	0.825	0.25	0.68125	**0.687**	0.857	0.875	0.25	0.786	**0.734**
(not actively licensed)	1	0.75	0.25	0.75	**0.718**	1	0.825	0.25	0.825	**0.751**
Small portfolios										
	0	0.75	0.25	0.25	**0.493**	0.25	0.75	0.25	0.375	**0.549**

True essentiality rate 40%

	If negative checks are confidential					If negative checks are confidential				
	Share subject to selection	Essentiality rate among selected	Essentiality rate among others	Essentiality rate	Confirmation rate	Share subject to selection	Essentiality rate among selected	Essentiality rate among others	Essentiality rate	Confirmation rate
Large portfolios										
(actively licensed)	0.75	0.825	0.4	0.71875	**0.703**	0.857	0.875	0.4	0.807	**0.743**
(not actively licensed)	1	0.75	0.4	0.75	**0.718**	1	0.825	0.4	0.825	**0.751**
Small portfolios										
	0	0.75	0.4	0.4	**0.56**	0.25	0.75	0.4	0.575	**0.639**

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