A 'Real World' Risk-Adjusted Patent Valuation Model

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Part One of a Two-Part Series

Patent valuation remains one of the most critical issues in patent management. It is important not only in regard to the sale of a patent, but also at every step of managing a patent portfolio. In general, a patent is akin to an option on bringing a patent infringement action. Consequently, the decision-making process requires valuing and re-valuing a patent at every step of the patent procurement and maintenance process.

In two previous articles on patent valuation, published in the September 2003 and October 2003 issues of *PS&M*, we described a model for valuing a patent portfolio, as well as valuing an individual patent in the portfolio. However, such a model functions in an ideal world, where everyone respects the intellectual property rights of others, and in which no infringement takes place. Needless to say, this is not the world we live in. In the real world, patents are routinely infringed and their validity is challenged. In this article, we describe a risk-adjusted approach to patent valuation that takes into account the uncertainties associated with maintaining and enforcing a patent monopoly.

A patent is an exclusive right, a limited monopoly protecting the market share of the patented invention. Therefore, by definition, a patent's value is the present value of the future *enhanced* cash flows due to the patent monopoly, *ie,* the value of the monopoly, as distinct from the value of the market share and the cash flows generated therefrom in *toto*:

$$1.\ PV(PP) = \sum_{i=1}^{l} \frac{\Delta_i}{(1+I_i)^i},$$

where $PV(PP)$ is the present value of the patent portfolio PP; Δ_i is the value of the patent monopoly in year i; I_i is the discount interest rate in year i; and l is the term of the patent monopoly, determined by the remaining life of the subsisting patents in the portfolio. Δ_i is defined as the incremental profit resulting from the patent monopoly:

$$2.\ \Delta_i = \overline{PRFT}_i - PRFT_i,$$

where $\overline{PRFT}_i$ is the profit obtained in year i under the patent monopoly conditions, and $PRFT_i$ is the profit, in the same year i, in a hypothetical, freely competitive environment, without the benefit of patent protection.

For example, if a patent protects goods sold by the patent owner and if the fixed costs in monopolistic and competitive scenarios are the same, the incremental profit can be represented by the incremental gross profit. The expression (2) can be further delineated as:

$$3.\ \Delta_i = (\overline{PR}_i - \overline{CG}_i)x\overline{S}_i - (PR_i - CG_i)xS_i,$$

where $\overline{PR}_i$ is the price of goods sold in year i; $\overline{CG}_i$ is the cost of goods sold in year i; $\overline{S}_i$ is the number of units sold in year I, all forecasted in the context of patent monopoly; and PR_i, CG_i and S_i are the price, cost and units of the goods, respectively, in the same year i, forecasted under freely competitive conditions without taking into account the patent monopoly. The expression (1) in this case takes the following form:

$$4.\ PV(P) = \sum_{i=1}^{l} \frac{(\langle PR\rangle_i - \langle CG\rangle_i)x\langle S\rangle_i - (PR_i - CG_i)xS_i}{(1+I_i)^i},$$

If the annual value of the patent monopoly remains the same throughout the life of the patent portfolio, we have a simple case of an ordinary annuity:

$$5.\ PV(P) = \Delta\left[\frac{1-\left[\frac{1}{(1+I)^l}\right]}{I}\right].$$

If we want to know the value of an individual constituent patent P^j in the patent portfolio that protects the annual market monopoly Δ_i, we have

$$6.\ PV(P^j) = \sum_{i=1}^{l} \frac{p_i^j \times \Delta_i}{(1+I_i)^i}.$$

where p_i^j is the patent portfolio index explained in our October 2003 article.

In the Real World

The above formulae describe the present value of patents in an ideal world, in which competitors respect the intellectual property rights of each other and do not infringe each others' patents. In the real world, where patent infringement is commonplace, we must assume that patents will be challenged by infringing competitors. We must, therefore, assume that the patents will need to be enforced in a court of law.

In order to adjust our formulae to the more realistic situation, we must consider several additional factors: 1) the probability that at least one patent in the patent portfolio protecting the market share will be infringed during the life of the portfolio; 2) the probability E that the patent owner will, in the event of infringement, enforce his/her patent rights; and 3) the probability F that the patent owner will prevail in court.

Although there are no statistics available for the percentage of patents infringed, it is nevertheless safe to assume that commercially valuable patents will be infringed. If the market that is being protected by the patents is worth protecting, it is almost certain that an enterprising competitor will intentionally or unintentionally infringe the monopoly. Therefore, we shall set the probability of infringement to unity. With this in mind, we can now rewrite expression (1) as follows:

$$7.\ PV(PP) = E \times F \times \sum_{i=1}^{l} \frac{\Delta_i}{(1+I_i)^i}.$$

The probability E that the patent owner, in the event of infringement, will enforce his/her patents depends mainly on two factors: the owner's willingness, E_w, and ability, E_a, to do so.

Needless to say, a patent portfolio owned by a litigation-averse company that is unlikely to enforce, is worth considerably less than a similar portfolio owned by a company that vigorously enforces its patents, all other factors being equal.

Another equally important factor that contributes to the probability of patent enforcement E, is the owner's financial ability to enforce the patents E_a. A patent in the hands of a well-financed corporation is worth more than a patent in the hands of a lone inventor, who, in the event of infringement, would be hard pressed to come up with the funds to bankroll the litigation.

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Valuation Model

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The willingness factor, E_w, and the ability factor, E_a, must both be taken into account when estimating the probability of patent enforcement E. Assuming that these two factors are independent, the total probability of enforcement E is the product of these two factors: $E = E_w \times E_a$.

If an owner is absolutely determined to enforce his/her patent portfolio, E_w=1, he/she can improve his/her ability to enforce, by securing a contingency arrangement with a law firm or patent enforcement organization, in which case E_a=1.

The probability F of prevailing at trial is also comprised of several factors: 1) the probability F_i that at least one of the patents in the portfolio will be found to have been infringed; 2) the probability F_v that at least one of the infringed patent(s) will not be found to be invalid; and 3) the probability F_e that at least one of the infringed and valid patent(s) will be found to be enforceable (A. Poltorak and P. Lerner, "Essentials of Intellectual Property." John Wiley & Sons: New York (2002)).

The statistical probability of these values is as follows: the probability F_i that a given patent will be found to have been infringed is 66%; the probability F_v that a given patent will not be found invalid is 67%; the probability F_e that a given patent will be found to be enforceable is 88% (K. A. Moore, "Judges, Juries, and Patent Cases — An Empirical Peek Inside the Black Box," 99 *Mich. L. Rev.* (2001)).

Although the value of a patent portfolio is not proportional to the number of patents in it, in the real world, the value of a portfolio increases with its size. Since all infringed patents must be found invalid, in order to avoid liability, the total probability of invalidating each individual patent is:

$$8.\ F_v = 1 - \prod_{j=1}^{n} (1-F_v^j).$$

where Π denotes multiplication by each patent P^j. Assuming, for simplicity, that all individual probabilities are equal ($F_v^j = F_v^1$), we have: $F_v = 1-(1-F_v^1)^n$.

For illustration purposes, let us assume that we have a portfolio of three patents. The statistical probability that at least one of them will survive the validity challenge is 66%. Thus, the probability that at least one patent in the portfolio will survive is $F_v = 1-(1-0.66)^3 = 0.96$, or 96 percent.

In addition, exactly the same situation is true with respect to the enforceability of patents. Therefore, we have:

$$9.\ F_e = 1 - \prod_{j=1}^{n} (1-F_e^j),$$

Lastly, assuming for simplicity that all individual probabilities are equal $F_e^j = F_e^1$, we have: $F_e = 1-(1-F_e^1)^n$.

With respect to infringement, it is sufficient to prove that any one of the patents in the portfolio is infringed in order to establish liability. Therefore, in order to avoid liability for infringement, the defendant would need to successfully defend against each asserted patent. Thus, the probability of non-infringement is the product of non-infringement probabilities for each individual patent:

$$10.\ F_i = 1 - \prod_{j=1}^{n} (1-F_i^j),$$

Again, assuming for simplicity that all individual probabilities are equal ($F_i^j = F_i^1$), we have: $F_i = 1-(1-F_i^1)^n$. When a patentee asserts only one patent, the chances of success in proving infringement are 66%; for two patents, the chances improve to 89%; and for five patents, the chances are better than 99.5%. In effect, the chances improve exponentially as the portfolio grows.

The above calculations are all based on the assumption of event independence: in accordance with patent law, the questions of validity, enforceability, and infringement are decided independently for each patent. However, in reality, during jury deliberations, human psychology plays a role that is at least equally important as the law. Thus, juries, and, at times, even judges, tend to lump patents together, and this effectively destroys the assumption of event independence. In fact, judges rule in favor of the same party on both validity and infringement in 74% of the cases while juries rule in favor of the same party in 86% of the cases (*see* Moore).

Putting it all together, the present value of a patent portfolio is:

$$11.\ PV(PP) = E_w \times E_a \times \left[1 - \prod_{j=1}^{n} (1-F_v^j)\right] \times \left[1 - \prod_{j=1}^{n} (1-F_e^j)\right] \times \left[1 - \prod_{j=1}^{n} (1-F_i^j)\right] \times \sum_{i=1}^{l} \frac{\Delta_i}{(1+I_i)^i}.$$

In the simplified scenario of probabilities F_i, F_v, and F_e fixed for all patents in the portfolio, we have:

$$12.\ PV(PP) = E_w \times E_a \times \left[1-(1-F_e^1)^n\right] \times \left[1-(1-F_i^1)^n\right] \times \left[1-(1-F_v^1)^n\right] \times \sum_{i=1}^{l} \frac{\Delta_i}{(1+I_i)^i}.$$

To simplify it even further, note that patentees win 58% of cases that go to trial — 51% of bench trials and 68% of jury trials (*see* Moore). Thus, we can significantly simplify expression (12) by replacing the probability of successful enforcement F with this percentage, and by setting E to unity, assuming that the patent owner is determined to enforce the patent monopoly:

$$13.\ PV(PP) = 0.68 \times \sum_{i=1}^{l} \frac{\Delta_i}{(1+I_i)^i}$$

Note that we chose the larger success rate because the plaintiff can always demand a jury trial, which improves the statistical chances of success in litigation.

Expression (13) gives a reasonably good estimate of the patent portfolio value. Let us consider the same example as in the first article in this series, where the present value of a patent that secures a monopoly yielding a constant incremental annual value Δ, was calculated to be 3.9Δ, assuming a remaining life of 17 years (l=17) and a discount rate of twenty five percent (I=0.25). Further discounting this number for the uncertainties of litigation, we have $(0.68 \times 3.9)\Delta = 2.65\Delta$. Consequently, the rule of thumb we used in that article may be amended for the uncertainties of litigation: *two-and-a-half times the average annual value of the patent monopoly gives a quick and dirty estimate of the patent value on a risk-adjusted basis.*

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