Valuing Individual Patents Comprising a Portfolio

By Alexander I. Poltorak
Part Two of a Two-Part Series

The first installment of this series described the valuation of a patent monopoly secured by one or more related patents. This installment presents a methodology for valuation of individual patents comprising a multi-patent portfolio. Such analysis is necessary for the appraisal of a patent subject to sale, purchase, license or donation. It may also be useful for managerial decisions related to payment of patent maintenance fees or abandonment of certain patents.

Formulas obtained in the first article equally well describe the value of a single patent or an entire patent portfolio protecting a patented invention. For the purposes of this article, a patent portfolio represents a group of patents protecting a single revenue stream. This stream may be generated by a single product or service, a product line or by the enterprise as a whole (savings realized by using a patented process are treated as imputed revenue). Note that, theoretically, the value of a patent portfolio protecting a single product or service does not depend on the number of patents in the portfolio, as long as they do not extend the scope of the patent monopoly.

As shown in the previous article, the present value of a patent portfolio is calculated using the following general formula:

\[ PV = \frac{I_i}{(1+i)^t} \]

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

\[ \Delta_i = PRFT_i - PRFT_{i-1} \]

where \( PRFT_i \) is the profit obtained in year \( i \) under the conditions of patent monopoly, and \( PRFT_{i-1} \) is the profit in the same year \( i \) in a hypothetical freely-competitive environment without the benefit of patent protection. Assuming for simplicity that the fixed costs in both scenarios are the same and, therefore, the incremental profit can be represented by the incremental gross profit, this formula can be further delineated as:

\[ \Delta_i = (PR_i - CG_i) \times S_i - (PR_{i-1} - CG_{i-1}) \times S_{i-1} \]

where \( PR_i \) is the price of goods sold in year \( i \), \( CG_i \) is the cost of goods sold in year \( i \), \( S_i \) is the number of units sold in year \( i \) (all forecasted under conditions of patent monopoly), and \( PR_{i-1}, CG_{i-1} \) and \( S_{i-1} \) are, respectively, the price, cost of goods, and units of the same goods in the same year, but forecasted under the freely-competitive conditions without regard to the patent monopoly.

Suppose there are \( n \) patents in a portfolio. It would be logical to assume that the value of any constituent patent in this portfolio is its pro rata share in the value of the portfolio as a whole:

\[ V_i = \frac{V(PP)}{n} \]

However, this is true only when all patents in the portfolio are coterminous and are of relatively equal strength and scope. We intend to consider the more general case of a portfolio of patents with different terms, scope and relative strength. To do that, the analysis must be performed on an annual basis.

Previously, we introduced the concept of a Patent Portfolio Weight Matrix \( P \) (see A. Poltorak and P. Lerner, Essentials of Intellectual Property, Wiley, NY, 2002, pp 219-224). Essentially, this is a table wherein the rows correspond to the years of the portfolio's life, and the columns correspond to the individual patents in the portfolio. An active patent \( j \) in year \( i \) is represented by the matrix element \( p_{ij} \), which is a positive number \((0 < p_{ij} < 1\). If a certain patent is not "active" in a given year, \( i \) is either not yet issued or already expired, the corresponding matrix element is set to zero. The matrix elements must satisfy a simple rule: the sum of all elements in any row of the matrix must be equal to one:

\[ \sum_{j=1}^{n} p_{ij} = 1 \]

The meaning of this rule is that, no matter how many patents protect an invention, at the end of the day one can only get one monopoly on the invention.

For example, let us consider a patent portfolio consisting of four patents over a period of 5 years. Suppose, during the first year, the portfolio consisted of only one patent — \( P_1 \); during the second year, it consisted of two patents — \( P_1 \)
and \( P_2 \) (the second patent just issued); during the third year, there is only one patent — \( P_2 \) (the first patent expired at the end of the second year); during the fourth year, there are two patents — \( P_2 \) and \( P_3 \); and during the fifth year, there are three patents — \( P_2, P_3 \) and \( P_4 \). Let us present these facts as a table:

<table>
<thead>
<tr>
<th>Year</th>
<th>Patent 1</th>
<th>Patent 2</th>
<th>Patent 3</th>
<th>Patent 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year 1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Year 2</td>
<td>0.5</td>
<td>0.5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Year 3</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Year 4</td>
<td>0</td>
<td>0.5</td>
<td>0.5</td>
<td>0</td>
</tr>
<tr>
<td>Year 5</td>
<td>0.33</td>
<td>0.33</td>
<td>0.33</td>
<td>0.33</td>
</tr>
</tbody>
</table>

At this point, we have apportioned the values pro rata according to the number of patents active that year, ie the value in a given cell was chosen as \( 1/n \), where \( n \) is the number of patents active that year.

The Patent Portfolio Weight Matrix \( P \) looks, in this case, as follows:

\[
P = \begin{pmatrix}
1 & 0 & 0 & 0 \\
0.5 & 0.5 & 0 & 0 \\
0 & 1 & 0 & 0 \\
0 & 0.5 & 0.5 & 0 \\
0 & 0.33 & 0.33 & 0.33 \\
\end{pmatrix}
\]

The Patent Portfolio Weight Matrix \( P \) gives a complete picture of which patents are active in any given year over the life of the portfolio.

To account for the possibility that some of the patents may not have been active during the entire year, we should assign to a patent a number weighted according to the number of months the patent is active that year. Suppose that the third patent issued in the beginning of July. Then, instead of 0.5, the value for \( P_3 \) is 0.25. This automatically raises the value of the second patent in the third row (because the sum of all elements in the row must be equal to 1):

\[
P = \begin{pmatrix}
1 & 0 & 0 & 0 \\
0.5 & 0.5 & 0 & 0 \\
0 & 1 & 0 & 0 \\
0 & 0.5 & 0.5 & 0 \\
0 & 0.33 & 0.33 & 0.33 \\
\end{pmatrix}
\]

Aside from different terms, patents may have different values based on their relative strength and scope. A broad patent on a basic technology is not equal in value to a narrow patent on a minor improvement. If the first patent in our example was such a broad patent, responsible for, let's say, 80\% of the portfolio value that year, instead of 0.5 we would assign to it the value 0.8, leaving 0.2 for the second "improvement" patent:

\[
P = \begin{pmatrix}
1 & 0 & 0 & 0 \\
0.8 & 0.2 & 0 & 0 \\
0 & 1 & 0 & 0 \\
0 & 0.75 & 0.25 & 0 \\
0 & 0.33 & 0.33 & 0.33 \\
\end{pmatrix}
\]

Although, as mentioned before, strictly speaking, the value of a portfolio does not depend on the number of constituent patents (so long as they protect the same monopoly), the portfolio is still a sum of its constituent patents and, therefore, the annual value of a portfolio \( PP \) is the sum of the annual values of the individual patents:

\[ A_i(PP) = \sum_{j=1}^{n} A_i(P^j) \]

where \( A_i(PP) \) is the annual value of the portfolio in year \( i \); \( A_i(P^j) \) is the annual value of the \( j \)-th patent, \( P_i^j \), in year \( i \); and \( n \) is the number of patents in the portfolio.

Since, according to 0, the sum of all matrix elements in one row is equal to 1, we can multiply the left side of the equation by such a sum without changing the equation:

\[ A_i(PP) \times \sum_{j=1}^{n} P_i^j = \sum_{j=1}^{n} A_i(P^j) \]

Since the annual value of the portfolio, \( A_i(PP) \), is a constant, we can rewrite this equation as:

\[ A_i(PP) \times P_i^j = A_i(P^j) \]

From here it is logical to assume (although, strictly speaking, it is not the only possible solution of equation 0) that additive members on both sides of the equation are equal:

\[ A_i(PP) \times P_i^j = A_i(P^j) \]

Since the annual value of the patent portfolio is, by definition, the annual value of the patent monopoly, we have:

\[ A_i(PP) = A_i(P^j) \times D_i \]

Once we know the annual values of the patent \( P^j \), it is easy to discount them to the present value:

\[ PV(P^j) = \sum_{i=1}^{n} P_i^j \times \frac{1}{(1+i)^i} \]

This expression allows one to calculate the present value \( PV(P^j) \) of a constituent patent \( P^j \) based on the Patent Portfolio Matrix \( P^j=P^j \) and the annual values of the patent monopoly. Expression (9) for the present value of a constituent patent differs from expression (1) for the present value of the portfolio to the extent that, in expression (9), the annual value of the patent monopoly is weighted for the relative contribution of a constituent patent to the overall value of the portfolio.

The analysis presented here, as well as that presented in the first article, addresses valuation of an individual patent or a patent portfolio in an ideal environment free of patent infringement. In the future we will consider a more realistic scenario wherein a patent value is adjusted for the risks associated with patent enforcement.

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Valuing Patents as Market Monopolies

By Alexander I. Poltorak

Part One of a Two-Part Series

WHAT A PATENT IS
(AND WHAT IT IS NOT)

In order to value a patent, it is essential to first grasp the nature of the rights it affords. A patent is the statutory right to exclude others from making, using, selling, offering for sale, or importing the patented invention. It is clear from this definition that the only right a patent offers to its owners is a "negative" right — the right to "exclude others." It is equally clear that an invention is not synonymous with the patent protecting the invention. Moreover, a patent does not necessarily even afford its owner the right to practice the patented invention, as such practice may infringe the patents of others. Donald S. Chisum, Craig Allen Nard, Herbert F. Schwartz, Pauline Newman, F. Scott Kleff, Principles of Patent Law (1998). If an invention and the patent protecting it are not synonymous, it is clearly a mistake to value a patent by appraising the underlying invention — a mistake that, regrettably, is all too often made.

Value, in economics, is the measure of utility. The only utility a patent affords its owner is the patent monopoly, which is limited in duration to the statutory life of the patent and in scope by the patent claims and any applicable file wrapper estoppel. Consequently, the worth of a patent is a measure of the value of the associated patent monopoly. As the courts have stated in a number of cases, a patent is a grant of a government-sanctioned monopoly or public franchise. As far back as 1911, courts stated that "[t]he consideration on the part of the government given to the patentee for such disclosure is a monopoly for 17 years of the invention dis-

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closed to the extent of the claims allowed in the patent." Fried, Krupp Akt. v. Midvale Steel Co. 191 Fed. 588, 594 (3rd Cir. 1911). (The monopoly now expires 20 years from filing, although it begins only from issuance of the patent.) Strictly speaking, a patent lacks the negative characteristics of a monopoly and is more properly viewed as a public franchise (see Chisum, ibid, pp 52-58 and A. Poltorak, Are Patents Bad for the Economy? New York Business Focus, August 2002), however, for simplicity, we will refer to it as monopoly in the sense of an exclusive right.

WHAT IS A PATENT WORTH?

Now that we have clarified what a patent is and, more importantly, what it is not, we can ask the question: what is a patent worth?

To an entity competing in the marketplace by making and/or selling patented products or services or by employing a patented manufacturing process or business method, the patent affords a limited monopoly. Obviously, during the term of the patent, this monopoly will allow the company to enjoy a larger profit than after the patent's expiration, when competitors can join the fray and erode the patent-holding company's price and market share. Consider, for example, a pharmaceutical company selling a blockbuster patented drug. While the patent is subsisting, the company enjoys a larger market share and can charge whatever the market will bear for its drug. However, once the patent expires (or if it is held invalid by a court), a score of generic drug manufacturers enter the scene and the company's returns from the blockbuster drug inevitably suffer from both price and market share erosion. See Richard J. Findlay, "A Compelling Case for Brand Building," Pharmaceutical Executive 77 (February 1998) v18n2, Feb, p. 76-84.

CALCULATING THE
VALUE OF PATENT

Thus, to a company such as the one described above, a patent protecting particular goods would be worth exactly the net present value of the incremental ("enhanced") cash flow, or difference between the profits derived from the sales of the patented goods, under the patent monopoly and the corresponding profits derived from the sales of the same goods in a hypothetical freely-competitive environment without regard to the patent monopoly.

THE ANNUAL VALUE
OF PATENT MONOPOLY

Calculating this difference on an annual
basis, we have:

1. \( V(P) \times \Delta_i = PRFT_i \times PRFT_i \), or
2. \( V(P) = \left( PRFT_i \times CG_i \right) \times S_i \times \left( PRFT_i \times CG_i \right) \times S_i \),

where \( V(P) \) is the annual value of the patent in the year \( i \); \( \Delta_i \) is the incremental (or the enhanced) portion of cash flow in the year \( i \); \( PRFT_i \) is the profit made on the patented goods under monopolistic conditions in the year \( i \); \( CG_i \) is the cost of goods sold in the year \( i \); \( S_i \) is the market share in the year \( i \). All of these factors are projected under monopolistic conditions during the same year \( i \) within the term of the patent; and \( PRFT_i \), \( PR_i \), \( CG_i \) and \( S_i \) are respectively the profit, price, cost of goods, and the sales volume of the same goods in the same year \( i \) but without the benefit of the patent monopoly (i.e., the values are based on a freely-competitive scenario in which there is no patent protection).

**THE TOTAL VALUE**

To obtain the total value of the patent over its statutory life we need to sum this annual value expression by years — from the year the patent was issued (one can only enjoy patent protection from the date the patent is issued) until it expires. Assuming that an active patent has \( I \) years remaining in its term, we have:

3. \( V'(P) = \sum_{i=1}^{I} \frac{\Delta_i}{1+i-j} \times \left( PRFT_i \times PRFT_i \right) \times \left( CG_i \times CG_i \right) \times S_i \)

4. \( V'(P) = \sum_{i=1}^{I} \frac{\Delta_i}{1+i-j} \times \left( PRFT_i \times CG_i \right) \times S_i \times \left( PRFT_i \times CG_i \right) \times S_i \)

where \( PRFT_i \), \( PR_i \), \( CG_i \), \( S_i \), \( PRFT_i \), \( PR_i \), \( CG_i \) and \( S_i \) are values as in expressions (1) and (2) taken in a year \( i \) and summed by \( i \) from the year the patent issued until it expires. For simplicity, this sum is not yet discounted to present value, which we shall do later. Thus, the patent value is the sum of the incremental values of the patent monopoly on an annual basis over the life of the patent.

**OTHER FACTORS IN PATENT VALUATION**

In reality, the economic life of a product is often significantly less than the statutory term of the patent. Technological obsolescence, changing tastes and other factors may shorten the economic life of the product. Factoring in the potential of technological obsolescence, the average economic life of a patent is only about 5 years from the date of issue. See Samsom Vermont, "Business Risk Analysis: The Economics of Patent Litigation," in From Ideas to Assets: Investing Wisely in Intellectual Property (Bruce Berman, ed., John Wiley & Sons, Inc., New York). Based on this estimate, the sum (3) or (4) will have fewer terms as the sales volume eventually dwindles to zero. It is important to note, however, that for licensing purposes, the patent is enforceable during its entire term and, as long as patent claims can be read on new products or processes, licensing royalties may be exacted. Additionally, the scope of the patent protection is only limited by the legal scope of the claims, which may be broader than what the inventor originally had in mind, therefore, the patent may have value beyond the economic life of the underlying technology.

In valuing a patent, one should take into account that the annual incremental values \( \Delta_i \) change over the life of the patent. Such changes may result, for example, from product promotion, the availability (and cost) of substitute products, and general economic conditions. All such factors must be considered when determining values for the formulas (3) and (4), and these calculations should be done on an annual basis, as the relative impact of each of these factors may change from year to year.

**PRESENT VALUE OF A PATENT**

The formulas previously defined value the patent over its entire statutory or economic life. We now turn to determining the present value of a patent. In order to obtain the present value of the patent, we must discount the future incremental values \( \Delta_i \), as follows:

5. \( PV(P) = \sum_{i=1}^{I} \frac{\Delta_i}{1+i-j} \times \left( PRFT_i \times PRFT_i \right) \times \left( CG_i \times CG_i \right) \times S_i \)

6. \( PV(P) = \sum_{i=1}^{I} \frac{\Delta_i}{1+i-j} \times \left( PRFT_i \times CG_i \right) \times S_i \times \left( PRFT_i \times CG_i \right) \times S_i \)

where \( I \) is the discount interest rate in the year \( i \). This discount rate must reflect not only the traditional uncertainties associated in forecasting future profits, but also the risk of future patent infringement that may threaten the patent monopoly. If the patent is not enforced, such infringement may result in diminishment of the incremental value of a patent monopoly.

In a simplified case similar to an ordinary annuity, where the incremental annual value of a public franchise \( \Delta_i \) and the annual discount rate \( I \) remain constant \((\Delta_i = \Delta \) and \( I = I) \) throughout the life of the patent, expression (6) can be written as

7. \( PV(P) = \frac{1}{I} \left[ 1 - \frac{1}{(1+I)^I} \right] \)

For example, the present value of a patent, which secures a monopoly yielding a constant incremental annual value \( \Delta \), with a remaining life of 17 years \((I = 17)\), and a discount rate of 25% \((I = 0.25)\) is

\[
PV(P) = \frac{1}{0.25} \left[ 1 - \frac{1}{(1+0.25)^{17}} \right] \approx 3.3D
\]

Thus for \( \Delta \times 10,000,000, I = 25\% \) and \( I = 17 \) years, and assuming that the incremental revenues \( \Delta \) are received at the end of the annual period, the present value of the patent is \$35,099,280.

A simple rule of thumb can be derived from expression (8): four times the average estimated incremental value of the annual patent monopoly gives a quick and dirty estimate of the patent value.

**VALUING PATENT PORTFOLIOS**

The formulas set out above are based on the assumption that the patented goods are protected by one patent. Nevertheless, these formulas also describe the value of an entire patent portfolio protecting certain goods. For the purposes of this analysis, we take a patent portfolio to represent a group of patents protecting a single market segment, ie, a single monopoly. Theoretically, the patent owner enjoys no stronger a monopoly whether its product or service is protected by multiple patents or by one patent (this statement is only true in an ideal world where one does not need to resort to legal action to enforce one’s patents). A nonexclusive licensee who seeks the freedom to use, make and/or sell the patented goods does not care how many patents are involved — as long as it receives a covenant not to be sued, ie the right to practice the invention. Thus, the value of the patent portfolio protecting a single product ideally should not depend on the number of patents in the portfolio.

**CONCLUSION**

Patent valuation should not be equated with an appraisal of the underlying technology. A patent affords its owner only exclusory rights — ie a limited monopoly. The value of a patent or a patent portfolio is the present value of the incremental cash flows derived on an annual basis from the patent monopoly. An annual cash flow derived from a patent monopoly is calculated as the difference between projected annual profits with and without the patent protection. Since a patent is nothing more than a license to sue, the present value of the patent monopoly should be further adjusted for the uncertainties of patent enforcement, which will be the subject of the next article in this series.
A ‘Real World’
Risk-Adjusted Patent Valuation Model

By Alexander Poltorak, Ph.D.

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 PSM, 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, i.e., the value of the monopoly, as distinct from the value of the market share and the cash flows generated therefrom in toto:

\[ P(V_{PP}) = \sum_{i=1}^{\infty} \frac{\Delta_i}{(1+i)^i} \]

where \( P(V_{PP}) \) is the present value of the patent portfolio \( PP \); \( \Delta_i \) is the value of the patent monopoly in year \( i \).

1. \( P(V_{PP}) \) is the present value of the patent portfolio \( PP \); \( \Delta_i \) is the value of the patent monopoly in year \( i \).

2. \( \Delta_i = \frac{P_{PRF_i}}{1+i} \cdot \frac{P_{PRF_i}}{1+i} \cdot \frac{\bar{G}_i}{1+i} \cdot \frac{S_i}{1+i} \cdot \frac{S_i}{1+i} \)

where \( P_{PRF_i} \) is the profit obtained in year \( i \) under the patent monopoly conditions, and \( P_{PRF_i} \) is the profit, in the same year, 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 are 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. \( \Delta_i = (\bar{P}_{RO_i} \cdot \bar{C}_G) \cdot S_i \cdot (\bar{P}_{RO_i} \cdot \bar{C}_G) \cdot S_i \)

where \( \bar{P}_{RO_i} \) is the price of goods sold in year \( i \), \( \bar{C}_G \) is the cost of goods sold in year \( i \), \( S_i \) is the number of units sold in year \( i \), all forecasted in the context of patent monopoly; and \( \bar{P}_{RO_i} \) and \( \bar{C}_G \) 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. \( P(V_{PP}) \sum_{i=1}^{\infty} \frac{(\bar{P}_{RO_i} \cdot \bar{C}_G) \cdot S_i}{(1+i)^i} \cdot \frac{\bar{P}_{RO_i} \cdot \bar{C}_G \cdot S_i}{(1+i)^i} \)

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. \( P(V_{PP}) = \frac{1}{1+i} \cdot \frac{1}{(1+i)^i} \)

If we want to know the value of an individual constituent patent \( P \) in the patent portfolio that protects the annual market monopoly \( \Delta_i \), we have

6. \( P(V_{PP}) = \sum_{i=1}^{\infty} \frac{P_i \cdot \Delta_i}{(1+i)^i} \)

where \( P_i \) 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 enterprise 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. \( PV(PP) = E \cdot F \cdot \sum_{i=1}^{\infty} \frac{\Delta_i}{(1+i)^i} \)

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

continued from page 4

The willingness factor, \( E_{WP} \), 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: \( E = E_{WP} \times E_{A} \).

If an owner is absolutely determined to enforce his/her patent portfolio, \( E_{WP} = 1 \), 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 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 \( F_{U} \) that at least one of the infringed patents(s) will not be found to be invalid; and 3) the probability \( F_{I} \) that at least one of the infringed and valid patents 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 this value is as follows: the probability \( F_{I} \) that a given patent will be found to have been infringed is \( 66\% \); the probability \( F_{U} \) 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 Peck 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

\[ F_{I} = 1 - \prod_{j=1}^{n} (1 - F_{I}^{j}), \]

where \( n \) denotes multiplication by each patent \( F_{I} \). Assuming, for simplicity, that all individual probabilities are equal \((F_{I} = F_{I}^{j})\), we have:

\[ F_{I} = 1 - (1 - F_{I}^{j})^{n}. \]

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 \( F_{I} = 1 - (1-0.66) = 0.96 \), or 96 percent.

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

\[ F_{E} = 1 - \prod_{j=1}^{n} (1 - F_{E}^{j}), \]

Lastly, assuming for simplicity that all individual probabilities are equal \((F_{E} = F_{E}^{j})\), we have:

\[ F_{E} = 1 - (1 - F_{E}^{j})^{n}. \]

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:

\[ F_{I} = 1 - \prod_{j=1}^{n} (1 - F_{I}^{j}). \]

Again, assuming for simplicity that all individual probabilities are equal \((F_{I} = F_{I}^{j})\), we have:

\[ F_{I} = 1 - (1 - F_{I}^{j})^{n}. \]

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

\[ PV(PP) = E_{WP} \times E_{A} \times \left( \prod_{j=1}^{n} (1 - F_{I}^{j}) \right) \times \left( \prod_{j=1}^{n} (1 - F_{E}^{j}) \right) \times \frac{\Delta}{r (1 + r)^{n}}. \]

In the simplified scenario of probabilities \( F_{I} \), \( F_{E} \), and \( F_{I} \) fixed for all patents in the portfolio, we have:

\[ PV(PP) \approx E_{WP} \times E_{A} \times \left( (1 - F_{I}^{j})^{n} \right) \times \left( (1 - F_{E}^{j})^{n} \right) \times \frac{\Delta}{r (1 + r)^{n}}. \]

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:

\[ PV(PP) \approx 0.58 \times \left( (1 - F_{I}^{j})^{n} \right) \times \left( (1 - F_{E}^{j})^{n} \right) \times \frac{\Delta}{r (1 + r)^{n}}. \]

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 \( \Delta \) was calculated to be \( 3.9 \Delta \), assuming a remaining life of 17 years \((l=17)\) and a discount rate of twenty-five percent \((r=0.25)\). 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.