# Modelling Strategic Actor Relationships to Support Intellectual Property Management

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## Abstract

The value of knowledge is increasingly being recognized in today's knowledge economy and society. In the business arena, how specialized knowledge is created, managed, and used is becoming a crucial factor for success. Patents and other forms of intellectual property mechanisms are used to protect inventions, generate revenue, and build strategic alliances. Techniques from conceptual modelling can be used to analyze the structure of knowledge, highlighting crucial entities and relationships. However, to analyze the strategic significance of particular pieces or bodies of knowledge within an organizational and business context, we need an ontology that captures the social and intentional dimensions of knowledge management. In this paper, we outline the use of the i* strategic actor relationships modelling framework to support IP management. In i*, actors have goals, and know-how and resources for achieving goals. Patents restrict the use of know-how, thus prompting actors to reposition themselves within a network of dependency relationships. Examples from the e-commerce domain are used to illustrate.

## 1 Introduction

The value of knowledge is increasingly being recognized in today's knowledge economy and society. In the business arena, how specialized knowledge is created, managed, and used is becoming a crucial factor for success. Conceptual modelling techniques play an important role in managing knowledge in enterprise information systems. As organizations become more complex and dynamic, richer conceptual models are needed to help manage the wider range of enterprise knowledge. Conceptual modelling have focused in the past on static (entities, relationships, states, etc.) and dynamic (flows, transitions, etc.) ontologies. The management of knowledge in a social organizational context requires ontologies that incorporate the intentional and social dimensions [6], so that one can express and reason about motivations and rationales, and capabilities and vulnerabilities of social actors [19, 15].

The management of intellectual property (IP) is an important component of enterprise knowledge management. Patents and other forms of intellectual property mechanisms are used to protect inventions, generate revenue, and build strategic alliances. To manage IP effectively, one needs to understand a wide range of issues from technology innovations to product/service design to competitive strategies. For example:

- What innovative technologies are needed to sustain products and services in my business today and tomorrow?
- Which technologies do I have exclusive rights on, and which ones are owned by other players?
- How does the IP landscape constrain or enable my products and services strategies?
- What options are available to make the best use of IP in a given context, e.g., licensing, alliances, acquisitions, in-house R&D?

These and other issues related to IP management are evolving and expanding rapidly as technological advances continue at a rapid pace, and as various players constantly realign themselves in response. A systematic approach based on conceptual modelling can help manage the complex knowledge needed to support IP management.

This paper outlines an initial attempt to use strategic actor relationships modelling to express some key issues and relationships in IP management, and to illustrate how such models can support analysis and reasoning. We focus on the strategic context of patents. Patents restrict the use of know-how, thus putting constraints on the space of strategic actions that players can adopt. Strategic actors therefore need to assess their means and ends, as well as those of other actors, in seeking favourable positions for themselves within networks of inter-dependencies.

Section 2 briefly reviews the i* framework, introducing its basic concepts using examples from the e-commerce domain. Section 3 presents a model of the relationships in a typical patent setting. Section 4 considers three examples of the strategic context for IP analysis – business expansion acknowledging patent protection, infringement settlement, and the selection of patent-related alliance or partners. The impacts of IP on business decision making are explored through i* modelling. Section 5 discusses our contributions, related works in various area, as well as future research. The examples are intended for illustrating the modelling framework and are not necessarily accurate reflections of the domain.

## 2 Strategic Actor Relationships Modelling

Much of conceptual modelling has focused on information content and processes that are to be embedded in automated systems. Such models aim to be precise, detailed, and complete so that the behaviour of the target system could be generated. Increasingly, it has been realized that it is equally important to model and analyze the surrounding context of systems so that the right system would be built, and that it would be able to respond to changing needs – the task of requirements engineering. Conceptual modelling techniques therefore need to be extended to encompass systems and world phenomena that are not fully controllable or knowable.

In an agent-oriented modelling approach [15], we treat systems and elements in the environment as only partially knowable and controllable. Agents are autonomous so that their specific actions are ultimately unpredictable. However, in a multi-agent world, the existences of mutual dependencies result in socially constrained behaviour. By characterizing the relationships among agents at an intentional level – i.e., in terms of what each agent wants, and how those wants might be satisfied, possibly through other agents – one can express the different ways in which agents could associate with each other, without detailing specific actions and interactions.

This high level of abstraction is quite adequate for supporting the kind of strategic reasoning that is needed for exploring what system to build during the early stages of requirements engineering [16], and offers richer support for reasoning about business processes than conventional (non-intentional) process models [19]. As software agent technologies are beginning to come into the mainstream in network-centric and web-based computing, an agent-oriented modelling paradigm can potentially serve to link all stages of information and knowledge management, from enterprise conception to business process design to system requirements to implementation [7, 3, 20]. This would facilitate business analysis to take advantage of advanced systems technologies, and systems analysis to respond quickly to business level changes.

Intellectual property management is one specialized area of enterprise knowledge management in which the need for strategic modelling and reasoning is quite apparent. An agent-oriented modelling approach offers the potential for systematically relating technology decisions to

business design to competitive strategy analysis. In this paper, we explore the use of the i* strategic actor relationships modelling framework to model and reason about IP management issues.

The i* framework consists of two kinds of models. The Strategic Dependency model describes the network of intentional relationships among actors. Actors depend on each other for goals to be achieved, tasks to be performed, and resources to be furnished. These dependencies are intentional in that they are based on underlying concepts such as goal, ability, commitment, belief, and so on [17]. The Strategic Rationale model describes and supports the reasoning that each actor has about its relationships with other actors, its alternative means to achieve its goals, and how the qualitative expectations of actors are satisficed by these alternatives. Actors in i* are strategic in that they evaluate their social relationships in terms of opportunities that they offer, and vulnerabilities that they may bring. Strategic actors seek to protect or further their interests.

### *2.1 The Strategic Dependency Model*

Figure 1 shows an example of a Strategic Dependency (SD) model for a buyer-driven e-commerce system. In such a system, the customer depends on a middleman to find a service provider who is willing to accept a price set by the customer. The customer submits a priced request to a middleman. The middleman forwards the request to suppliers. If a supplier decides to accept the request, it makes an agreement with the middleman. The middleman expects the customer to pay for the purchase in time.

Note that while business processes are often described in terms of sequences of events or actions, what the SD model focuses on are the dependency relationships. In particular, some relationships do not have directly associated actions. In this example, the supplier depends on the middleman to attract more customers, which in turn relies on the middleman having loyal customers. The customer depends on the supplier for quality service (since the service is coming from the supplier, not from the middleman). Finally, the scheme works only if the prices set by customers are acceptable to suppliers.

A Strategic Dependency (SD) model consists of a set of nodes and links. Each node represents an actor, and each link between two actors indicates that one actor depends on the other for something in order that the former may attain some goal. We call the depending actor the depender, and the actor who is depended upon the dependee. The object around which the dependency relationship centers is called the dependum. By depending on another actor for a dependum, an actor (the depender) is able to achieve goals that it was not able to without the dependency, or not as easily or as well. At the same time, the depender becomes vulnerable. If the dependee fails to deliver the dependum, the depender would be adversely affected in its ability to achieve its goals.

The Strategic Dependency model distinguishes among several types of dependencies based on the ontological category of the dependum and the degree of freedom the dependee has when delivering the dependum to the depender. In a *goal dependency*, an actor depends on another to make a condition in the world come true. In Fig. 1, the goal dependency Low Price Service Provider be Found from the customer to the middleman means that it is up to the middleman to decide how to find the low price service provider.

In a *task dependency*, an actor depends on another to perform an activity. The activity description specifies a particular course of action. For example, the task dependency Name a Price [Service] expresses that the customer depends on the middleman to name his own price for the service in need by specifying the standard procedure for naming a price.

In a *resource dependency*, an actor depends on another for the availability of an entity. The depender takes the availability of the resource to be unproblematic. In Fig.1, the customer's dependency on the supplier for agreement on price is modelled as a resource dependency.

The fourth type of dependency, *softgoal dependency*, is a variant of the first. It is different from a (hard) goal dependency in that there are no a priori, cut-and-dry criteria for what constitutes meeting the goal. The meaning of a softgoal is specified in terms of the methods that are chosen in the course of pursuing the goal. The dependee contributes to the identification of alternatives, but the depender makes the decision. The notion of softgoal allows the model to deal with many of the usually informal concepts. For example, the customer's dependency on the supplier for good quality service can be achieved in different ways. The desired degree of how good the quality should be is ultimately decided by the depender.

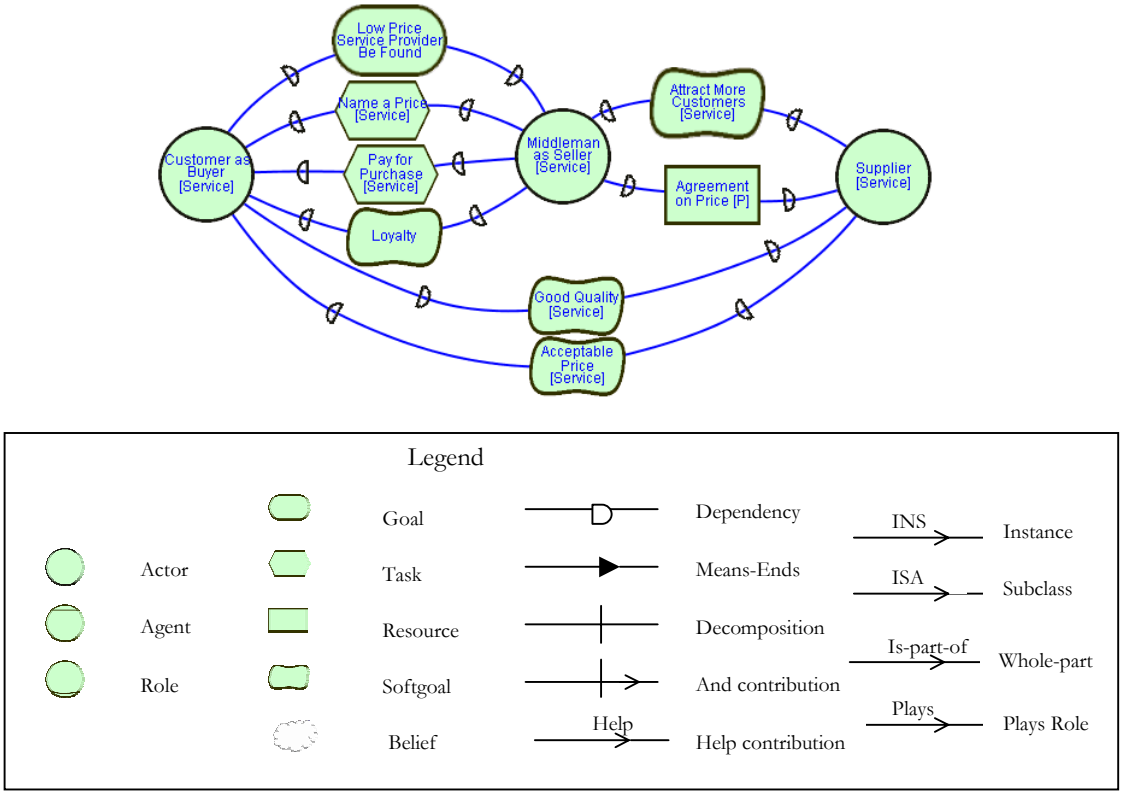


Fig.1 Strategic Dependency model of a buyer-driven e-commerce system with middleman

### *2.2 The Strategic Rationale Model*

The Strategic Rationale (SR) model provides a more detailed level of modelling by looking "inside" actors to model internal intentional relationships. Intentional elements (goals, tasks, resources, and softgoals) appear in SR models not only as external dependencies, but also as internal elements arranged into (mostly hierarchical) structures of means-ends, task-decompositions and contribution relationships.

Fig.2 is an SR model of the buyer-driven e-commerce system with middleman corresponding to Fig. 1. In this model, the internal rationale of the customer and the middleman are elaborated. The customer's main goal is that Service Be Purchased [Service]. The goal is parameterized on Service so that the graph may be evaluated differently for different services.

One possible way to accomplish this goal is through the task Purchase By Naming My Own Price [Service]. It is connected to the goal with a *means-ends* link. This task has two sub-

elements connected to it through *decomposition* links – the sub-task Name A Price [Service], and the sub-goal Low Price Service Provider Be Found. The purchase task is achievable only if all its sub-elements are achievable.

Naming one's own price contributes positively (Help) to the buyer's softgoal of Low Price, but negatively (Hurt) to Flexibility [Purchasing] because preferences about schedule, choice of airline, etc., could not be accommodated.

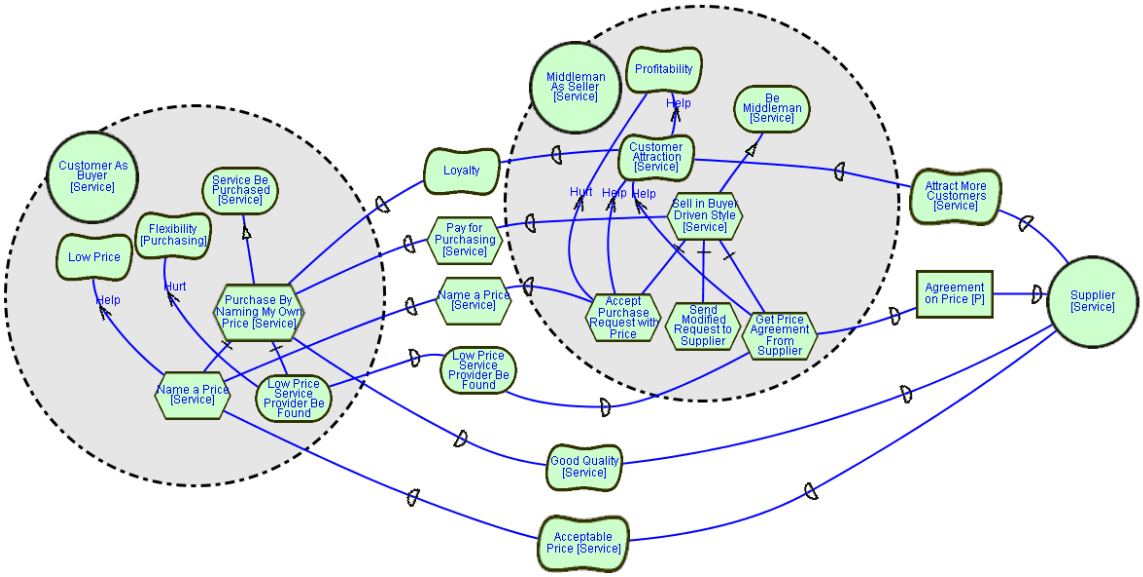


Fig.2 Strategic Rationale model of a buyer-driven e-commerce system with middleman

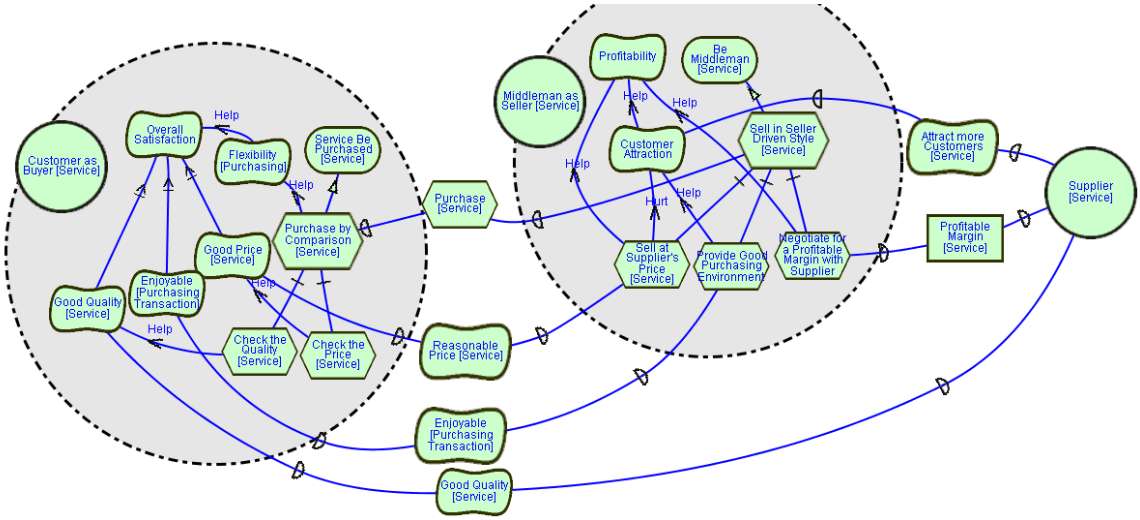


Fig.3 Strategic Rationale model of a seller-driven e-commerce system with middleman

The buyer-driven system may be contrasted with the more familiar seller-driven system in Fig.3. Here, the Be Middleman goal is addressed by an alternate task Provide Comparison Shopping Service. By doing this, the middleman is more profitable as he could earn more revenue by maximizing the margin. Though the higher price might impact Customer Attraction negatively (Hurt contribution from Sell at Supplier's Price [Service] to Customer Attraction), the middleman could regain some customer attraction by Provide Good Purchasing Environment. At the same time, the customer can enjoy more Flexibility [Purchasing] and is more likely to get overall satisfaction.

An interactive qualitative reasoning process [19] is used to evaluate whether an intentional element (goal, task, resource, or softgoal) is viable or not (e.g., whether a softgoal is sufficiently met). In the reasoning process, a semi-automated labeling algorithm propagates a series of labels through the graphs. The propagation depends on the type of link. For example, the positive contribution link types for softgoals are Help (positive but not by itself sufficient to meet the higher goal), Make (positive & sufficient) and Some+ (positive in unknown degree). The corresponding negative types are Hurt, Break and Some-. And means if all subgoals are met, then the higher goal will be sufficiently met. Or means the higher goal will be sufficiently met if any of its subgoals are met.

In i*, the term *actor* is used to refer generically to any unit to which intentional dependencies can be ascribed. An *agent* is an actor with concrete, physical manifestations, such as a human individual or an actual organization. A *role* is an abstract characterization of the behavior of a social actor within some specialized context or domain of endeavor.

# 3 Modelling for IP management

Intellectual property includes patents, trademarks, copyrights and trade secrets. We will use patents to illustrate our modelling approach.

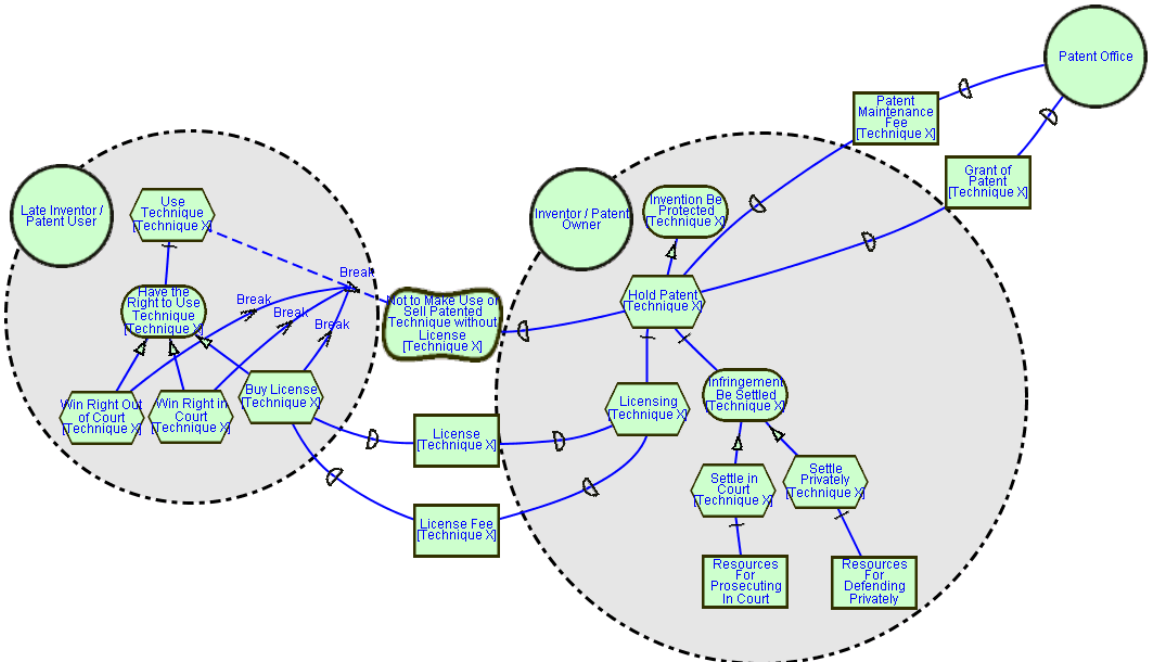


Fig. 4 A Simplified Generic IP Management Model

Figure 4 provides a model showing some key relationships surrounding a patent. The inventor of Technique X has the goal that the invention be protected. One way to achieve the goal is to hold a patent on the invention. The effect of the patent is represented as a softgoal dependency with the inventor/patent owner as depender. The patent owner depends on others Not to make, use or sell the patented technique without license. Representing the patent as a softgoal reflects its disputable nature, requiring argumentation (possibly in court) to support its effectiveness. When someone other than the patent owner uses technique X (or a close resemblance), this dependency is violated. This is represented by the BREAK contribution link towards the softgoal. The dotted line notation indicates that this is a side effect arising from the "late inventor's" decision to use technique X. The task Use Technique now incurs a sub-goal Have The Right To Use Technique. This sub-goal can be met by any of three alternatives – Buy License, Win Right in

Court or Win Right Out of Court. All of these are parameterized on [Technique X]. Each of these is sufficient to overcome the infringement conflict between the patent owner and the patent user – hence the BREAK contributions towards the dotted line BREAK.

This model illustrates the strategic nature of IP management reasoning and action. While there may be social constraints and even legal sanctions on agent behaviour, opportunistic agents can choose to violate them and risk the consequences. The patent user may choose different actions depending on its assessments of its own strategic position and the patent owner's, e.g., requisite resources for prosecuting or defending an infringement.

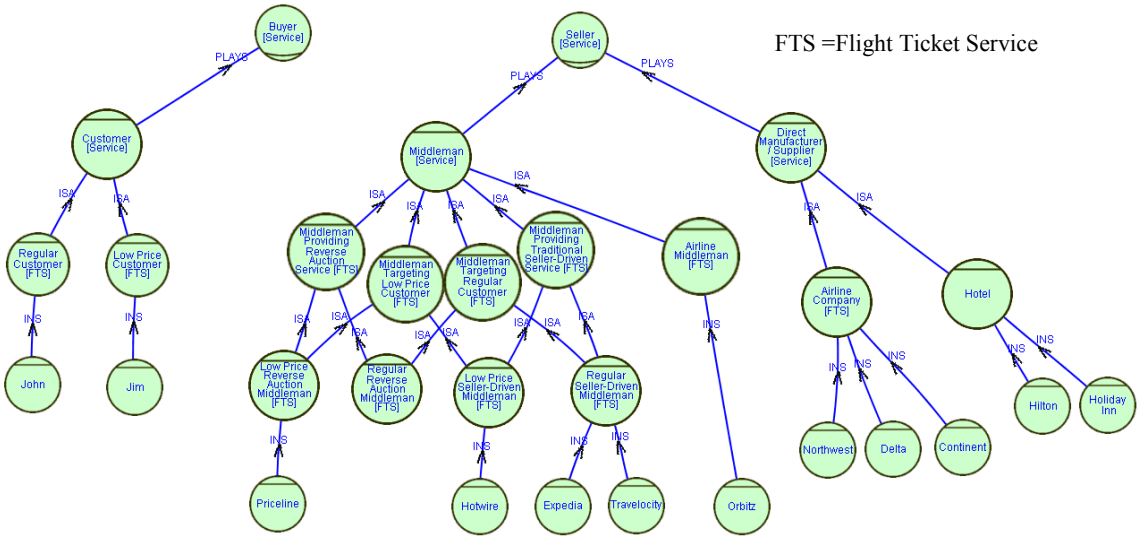


Fig.5 Some classes of actors in the travel e-business domain

This basic pattern of relationships may appear in various contexts in which IP and potential infringements may occur. To place IP within its broader context (as in Fig. 5), one needs to ask a wide range of questions such as:

- Who are the major players in the business domain?
- What kinds of relationships exist among them?
- What are the business objectives and criteria of success for these players?
- What are the alternative business processes/methods or technologies used in this industry? How are these alternatives serving the business objectives and the quality expectations of players? What are the essential sub-processes/components to implement these alternatives?
- What patents or other IP exist within the domain? Who owns them? Who depends on them?
- Are there any infringements on the IP rights? How are they likely to be settled?
- Should a new innovation be patented or kept as a trade secret? Is the innovation likely to be granted a patent?

The proposed modelling approach can help address these questions systematically. The next section considers three examples of modelling and reasoning in particular settings.

## 4 Strategic Issues for IP Management

In this section, we use the online travel booking industry to illustrate strategic issues for IP management. Major products and services provided in this industry are airline ticket sales, hotel

reservations, and car rentals. The main players used in our examples are Expedia (www.expedia.com), Travelocity (www.travelocity.com), Hotwire (www.hotwire.com), Priceline (www.priceline.com) and Orbitz (www.orbitz.com). A summary of the major actors are shown in Figure 5.

### *4.1 Business Expansion Acknowledging Patent Protection*

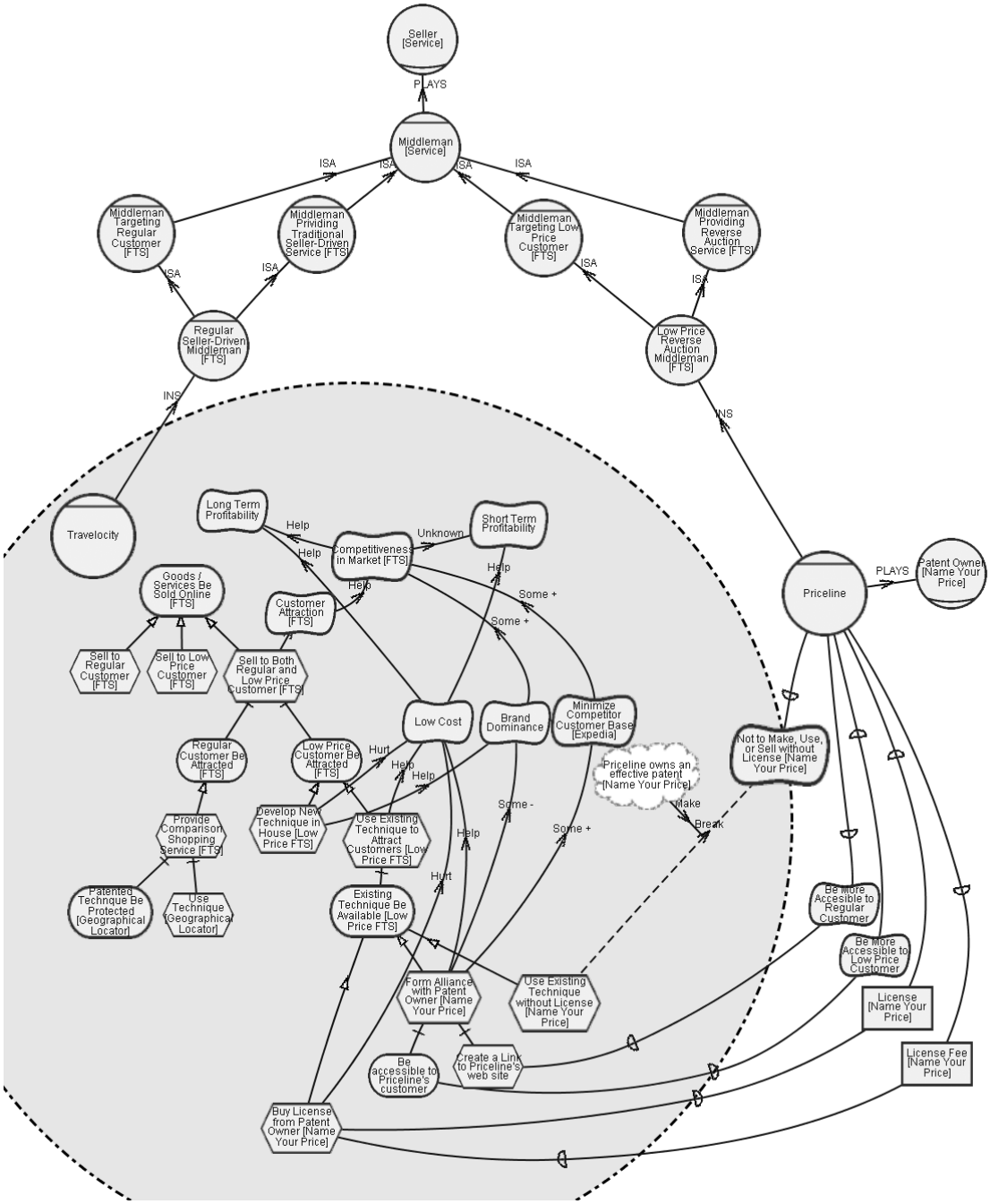


Fig.6. Reasoning behind business expansion acknowledging patent protection

This section considers the strategic reasoning of a company wishing to adopt a new business method but is blocked by a patent.

Travelocity is an online travel booking service. It started with a seller-driven system targeted at regular customers. To expand its business, Travelocity would like to target low price customers as well. Fig. 6 shows Travelocity as having the main business goal of Goods/Services Be Sold Online. There are three means to this end: Sell To Regular Customer; Sell To Low Price Customer; Sell To Both Regular And Low Price Customers. To Sell To Both Regular And Low Price Customers, one of the subgoals is Low Price Customers Be Attracted. This goal can be met by Develop New Technique In House or by Use Existing Technique To Attract Customers. The subgoal of Use Existing Technique is Existing Technique Be Available. Three alternative ways to achieve this goal include Buy License From Patent Owner, Form Alliance With Patent Owner, and Use Existing Technique Without License [Name Your Price].

As in Fig. 4 of Section 3, the effect of holding a patent is represented as a dependency from patent owner to patent user Not to make, use or sell patented technique without license. In this case, the fact that Priceline holds a patent on Name Your Price Technique constrains the freedom of action that Travelocity has, because the alternative of Use Existing Technique Without License [Name your price] BREAKs the dependency link from Priceline on others Not to make, use or sell patented technique without license. Since Travelocity is aware that Priceline owns an effective patent [Name Your Price] (expressed by a *belief* in the model), this *belief* by Travelocity confirms the BREAK link.

The alternative Buy license costs more and is not necessarily effective in competing with Expedia (Travelocity's major competitor). Form Alliance contributes negatively (Some-) to Brand Dominance of Travelocity, but HELPs Low Cost and aids in (Some+) Minimize Competitor Customer Base. Through alliance, Travelocity could also form more open and reciprocal relationships with Priceline [8]. Therefore, the alternative of Form Alliance is a better choice.

From this model we can see that i* modelling technique enables methodical consideration of goals and how they can be met. Business objectives can be systematically refined into tasks which may contain further subgoals and subtasks. Evaluation of alternative ways to achieve a goal is realized through qualitative contributions to softgoals. Agents and roles concepts are also beneficial in reflecting the actors' positions in industry and identifying potential relationships between the actors.

### *4.2 Patent Infringement Settlement*

This part highlights the use of the *belief* concept and the BREAK link in i* modelling to express the conflict arising from actors' different beliefs.

The actors' industry position reflected in the top part of the model is similar to Fig. 6. Expedia is comparable to Travelocity in which they are both providing services to regular customers in a seller-driven system. And Priceline's role as a low price reverse auction middleman remains the same.

Expedia is another online travel booking service targeting regular customers in a seller-driven system. It differs from Travelocity in that it went ahead to offer a buyer-driven service called Price Matcher without obtaining a license from Priceline. This BREAKs the dependency link from Priceline to depend on patented technique users Not to use without a license. This break link arises due to Priceline's claim (*belief*) that Expedia's Price Matcher Service is covered by Priceline's patent [Name Your Price]. However, Expedia has a different opinion on Priceline's patent – Expedia believes it is not a valid patent (The Break contribution link from the claim to

the Make contribution link). To settle this contradiction, they may either go to court or settle privately. Win Right out of Court contributes positively to Minimize Cost and Business Image. Win Right in Court HURTs Minimize Cost but has a positive contribution to Brand Dominance. Based on the contributions of two ways to achieve the goal of Having the Right to Use the Technique [Price Matcher], an out-of-court approach is a better choice for Expedia [14]. As the patent owner, Priceline can do the same evaluation based on contributions to softgoals from alternative tasks to settle infringement.

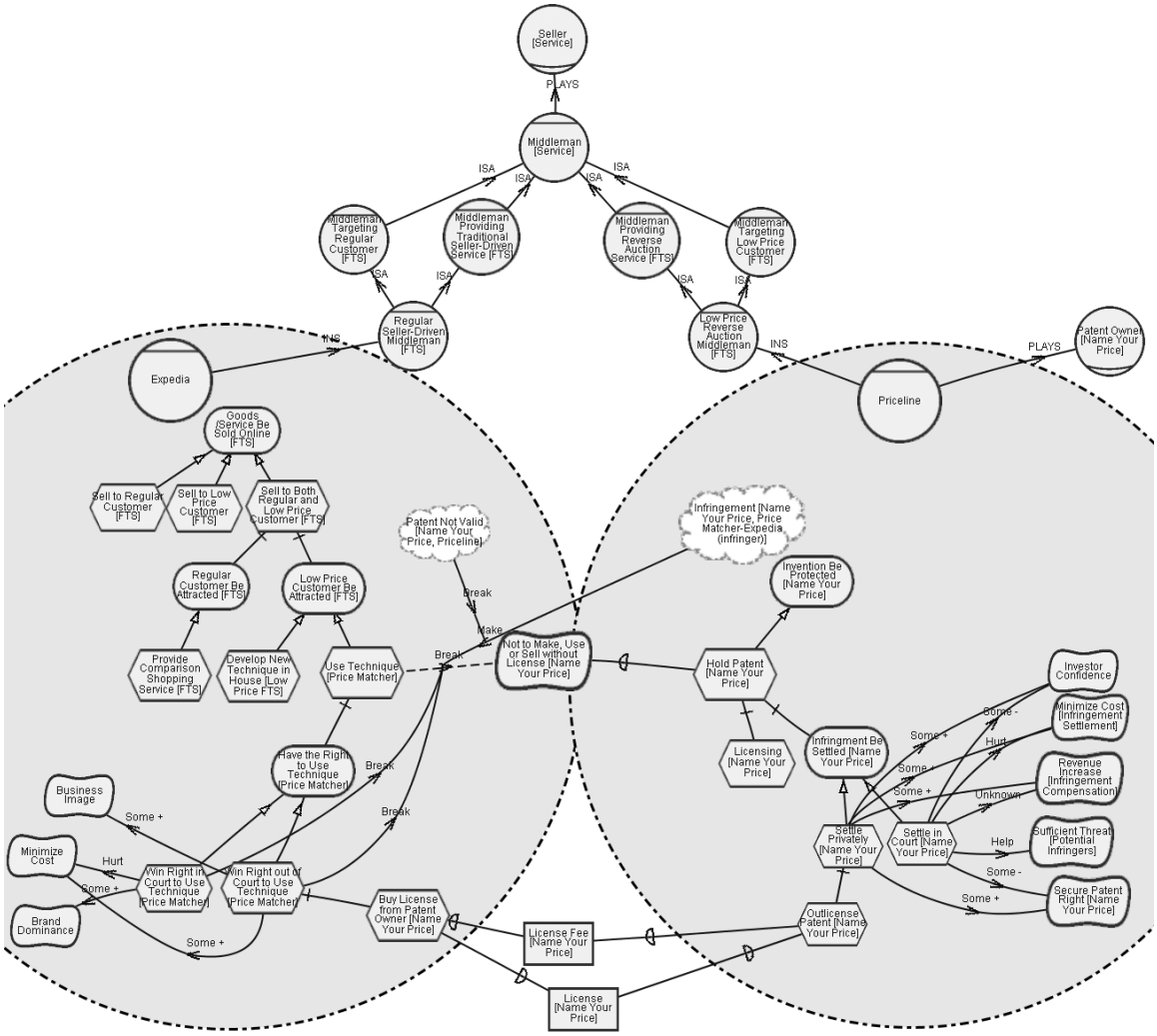


Fig.7. Infringement settlement

### *4.3 Patent Related Partnerships and Alliances*

Now we consider IP related decisions in the context of overall business objectives. The model in Fig. 8 highlights the refinement of softgoals from higher level to lower level, and the reasoning for making choices among alternative options based on both strategic dependency relationships with other actors, and contributions to softgoals from alternative options.

Orbitz is an online travel middleman founded by five airline companies. Its major service is comparison shopping for airline tickets targeted towards regular customers. In order to expand the market, Orbitz could decide to provide low price flight ticket service to price sensitive customers.

The following model presents how i* modelling can support Orbitz's decision making among alternative ways of providing low price ticket service. Four alternatives in the model are Form Partnership with Priceline, Form Marketing Alliance with Priceline, Buy License from Priceline, and Form Partnership with Hotwire. Marketing alliance here means the participating party provides some kind of advertisement for the other party or provides a link to the site of the other party. Partnership has a degree of ownership and usually means both parties invest in a new company and provides support for the new company.

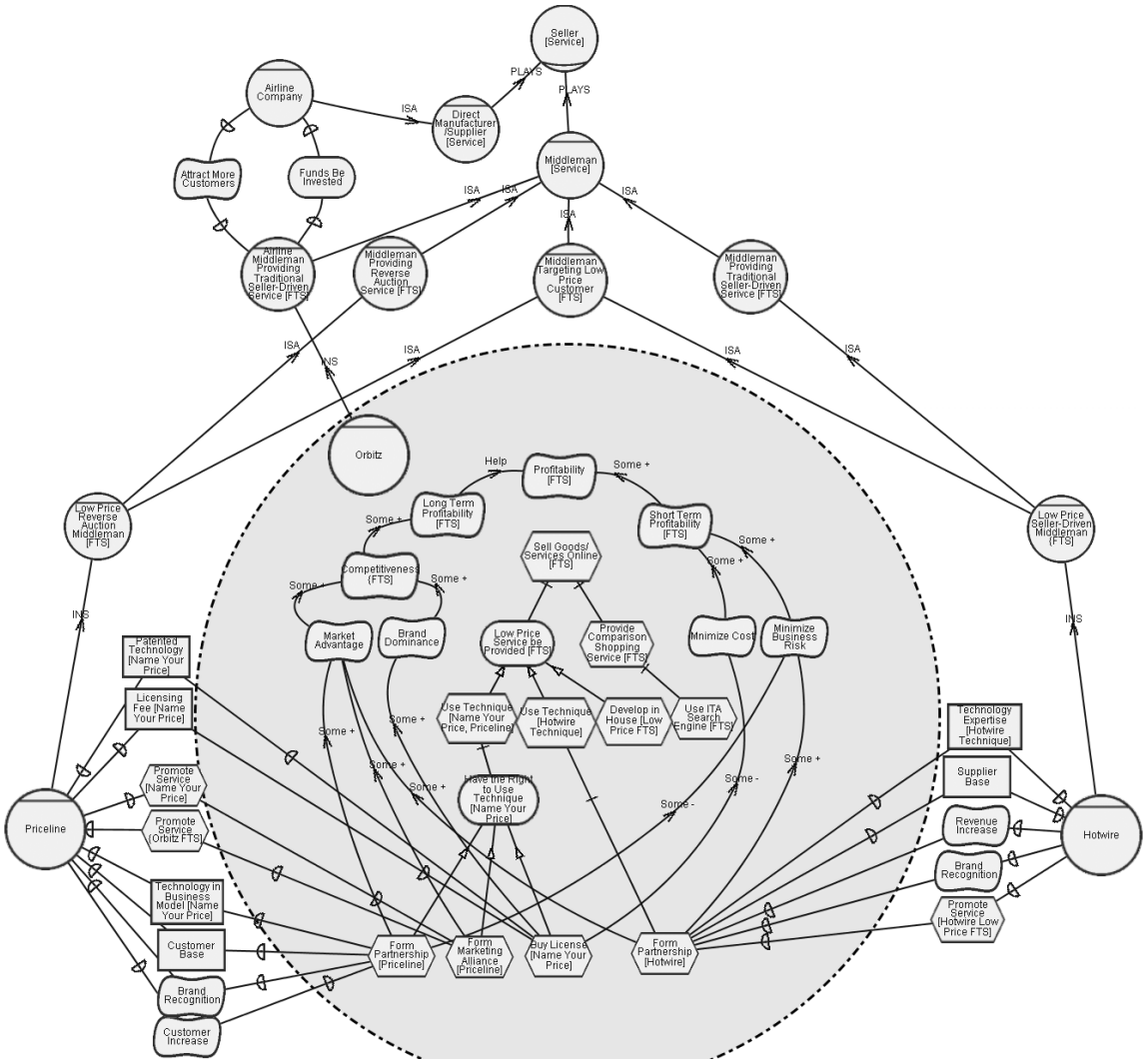


Fig.8. Patent related partnerships and alliance

The top part of the model shows the agents and roles of the actors at issue. Orbitz is an alliance founded by airline companies. It is categorized as a special middleman called airline middleman who depends on airline companies for Investment and is depended upon by airline companies to Attract More Customers. In this case, it plays more of a seller's role than a supplier's role.

Softgoals are developed in a systematic way to depict the progress from high level goals to low level goals. Only the most relevant softgoals in this example are presented to simplify the model. The highest level softgoal is Profitability. It is further developed into Short-term Profitability and Long Term Profitability. Minimize Cost and Minimize Business Risk are lower level softgoals to fulfill Short-term Profitability. Competitiveness is one lower level softgoal for

Long Term Profitability. Market Advantage and Brand Dominance are softgoals to accomplish Competitiveness of the firm's business.

Orbitz has more important dependencies on Priceline than the other way around through establishing partnership with Priceline. Therefore, it is difficult and uncertain for Orbitz to enforce the dependency relationships between Orbitz and Priceline. On the other hand, establishing partnership with Hotwire puts Orbitz at an advantage since Hotwire depends to a great extent on Orbitz for Revenue Increase and Brand Recognition while Orbitz's dependencies on Hotwire are not as important.

After evaluating the four alternatives based on their contributions to softgoals and strategic dependency relationships, one could conclude that establishing partnership with Hotwire is a better choice. This example illustrates the need to assess the validity of dependencies and how they contribute to meeting strategic goals.

# 5 Discussion and Conclusion

We have outlined an approach to modelling and analyzing IP management issues. The approach is based on an intentional and social ontology that is centred around strategic actor relationships. This ontology allows us to go beyond entity relationships and mechanistic behaviour, to deal with the opportunistic behaviour of strategic actors. Interdependencies among actors place constraints on their freedom of action. Nevertheless, constraints can be violated due to agent autonomy (unlike in mechanistic systems) as in the patent infringement example. Strategic actors seek to achieve goals (hard and soft) by exploring and evaluating alternatives, taking into account the opportunities and vulnerabilities arising from various dependency relationships, as illustrated in the patent licensing and alliance partnering examples.

Our approach is complementary to existing frameworks and techniques for IP management. Recent approaches have emphasized systematic IP management processes [12, 13] and analysis, particularly the quantification of economic value of intangible assets and intellectual property [11]. There is also increasing use of computational techniques, e.g., patent database search and retrieval, and cluster analysis to determine distribution of patents among subject areas [9]. Our approach emphasizes the systematic analysis of relationships among strategic actors by extending conceptual modelling techniques. It supports the exploration and management of structural alternatives, based on a qualitative style of reasoning, thus complementing the quantitative orientation of recent IP analysis techniques.

IP management is increasingly connected with other activities in enterprise management [9]. The strategic modelling approach provides a way of linking IP analysis to business strategy analysis and technology analysis. The recent trend towards the patenting of software and business processes and methods makes IP management a direct concern for information systems as well. A strategic conceptual modelling approach can thus provide a unifying framework for enterprise information systems, supporting decision making and the management of change across technical system development, business development, and IP management.

In information systems and software engineering research, enterprise modelling has been of interest, often in connection with requirements engineering. Goal-oriented approaches has been used in this context, and agents or actors are often part of the modelling ontology [4, 1, 10, 2, 5]. However, the i* approach is distinctive in its treatment of agents/actors as being strategic [15], and thus readily adaptable to the IP analysis domain illustrated in this paper. A related technique was used earlier to model security and trust in a multi-agent context [18].

While this paper has outlined some basic modelling concepts, much remains to be done. There is much potential in the synergy between strategic modelling and the foundational principles in conceptual modelling. For example, in analyzing the content of intellectual properties, one would like to model the inter-relatedness (similarities and differences) among their subject matters. The interaction between intentional concepts and relationships (e.g., strategic actors, intentional dependencies) and non-intentional ones (e.g., specialization, instantiation, aggregration, time, etc.) need to be detailed. Libraries of reusable knowledge about classes of strategic agents and roles, and common patterns of relationships, would be very helpful during modelling and analysis. Methodologies and tools need to be developed. These are topics of ongoing research.

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