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***Abstract* - Among other proposals to reform the German outpatient health care system the establishment of networks of cooperating physicians (doctors' networks) has found high and controversial consideration in recent years. In this paper we analyze doctors' networks both from an economic perspective, particularly with a view on network strategies, and the perspective of supporting information technologies. Our main conclusions are that the viability of doctors' networks critically depends on trust-building mechanisms like the restriction of the network in size and complexity and the application of fair profit allocation rules. Concerning information technology the implementation and use of highly integrated interorganizational systems appears most promising. We propose an architecture of such systems. It integrates information technology along the medical, the business and the communication systems dimension and serves as a vehicle for efficient use of shared patient data and other network resources, knowledge creation, fair profit allocation, improved business control and a high level of integrity vis-a-vis the patient.**

I. Introduction: From the Doctors' Association to Doctors' Networks

Because of its already very high and still increasing costs the German health care system has been under heavy debate during recent years. Solutions have been searched for that maintain the current quality standard of medical treatment while reducing costs or at least stopping their increase. The actual health care system is embedded into a strong regulatory framework which handles the relations between patients, physicians, and insurance companies. About 90 percent of the total population is covered by the system mainly because of its statutory character for salaried employees up to a certain income, but also because of comparative advantages for larger families [1]. The remaining part of the population is basically covered by private insurance schemes which are not considered in this paper because of their relatively small relevance to the overall problem.

Important parties of the regulatory framework are the „Kassenärztliche Vereinigung", i.e. the association of the physicians in outpatient health care, and the statutory health insurance companies which are admitted to the system. In the following, we refer to these two parties simply as "doctors' association" and "insurance companies". The doctors' association has mainly two objectives: firstly to serve as a professional organization for the member physicians and to represent their interests in society, secondly to negotiate with the insurance companies for a yearly amount of outpatient care and redistribute this amount to the doctors proportionally to outpatient services provided. Other than in the private insurance scheme, in the statutory scheme the doctor does not collect fees directly from the patient but is reimbursed by the doctors' association. The patient may not even know the volume and the specifics of the fee. Within the statutory system, the doctors' association therefore serves as a clearing organization between physicians and insurance companies [2, 3].

With more and more financial constraints on the statutory scheme, the system exhibits some serious deficiencies. As the total financial volume for redistribution to the physicians is fixed, the system invites for opportunistic behavior on the doctors' side who try to get a share of the cake as large as possible. This typically leads to hidden, but nevertheless fierce competition between the physicians to increase the volume of services provided, and jeopardizes the cost efficiency of the system [4, 5].

Therefore, other solutions have been proposed. One of these solutions is the voluntary establishment of „doctors' networks". The fundamental idea of this proposal is to lower regulatory forces and to introduce more market-like elements into the health care system. In the doctors' network approach several physicians from complementing disciplines establish a relatively stable and long-term cooperation. A constitutional element of a doctors' network, hereby, is the joint treatment of a patient by several legally independent network members for a lump fee which has to be allocated to the treating physicians by some network-internal mechanism. In this sense a doctors' network is quite distinct from and goes far beyond other forms of cooperations between physicians which share some information (e.g. quality circles) or some physical resources (e.g. joint doctors' offices) or from arrangements with joint legal responsibility. The lump fees are negotiated between the doctors' network and the doctors' association or even directly with some or all of the statutory insurance companies on a case-specific as well as a network-specific level. By that, it is expected that the budget uncertainties in the current system are reduced and activities are performed more efficiently. Within the proposed scheme, the doctors' association obviously does no longer play the role of a general clearing organization. However, the association clearly supports the establishment of networks [6] and will still act as clearing organization for all physicians not organized in networks. Within the doctors' network, one network member has to assume the role of a coordinator and gatekeeper to the patient, usually a general practitioner ("family doctor").

In the meantime a few pilot networks have been under operation in Germany [6]. Most known are the "Rendsburg Initiative", the project "Physicians in the Ried-Area", and the initiative "Quality and Humanity" [6]. Although the first results seem to indicate progress in cost efficiency it is too early to draw firm conclusions from these experiments. Other experiences with doctors' networks like managed care in the United States and in Switzerland are based on different social and legal prerequisites and are not directly transferable to the German situation [7].

While the doctors' network approach would reduce the problem of opportunistic behavior in the current system, it poses new problems. One is the potential rivalry between the doctors within a given network that would transport the problem of opportunistic behavior only to another level. A second question concerns the competition between networks and the creation of competitive advantages of one network against rival networks. Thirdly, and most importantly, the network approach must be accepted by the patient, i.e. must be more attractive than the current situation with individually operating physicians. Attractiveness may be increased either by superior medical service quality or by lower insurance costs or by both. Besides political and legal influences the solution to the three problems obviously depends on the distinct medical, economic, and social competencies of the network. Besides many other factors, these competencies are also impacted by the proper use of information technology in a doctors' network. As we will argue, a common and highly integrated information system constitutes an important strategic resource that helps to add value to the services rendered to the patient, to keep cost under control and to position the network against rival networks.

The aim of our paper, therefore, is to evaluate and compare the current and the proposed health care system both from an economic and information technology (IT) perspective. In chapter 2 we apply a framework for strategic planning in networks, that we have developed for the analysis of different types of networks in general, to the specific case in hand. Chapter 3 deals with the role of IT in health care systems more specifically, and proposes an overall architecture for an interorganizational information system (IOS) in doctors' networks. Chapter 4 concludes the paper with a summary and open questions for further analysis.

II. Framework for Strategic Planning in Networks

A. Strategic Framework

Strategic planning in networks has to cope with two interdependent strategy levels: Collective network strategies and firm-level network strategies [8]. Fig. 1 exhibits these two levels in the specific context of doctors' networks. The conceptual distinction of the two levels expresses the coexistence of competitive and cooperative elements in any network arrangement.

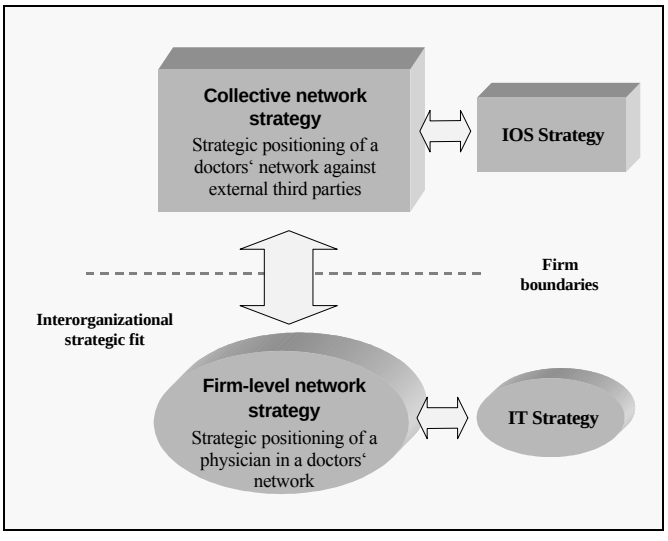

Fig. 1. Framework for strategic planning in networks.

Collective network strategies focus on positioning a network as a whole relative to its environment, i.e. patients, rival individual doctors and doctors' networks and the statutory insurance companies. They represent an extension of strategic planning under conditions of joint strategic goals of the network participants. The key focus of collective network strategies is on realization of sustained cooperative advantages with regard to costs, quality, timeliness, flexibility, and risk sharing. As part of a collective network strategy, joint investment plans for IOS play an important role.

Firm-level network strategies, i.e. in our specific case the strategies of each individual physician in a doctors' network, are inside oriented and concentrate on the positioning of each member of the network vis-a-vis the other network members. Firm-level strategies serve as a buffer between the network perspective and the internal perspective and focus on the alignment between collective network strategies and firm-level functional strategies including the integral IT strategy of the single physician.

B. Collective network strategies

The formalization of collective network strategies essentially depends on network size and network interdependencies, see Fig. 2. Network size describes the number of members of a network. Network interdependencies relate to the distribution of bilateral links in the network. In the symmetric case many network members interact with many other members, either directly or via a joint activity such as a professional association. In the asymmetric case, there exist some network members which have significantly more bilateral links than others, like in buyer-supplier networks where some buyers do business with several suppliers, and where little interaction occurs between the suppliers. In extremely asymmetric constellations focal firms may take the position of an indispensable agent. If they are excluded from the arrange-

ment, the network will not produce any value at all. Asymmetric networks exhibit substantial asymmetries in bargaining power. Their economic performance strongly depends on the provision of trust-building mechanisms. This argument is formally developed in [8] by means of cooperative game theory.

Consistent with [8] four different strategic positions can be identified within this framework: confederate collective strategy, conjugate collective strategy, emergent collective strategy, and the impossibility to work out a formal collective strategy because of the size and complexity of the underlying network with highly asymmetric distribution of bargaining power (no formal collective strategy).

In our specific case we concentrate on two particular network types: the doctors' association and the doctors' network. Their strategic position corresponds to the confederate collective strategy and the conjugate collective strategy, respectively, see Fig. 2.

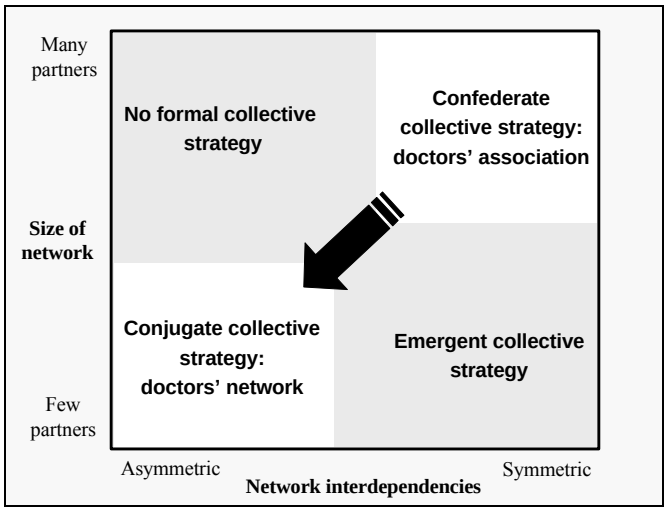

Fig. 2. Typology of collective network strategies.

Doctors' associations are characterized by a large network size as well as relatively symmetric network interdependencies. Central objective of the underlying confederate collective strategy is to lower the direct competition between the horizontally positioned physicians in certain domains. This effect can actually be observed in the German health care system where competition based on service as well as on prices is almost non-existent [9, 10]. Yet, since the participating doctors are either direct or indirect competitors the risk of opportunistic behavior is inherent to the doctors' association. To mitigate the obvious conflicts between competitive and cooperative forces a high degree of formalization in interorganizational coordination mechanisms is necessary. In the German health care system, the doctors' association therefore relies on relatively well-specified contracts and rules predominantly institutionalized by legal regulations [10, 11]. Nevertheless, the underlying neoclassical contract types always remain partially incomplete, in contrast to market contracts [12]. This leads to frequent internal disputes about the interpretation of the existing regulations and requires the doctors' association to employ third parties for conflict resolution and performance evaluation. Generally, the role of the third party is represented by internal decision making units within the doctors' association. Also because of the competitive bias of the doctors' association, information exchange between the network members is coordinated through open and standardized information systems. Investments into interorganizational process integration, that would lead to undesired lock-in effects, are unusual.

In contrast, the proposed doctors' networks constitute relatively small networks with dominantly asymmetric interorganizational interdependencies. They essentially rely on gatekeepers that take the role of network coordinators and represent the network as a whole against the external environment (e.g. patients, the doctors' association, or the insurance companies). Typical tasks of gatekeepers are the negotiation of case-specific or network-specific lump fees with the doctors' association or directly with the insurance companies as well as the routing of patients through the network. Gatekeepers are usually represented by highly reputable general practitioners that may also take the role of the network initiator and composer. Obviously, because of the resulting information asymmetries the general practitioner exhibits a dominant bargaining position. Nevertheless, the participating physicians are not direct competitors but possess complementary skills and aim to cooperate on a stable and long-term basis. Because of these characteristics a conjugate collective strategy seems to be most suited. Other than with the confederate collective strategy, the key focus is not so much on the pooling of common interests, but on the long-term viability of efficient symbiotic interorganizational relationships. Because of the long-term perspective it is difficult to institutionalize collective network strategies based on ex ante specified contracts and rules. Instead, conjugate collective strategies aspire after joint, periodically renegotiable service agreements. Furthermore, they include common investment strategies, e.g. into expensive medical technologies, but also into proprietary and highly integrated IOS to gain sustainable competitive advantages against rival networks. Conjugate collective network strategies typically rely on implicit relational contracts [12, 8]. The objects of agreement usually are not verifiable by a third party, though they may be observable by the participating network members. In consequence, the underlying variables cannot be formalized in an ex ante comprehensive contract and the applicability of network coordinators for dispute resolution and performance measurement is restricted. Because of the incompleteness of contracts and the asymmetric distribution of bargaining power conjugate collective strategies require trust-building mechanisms to ensure the long-term viability of the doctors' network. These mechanisms are related with the alignment strategies on the firm-level and will be discussed in more detail in chapter II.C.

Table I summarizes the main features of collective strategies in the doctors' association and the doctors' network, respectively.

TABLE I
MAIN FEATURES OF COLLECTIVE STRATEGIES

Main features	Doctors' association	Doctors' network
Degree of formalization	Formal neoclassical contracts	Implicit relational contracts
Bargaining power distribution	Symmetric	Asymmetric
Interorganizational process integration	Low	High
IOS type	Open / standardized / non-strategic	Proprietary / integrated / strategic

C. *Firm-level network strategies*

Firm-level network strategies comprise two dimensions: Profit allocation strategies and interorganizational resource strategies [8], see Fig. 3.

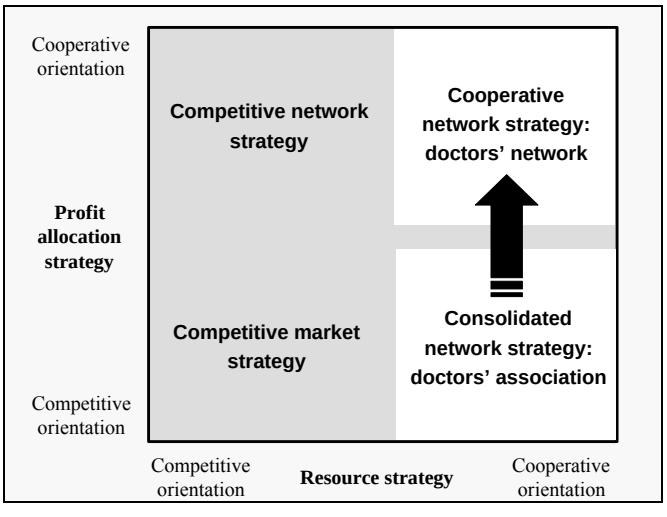

Fig. 3. Typology of firm-level network strategies.

Profit allocation strategies are concerned with the sharing of revenues, investments, and costs and depend on the strategically motivated application of bargaining power. "Competitive profit allocation strategies" are characterized by a full exploitation of bargaining power. Firms appropriate rents according to their relative threat potentials determined by the expected network profits in comparison to anticipated profits from alternative arrangements adjusted for switching costs [13, 8]. In contrast, "cooperative profit allocation strategies" institutionalize voluntary constraints in order to limit the potentials of bargaining power exploitation. For example, such constraints can be incorporated by the ex ante implementation of fair profit allocation rules including fair sharing of joint investments or by the ex ante restriction of the network size.

The resource strategy focuses on the management of resource positions in interorganizational arrangements. Engagement in networks constitutes a complementary strategy to the concentration on core competencies and can be viewed from a cooperative as well as from a competitive perspective [14, 8]. "Cooperative resource strategies" focus on the pooling or reciprocal sharing of core competencies and resources in networks whereas "competitive resource strategies" strictly emphasize the protection of core competencies and resources.

Based on the cross comparison along the cooperative respectively competitive orientation of the two strategic dimensions four distinctive categories of firm-level network strategies can be distinguished: Consolidated network strategy, cooperative network strategy, competitive network strategy, and competitive market strategy [8], see Fig. 3.

Physicians participating in a doctors' association are characterized by "consolidated network strategies" that are in alignment with confederate strategies on the collective network level. Consolidated network strategies are based on a mix of competitive profit allocation strategies and cooperative resource strategies on the firm level. Doctors' associations focus on the pooling and joint utilization of similar resources, particularly on data aggregation and fee settlement. But because of the competitive nature of the arrangement other information exchange is usually restricted to distinct domains of interorganizational collaboration. Furthermore, the inherent competitive elements induce low incentives for joint investments into integrated IOS. More generally, because of the well-specified contracts and the low degree of interorganizational process integration non-contractible joint investments are of minor relevance [15] and voluntary constraints in order to limit exploitation of bargaining power are not required. Consequently, for the doctors' association trust-building mechanisms play a less important role.

In contrast, physicians participating in a doctors' network can benefit from a mix of cooperative resource strategies and cooperative profit allocation strategies. The underlying "cooperative network strategy" on the firm-level matches with conjugate strategies on the collective network level. Reciprocal sharing of medical core competencies and patient information hand in hand with joint investment into medical technology or integrated IOS constitute central objectives of a doctors' network. Chapter III will discuss the aspect of IOS in some detail. Furthermore, the creation and nurturing of social and managerial network competencies including the ability to develop trust, to share risk and to enhance collective learning are of central importance. Typically, a key strategic asset in doctors' networks stems also from the high degree of interorganizational process integration. The productivity of an individual doctor in the network and the investment incentives of the other network members are reciprocally dependent. As a consequence, cooperative profit allocation strategies to strengthen mutual trust and investment incentives are critical for the long-term viability of doctors' networks. Trust building requires a renunciation of bargaining power exploitation by dominant network members, particularly on the side of the gatekeeper. The restriction of overlapping competen-

cies in doctors' networks hand in hand with the ex ante limitation of the network size constitute important trust-building mechanisms. If asymmetric bargaining power is exploited or merely preserved, the weaker partners tend to underinvest and the resulting economic position is worse for all actors in the network [16].

Table II summarizes the main features of firm-level network strategies in the doctors' association and the doctors' network.

TABLE II
MAIN FEATURES OF FIRM-LEVEL NETWORK STRATEGIES

Main features	Doctors' association	Doctors' network
Trust	Not required	Imperative
Profit allocation strategy	Exploitation of bargaining power, if existent	Voluntary constraints
Investment incentives into IOS	Low	High

"Competitive market strategies" and "competitive network strategies" on the firm level in Fig. 3 match with the categories "no formal collective strategy" respectively "emergent collective strategy" on the network level in Fig. 2. "Competitive market strategies" typically prevail in large and complex interorganizational relationships, whereas "competitive network strategies" are especially suited for networks cooperating on a temporary basis [8].

In our medical context competitive market strategies would be the result of large and highly interrelated doctors' networks where some physicians participate permanently in more than one network. It is almost impossible to establish and control trust-building mechanisms in such complex arrangements with highly asymmetric distribution of bargaining power. This may be the reason why some of the managed care systems in the United States make use of employed rather than independent physicians. Within a hierarchy opportunistic behavior can be much better kept under control.

Competitive network strategies apply to physicians who do not cooperate within the network on a permanent base, particularly to highly specialized physicians whose services are purchased by a doctors' network on demand. Since there are no incentives for resource sharing in this case, we also would not assume joint investments into highly integrated IOS.

With the emphasis on trust-building mechanisms, on a high degree of IOS integration and on the creation of a network-specific knowledge base, doctors' networks stand in sharp contrast to other forms of cooperative doctors' arrangements. They substantially differ from quality circles and joint doctors' offices that primarily focus on the pooling of information respectively physical resources, but not on the integration of the core competencies of the network members.

III. IMPLICATIONS FOR THE IT STRATEGY OF DOCTORS' NETWORKS

A. *Knowledge Creation and IT*

In the current German health care system competition between the physicians is reduced to a few parameters. There is no competition with regard to service and price, because the regulated fee order prescribes identical prices for comparable services [10, 11]. Since explicit advertisement is also not permitted [9], competition is basically geared towards increasing a physician's pool of patients through interpersonal recommendation.

Besides professional reputation of a physician, there exists one second essential competitive asset, namely knowledge about the patient and his or her treatment. This knowledge resides not only in explicit patient records, but also in implicit or "tacit" knowledge about each individual diagnostic and therapeutic case. Tacit knowledge cannot be codified and therefore also not transferred to other physicians except if they work very closely together. Here we see an immense source of enduring competitive advantage for doctors' networks. In tightly coupled and stable networks, learning as the result of the interaction between explicit and tacit knowledge [17] can be far more effective than individual learning or learning in short-term arrangements. We have pointed out in the last paragraph, that sharing of knowledge and collective learning are key characteristics of the cooperative network strategy which prevails in doctors' networks. Because of its limited transferability, this knowledge base constitutes a barrier for patients to move to other networks or physicians outside the network, even if explicit medical records would be transferred.

Because of the tacit component, knowledge in a doctors' network cannot be represented by electronic patient records, IT-based applications and databases as such. Yet, IT can significantly enhance the knowledge creation process even on the tacit level [18]. In addition, IT can also help to improve the economic efficiency of a doctors' network. In the following we propose an architecture for an integrated and IT-based interorganizational system (IOS) for doctors' networks which supports both the knowledge creation process as well as the search of economic efficiency.

B. *Architecture of an Integrated IOS in a Doctors' Network*

Fig. 4 gives an overview of the architecture for the IOS. It is characterized by stepwise system integration along three dimensions: integration of the medical system, integration of the business system and integration of the communication system.

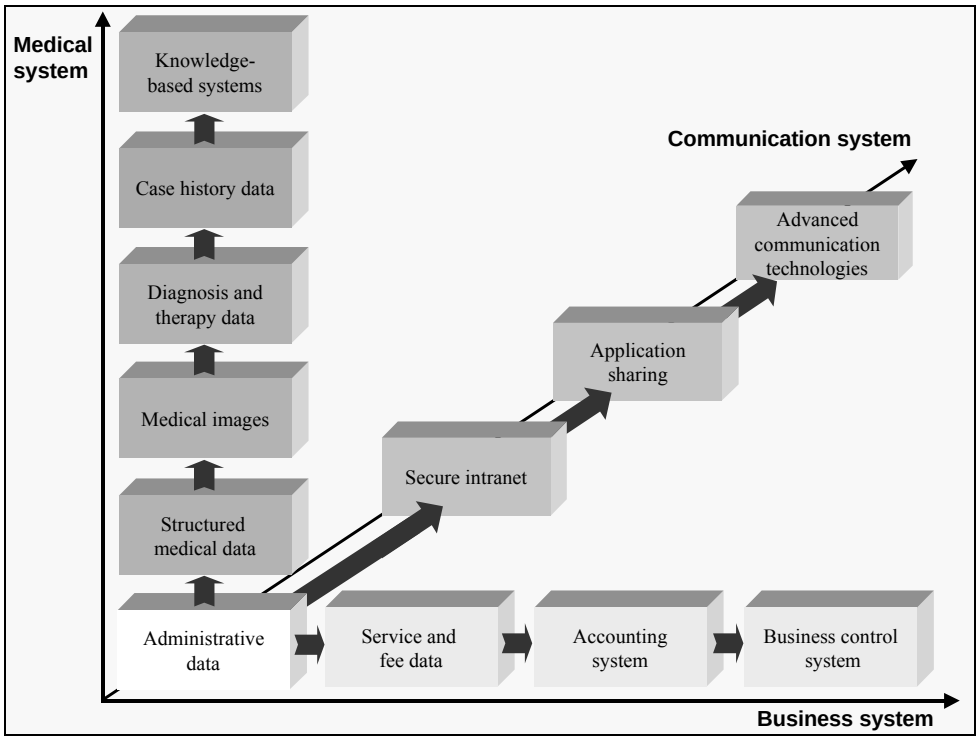

Fig. 4. Architecture of an integrated IOS.

The core and starting point for each dimension of integration is a shared database with administrative data, e.g. general patient data or general data of the participating physicians including specific competencies and installed medical technologies. This administrative data base is shared by all other applications along the three dimensions of integration.

Along the dimension of integration for the medical system we successively add to the administrative data the treatment-specific patient data including laboratory measurements, images produced by roentgen, acoustic, tomographic or nuclear technologies, data about initial findings, formal diagnosis and therapy, medical case history, and applications of knowledge-based systems which support the physician in diagnosis and therapy. Although the intensively discussed medical expert systems have not found wide appreciation in practice there exists a promising application potential for intelligent checklists or for the use of case-based reasoning in comparing an actual diagnostic or therapeutic case with previous cases of other patients [19]. However, unstructured elements in the electronic patient record (e.g. dictated or written reports) raise several problems in data communication, data management and data administration. Therefore, meta-data technologies that address the management of large bodies of text and facilitate the discovery and interconnection of similar medical cases play an important role [20]. The extraction of case history data represents a task far beyond the capability of administrative database systems. This implies to build up an extensive and formalized case history which certainly would constitute a major competitive advantage of a doctors' network.

The integration along the dimension of the business system starts with the compilation of network-specific lists for available services and fees. This module may also include an accepted algorithm for redistribution of fees between different service providers in the network and the calculation of the overall remuneration for each physician. A common accounting system as a next step of integration would contain all important business data like investments into medical, office or information technology, salaries, material costs, and purchases from services outside the network. The accounting system will ultimately serve as the basis for a business control system which provides and compares various indicators to measure the economic efficiency of the network. Latest at this point the business system should be also linked to the medical system to allow for cost comparisons by disease and treatment categories.

The integration along the dimension of the communication system starts with the provision of a secure intranet. Because of the sensibility of patient data strict measures of system security have to be taken. This comprises the control of access rights (which are basically at the patient's side and have to be verified by the patient) and the secure encryption of data, preferably already in the database but in any case when passing through public networks. Application sharing allows several physicians to share the same application. This is particularly important for the update and retrieval of patient data, but also for most of the other applications in the IOS. Architecture-independent Java applets coupled with markup languages (SGML and its subset XML) represent cost efficient options to work simultaneously at different locations with one set of data and applications [20]. Advanced communication technologies such as video-conferencing improve the real time communication between the doctors in the network. The use of Email and the World Wide Web on the Internet may serve as a platform for effective communication also with the patients.

The IOS components in Fig. 4 are certainly far from being complete and should only give some important directions of

integration. At the very end, the objective of the IOS is to present the network to the patients and to the participating physicians as one entity rather than a collection of services from different sources.

A high degree of IOS integration along the medical, business, and communication dimensions surely is a necessary prerequisite for knowledge creation in tightly coupled doctors' networks, but by itself it is not a sufficient condition. Social and managerial network competencies including capabilities for conflict resolution and trust building represent further flanking mechanisms for the efficient creation of a knowledge base in doctors' networks.

IV. Summary and Conclusion

Within this paper we have analyzed the transition from the current system of outpatient health care in Germany to a system which supports a stronger cooperation between physicians in ambulant medicine. The analysis comprised aspects of economics and of information technology.

On the economics side we have identified doctors' networks as organizations of the conjugate network strategy type. This implies that doctors' networks are based on implicit relational contracts and are exposed to bargaining power asymmetries and as a consequence to problems of distrust. To ensure long-term viability of the network trust-building mechanisms have to be established. These mechanisms include the restriction of the size and complexity of the network as well as fair rules for fee, investment, and cost allocation. The restriction in size contradicts with often heard proposals to establish larger networks because of inherent economies of scale. It also contradicts with the configuration of the current pilot networks in Germany which seem to be quite large [6]. Furthermore, the pilot networks seem to involve overlapping competencies of the participating physicians [6], a central inhibitor of trust building in network arrangements. The restriction in size and complexity finally puts a limit to the interaction between networks, and particularly to the permanent presence of some physicians in more than one network. The experiences in the United States indicate that large and complex networks should rather be operated by employed physicians, a solution which certainly is not favored by the German health care system.

Concerning interorganizational information technology we have voted for several reasons for a highly integrated solution. One reason stems from the long-term nature of the cooperation and the importance of trust. The second reason relates to the sharing of common resources as one important objective of doctors' networks. Integrated IOS make this sharing more efficient. Another reason is the creation of a knowledge base. A fourth reason, finally, concerns the patient. Only a strong and highly integrated IOS provides the integrity (or to use the iridescent term "virtuality") to the patient in the sense that he or she has the impression to be treated by a well-organized and well-informed medical entity rather than by a collection of more or less independent physicians.

Our analysis leaves a series of questions open. One is the coexistence of individual physicians and physicians organized in networks. Another open question concerns the cooperation between doctors' networks, hospitals, and highly specialized physicians. Also cooperative arrangements between doctors' networks and insurance companies constitute a topic for further investigation. Some legal aspects were touched only very briefly, particularly the sensitive question of patient data protection. Much research in these areas is still needed. The objective of our paper was to highlight some aspects relating to the importance of trust building in doctors' networks in general and as a consequence to the relevance of proper size and complexity of the networks and of the development and use of integrated IOS.

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