GSB WORKING PAPER NO. 27

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ISSN 1323-7853
ISBN 1 74067 159 7
July, 2002
CRICOS Provider Code No. 00301J

No. 27
Working Paper Series
02.04

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Working Paper Series 02.04 (Curtin University of Technology, Graduate School of Business)

ABSTRACT

Research into strategic alliances has traditionally focused on motivation and performance. More recently, network dynamics and alliances as complex and evolving arrangements are themes that are emerging as key areas for investigation. Thus far, little research has been undertaken that integrates these emerging themes in the context of the impact of deteriorating exogenous environments on network alliances.

The ICT industry provides such a context, with the rapid deterioration of fortunes in the industry as a result of equity market moves since early 2000. This research looks at the Bluetooth consortium, a loosely framed network of firms involved in the development and commercialisation of wireless technical applications for information technology based products. It finds that matters related to intellectual property ownership and inter-firm coordination in complex product development have been problematic, with the deterioration of environmental munificence driving a slowing of network investment and product development success.

Introduction

Child and Faulkner (1998), Inkpen (2001) and Gulati, Nohria and Zaheer (2000), in recent reviews of the various perspectives employed to understand inter-organisational alliances, note that economics, game theory, strategic management, behavioural perspectives, stakeholder approaches and organisational theory have all made contributions to our emergent understanding of the nature and dynamics of cooperative relationships between firms. If there is some commonality in the thematic development across these theoretical perspectives it is that that alliances are increasingly viewed in complex, multidimensional and adaptive, rather than stable and dyadic, terms (Larson and Starr, 1993; Gulati, Nohria and Zaheer, 2000).

While any network arrangement tends to operate functionally as a series of dyads, adopting the interconnected network as a unit of analysis provides new perspectives and insights for the researcher. Coupled with and related to this emerging network perspective, dynamic rather than static and equilibrium inspired views are also seen as more convincing reflections of the manner in which networks and alliances truly function (Jones, Hesterly and Borgatti, 1997). The importance of such a focus is especially present in complex organisational environments, where exogenous drivers of dynamism and change play a role in continually reforming the alliance arrangements and the relative positions of the alliance members.

These moves towards more complex theoretical understandings are mirrored across the strategic management literature (Stacey, 1995; McKelvey, 1999) - creating an impetus towards the use of complex adaptive systems as appropriate units of analysis in strategic management research, rather than firms or industries (Morel and Ramanujam, 1999; Markides, 1999). The use of a systemic focus by organisational management within inter-firm networks (Stuart, 2000), within regions or nations (Lundvall, 1992) or globally (Zanfei, 2000) have been shown to be a strong facilitator of effective knowledge utilisation and innovation.

At the more micro-level of analysis, networks are viewed in the resource-based framework as a contingency-based response to the potential benefits and inherent problems of heterogeneous firm resources (Das and Teng, 2000). By linking the internal capabilities of the firm to the outside environment, organisational resources are freed to operate as a source of creative novelty and product or service value (Hagedoorn and Schakenraad, 1994). They determine the uniqueness of the goods

and services provided by the firm and help to maintain this uniqueness through the erection of barriers to rivalry: whether through imitation, substitution or eventual market displacement.

Alliances tend to be driven by potential complementarities between some types of characteristics held by the firms involved. Stuart (2000) notes that the potential benefits for firms differ – for small firms the reputational benefits of involvement with a large, innovative firm tend to be significant. For larger firms, access to resources and know-how tend to be key drivers. Where alliances require the development and maintenance of physical assets, they tend to be more concrete in their form and durability. Where the resources involved tend to be intangible (like reputation) or knowledge based, more innovative structures tend to be required that can take into account the asymmetric nature of the knowledge development process.

Given the increasing rate of technological change, a degree of dynamism is an important aspect of any proposed technology and knowledge strategy adopted by firms. Foss (1997, 311) notes that the major function of all firms is to deal with the challenges presented by “changing, partial, tacit, complex, asymmetrical etc. knowledge and its useful application”. The growing importance of knowledge as an asset is also challenging old assumptions regarding resource allocation within and between firms.

As complexity in information technology and telecommunications has increased, a degree of vertical and horizontal disintegration has occurred in these industries (Lamming, 1993), requiring firms to cooperate within both design and supply chains to develop products and services (Lynskey, 1999). Processes of disintegration have created both the opportunity and need for network development between firms in developing complex products or services that are compatible with complex broader systems.

As knowledge development becomes more important as the basis of strategic alliances between firms, there is an opportunity and indeed a necessity to ensure a degree of fluidity and dynamism in its allocation and development. Thus a strategic dilemma of sorts has emerged for many industry participants in high technology endeavors. A degree of knowledge sharing is necessary to ensure a role in a broader complex system, while a degree of exclusivity is also necessary to ensure differentiation from other industry participants. This dynamic tension is at the core of

the planning for and implementation of network alliance relationships among firms and creates operational challenges in a number of areas.

The Matter of Uncertainty

From a strategic perspective, firms (especially those in high-technology industries) are charged with making often-irreversible investments within a highly uncertain context. Both task uncertainty and environmental uncertainty must be appropriately managed in alliance arrangements. Uncertainty can arise from many exogenous factors, including unpredictability in technologies, markets and the competitive environment. In networks, dynamism and relational arrangement provide further potential for uncertainty relating to emergence of new relativities between partners. Such a complex and fluid situation creates a raft of operational and strategic challenges.

In dealing with these challenges, Geletkanycz and Hambrick (1997) note that executives seek external cues for referencing their strategic decisions. Subjectivism in such analytical processes relating to managerial assessments of the importance and real nature of environmental forces provides further challenges requires careful consideration due to the competing problems of bounded rationality and information asymmetries (Reed, Lemak and Montgomery, 1996).

Structural considerations are also important. Waddock (1991) noted that much academic thinking views collaboration between firms, *per se*, as a way of structuring the organisational environment in such a way that uncertainty is reduced. Gresov and Drasin (1997) proposed that low task uncertainty tends to require a mechanistic relationship arrangement between partners to handle routinized tasks, while horizontal interdependence, organic organisational structures and partner flexibility are more appropriate relationship features where task uncertainty is high. Such findings are commensurate with those of Lindsley, Brass and Thomas (1995), who contend that cross-level relationships within and between firms will be stronger when task uncertainty or complexity is high, and weaker and less defined under low task uncertainty or complexity.

Geletkanycz and Hambrick (1997) found that in uncertain environments (in the case of their paper, the computer industry), organisational performance is more positive in

uncertain industries when firms tend to conform to industry norms, while this is not the case in stable industries (they investigated the food industry in this regard).

Countering this negative view of uncertainty in the Resource Based Value perspective, which proposes that resource immobility guarantees that it is the firm rather than the resource owner who appropriates the returns derived from possession of the key resources that determine competitive success. Positive information and transaction costs are seen to play a key role in erecting ex-ante limits to competition. Uncertainty in this equilibrium context implies causal ambiguity about the factors that influence inter-temporal returns. In practice, the presence of this kind of uncertainty means that resources are often acquired at prices below the net present value of future cash inflows: this is the all-important source of Ricardian rents to the firm. At the same time, there are sizable ex-post limits to competition effected through barriers to imitation and substitution: these limits guarantee the sustainability of competitive advantage.

This emphasis on resource-based capability and competitive advantage appears to be at odds with the emphasis on sharing and collaboration that is found in the literature on knowledge-management, though Stuart (2000) finds that:

> *researchers in the field of strategic management have long understood that competitive advantage depends upon the match between distinctive internal (organizational) capabilities and changing external (environmental) circumstances.*

Indeed, an integrative application of RBV theory (Schilling, 1998) finds no dichotomy:

> *The resource based view of the firm also explains that the heterogeneous distribution of these capabilities* [within both firms and networks] *and absorptive capacity* [ditto] *is what often gives one firm an advantage over another.*

Research by Larson (1992) emphasizes the importance of stable, multidimensional and complex inter-organizational exchange relationships in the development of new products. Specifically, he investigates the importance of these relationships for entrepreneurial and innovative firms. Eisenhardt and Schoonhoven (1996) found that when industries were characterized by emergent technologies, alliances were

beneficial due to the potential for the emergence of synergistic knowledge benefits and risk sharing.

The competency-based framework views core competencies as spanning both specific constellations of business activities and also particular groupings of products. The central organisational competence of any organisation is thus the ability to ensure the coordination of diverse production skills across constellations of technologies. Furthermore, competencies act as a locus of competitiveness, exercising temporal dominance (products are merely the momentary expression of a corporation's core competencies, which are more stable than, evolve more slowly than products themselves), and also span a variety of products. In addition, they operate as a basis for learning by doing (core competencies are an expression of collective learning in the organization and are enhanced through application and shared utilization) (Rumelt, 1994, p. xvi, cited in Lawson, 1999, p. 154).

In contrast to the RBV approach, the core-competencies framework that has developed from earlier work by Edith Penrose (1957) and Alfred Chandler (1962) adopts a more evolutionary rather than a more specifically dynamic approach: one that is similar to that espoused by Nelson and Winter. Here, the emphasis is on disequilibrium and process analysis. In this framework, uncertainty is associated with "disequilibrating" processes of discovery, novelty and surprise. Through processes of search, learning and discovery both creativity and unpredictable forms of novelty are injected into the business environment. Another key feature is the irreversibility and path-dependency of outcomes that are an inevitable expression of organizational learning (Brown and Eisenhardt, 1998), Arthurian returns to scale and cumulative process of competency building.

Over time, managers face expanding opportunity sets and must develop entirely new means, ends, and means-ends structures to accommodate changes in the corporate environment. From a strategic management perspective emphasis is not only placed on the benefits of specialization but also organizational flexibility and responsiveness. Nevertheless, as organisations grow, excess resources often accumulate, affording opportunities for low cost diversification into new areas of activity that will hopefully continue to be congruent with the firm's inherited competency base.

Uncertainty and Risk

Shepherd (1991) notes that inter-firm networks emerge to both facilitate entrepreneurial knowledge flows and also to allow for a reduction in investment risk, especially in innovative endeavours. Research has indicated that most managers, *ceteris paribus*, tend towards risk aversion if possible (Beatty and Zajac, 1994). Managers, confronted with risky or uncertain investment scenarios have available to them a number of strategic alternatives. King (1995) noted that "obviously, diverse portfolios of assets, like portfolios of stocks, can reduce the risk of investment and allow investors greater flexibility". Formal and informal alliance arrangements tend to provide further avenues of technology 'options' within an organisational portfolio, just as formally traded options in the finance market may assist in the reduction of portfolio risk if carefully employed.

Alliance arrangements may be categorised as a positive way of minimising the organisational downside of commitment to a particular emergent technological or market paradigm. Other options available may be to wait until the technological, market and competitive environment becomes more clear, though this may be at the expense of early-mover advantages that are a vital component of strategic success in new ventures.

Portfolio-based risk management techniques help to reduce risk *within* a technological system (broadly defined). For example, developing alliances with the proponents of competitive standards developers may assist a firm in escaping from being "locked-out" of an emergent technological paradigm. Portfolio approaches, though, evidently do not protect firms from contractions across entire industry sectors or other problematic exogenous environmental factors – indeed the costs associated with the various alliance arrangements may over-extend firms and limit their capacity to reduce their exposure to a given set of commitments when such a strategy may be warranted. These inherent costs have many causes, not the least the potential for opportunistic knowledge flows within and between value chains that may have deleterious effects on the value of firm knowledge stocks (Matusik and Hill, 1998). Effective coordination may also be difficult to achieve and costly (Gulati and Singh, 1998), especially in contrast to traditional hierarchies.

In periods of industrial contraction, the costs of alliance formation and maintenance tend to more than counterbalance any benefits flowing from the alliance. Slowing

expenditure on research and development may support a more defensive posture by managers with regards to knowledge sharing. Furthermore, the slowing investment may slow the processes of technological commercialisation, adding further pressure on firms to withdraw of re-assess their participation in alliances.

Network Dynamics

Gulati, Nohria and Zaheer (2000) note that while many networks are stable, there is increasing evidence that alliances tend toward dynamism in the presence of changing exogenous and endogenous forces.

The typology adopted by these authors with regards to the causes of network dynamics relate to relational arrangements (lock-in and lock-out constraints, both formal and informal).

Managerial Strategies in Response to Risk, Uncertainty and Contextual Pressures

Gulati, Nohria and Zaheer (2000) note that in extreme cases, undesirable exogenous factors can place pressure fatal on alliance arrangements. Certainly the operational environment within which the firm and alliance operates creates Das and Teng (1998) noted that:

> *Should partners become concerned about potential inequities in profit distribution, for instance, their confidence in and commitment to the alliance most likely would recede, even if the alliances are about to bring positive results*

One could expected that the combination of undesirable exogenous factors creating pressure on potential future profits and a degree of uncertainty about division of profits in new technological applications would create a highly difficult environment for alliances. It is on this note that the case of the Bluetooth consortium is discussed.

Brief Note on Research Methods

The consortium investigated for this research has a fairly open and accessible governance structure, with regular publications of information relating to membership, technical and product innovations and dyadic and network arrangements emerging

within the consortium. Much information from within the consortium has been investigated for this research.

Furthermore, the Bluetooth technology has been a source of frequent analysis in the industry press, and articles relating to the technology have been analysed for this research.

Finally, interviews were undertaken with Product Managers within five leading firms within the consortium, namely Nokia, Ericsson, Toshiba, IBM and Intel.

Tensions and Contractions in the ICT Industry

The munificent economic climate of the mid to late 1990s provided strong impetus for investment and growth in the high-technology industries, especially those related to the information and communication technology (ICT) industries. The amounts of money invested in research and development and product and technological commercialisation was literally unprecedented. In early 1982, the Dow Jones Industrial Average (DJIA) stood at 875 points. The newly established NASDAQ index, an often-used proxy for investment in high-technology firms, was 196 points. At the peak of the global equities “bull-market” in early March 2000, these indices briefly exceeded 12,000 and 5,000 respectively (The Economist, 2001).

Strong equity markets were both a cause and an effect of a strong and dynamic industry that had been marked by growing knowledge creation and dissemination. Much of the industrial dynamics literature that investigated the ICT industries in this period of rapid expansion reflected this operational environment. Growth, driven by strong investment flows and technological innovation, was often an implicit assumption of research in the area. In ICT, technological innovation was strong, as were further social and economic drivers, including:

- Investments in ICT equipment by financial services and other sectors;
- Upgrading of computer hardware by home-users to support the take-up of internet services and;
- Creation of convergence appliances integrating information technology and communications technologies (both hardware and software) delivering valuable solutions-based applications to commercial users.

Like all booms, however, this one was destined to falter. At the close of 2001, while the broadly based DJIA stood at around 10,000, the technology-heavy NASDAQ stood at around 2,000 points, or about 40% of its historical peak. Such numbers belie significant operational and managerial challenges for the ICT industry. The declining fortunes of this sector are creating pressures for cost-reduction and other defensive managerial strategies.

Context of this Research

This research investigates current trends emanating from an ICT technology network – Bluetooth. Bluetooth is a communications standard for short-distance wireless communications, connecting electronic devices such as computers, peripherals and mobile and fixed-line telecommunications devices at speeds up to 1 mbps and distances up to 10 meters.

The technology in its current iteration seeks to remove the need for cabling in office environments, an innovation that will have large benefits for commercial and home users of information technology equipment. Bluetooth in effect creates a piconet around a given user, connecting up to eight compatible appliances within a dynamic and mobile personal network.

Bluetooth utilises the 2.45GHz frequency band has been reserved internationally for unlicensed use for industrial, scientific and medical (ISM) purposes. This frequency of the radio band is well suited for high rate data transmission within a local environment. A number of technologies have emerged that provide peripheral or direct competition for Bluetooth, including the IEEE standard 802.11.

The Organisation of Bluetooth

The Bluetooth standard has been developed and promoted within a semi-cooperative, non-proprietary framework based around open technical specifications (Eneroth and Malm, 2001). Ericsson, the Swedish telecommunications firm, first developed the technological bases of the standard between 1996 and 1997, and an early decision to work with the US firm Intel augured in a commitment to openness and incorporative knowledge sharing. Nokia joined the emerging consortium in 1998.

The driving forces for the commitment to openness can be summarised as follows:

- Competition: Bluetooth was a late entrant in the emerging wireless LAN market, with both proprietary and non-proprietary solutions from the United States and elsewhere emerging at the time;
- Compatibility: An openly available technical protocol was seen to be a strong promoter of device compatibility as applications emerged and;
- Complementarity: None of the businesses involved in the commercialisation of the standard perceived Bluetooth as a core-business activity. Nokia and Ericsson saw the potential for Bluetooth to add value in their core business (mobile telecommunications), while Intel saw the potential of the technology to assist in the networking of office and home computing environments. As such, the technology was complementary to the core businesses of the developer firms.

Toshiba and IBM joined this trio in May 1998 to form the Promoter Group (PG) of the technology. Interest soon emerged from smaller, developer firms in participation and thus a two-tier governance structure emerged, with a Special Interest Group (SIG) developed to allow open membership and dissemination of information, with the PG maintaining control on key issues relating to the standard's technical development. Within three months of formation of SIG there were more than 250 members of the SIG while in December 1999, Microsoft, Motorola, Agere Systems (then Lucent Microelectronics), and 3Com joined the first 5 members of the promoter group.

This research reports findings of interviews undertaken in five member firms of the Bluetooth Promoter Group (PG) in early 2001.

Competition as a Driver of Alliance Formation

The dynamic and competitive nature of the ICT industry serves as a strong driver of research and development investment. Toshiba was a late entrant to the consortium, and the Product Manager at Toshiba was questioned as to whether the presence of IBM in the consortium influenced their decision to join:

> *Yes, it certainly did. At that time IBM was our biggest competitor, and it helped us in making our decision to join the SIG. Not only because they were our competitors, but they had a very strong market position also, and it that time it looked like if two big players from the PC world join the SIG then the*

results could be very good. This is the same like Ericsson and Nokia for example, the two big competitors in the mobile phone industry.

Intellectual Property – Sharing the Knowledge Pie

The decision to make the Bluetooth standard "open" and free of royalties belies a raft of deeper and fundamental issues relating to the ownership of intellectual property. This was well illustrated in the rather prosaic area of ownership of the Bluetooth "brand" and runic character that represents Bluetooth.

Bluetooth had been created by Ericsson and Intel, and Ericsson made an early strategic decision to own both the figure mark and the brand name (together called the "combination mark").

Later entrants, including Nokia, had problems with the proprietary control proposed by Ericsson vis-à-vis the combination mark. Sami Inkinen of Nokia commented on the issue from the Nokia perspective:

Of course there are some areas where we could have put more effort in the beginning, rather than doing some corrective actions later on. A good example of this is the Bluetooth brand issue. Had we realised the importance of this issue in the beginning and formed a legal entity right away, then we could have avoided the entire hassle within the SIG at this stage.

Anders Edlund, the Bluetooth Product Manager at Ericsson, recounted in an interview conducted for this research that many firms within both the SIG and the PG found this problematic:

Some promoter companies wanted to transfer the brand name and the figure mark from Ericsson to the SIG, which was highly unacceptable to us, because of not only political reasons, but also sentimental reasons. After long discussions within Ericsson, we decided that it is in the best interest of all of us that the brand is transferred to the SIG, once the SIG is incorporated. We could see that if the brand is not transferred then the SIG might fall apart, and all the work done so far will go down the drain, and no one wanted that to happen.

The assertion that the SIG's entire future rested on such a decision (when Ericsson had made few plans or claims for royalties for IP and none for the brand name), leads one to question how more fundamental issues relating to patentable IP have been handled.

Recent arrangements between Ericsson and Intel go further to illustrate the problems with the proposed IP arrangements. In December, 2001, Ericsson and Intel entered into an exclusive arrangement to share both software and hardware IP related to the Ericsson Bluetooth "Host Stack". Such strategies seem to be logical rent-seeking from the scarce resource of a Bluetooth application module that actually works, though somewhat at odds with a true commitment to knowledge sharing.

The response by the Product Manager of IBM interviewed for this paper when asked about IBM's approach to IP management in the alliance serves to further illustrate this issue:

> *In the past IBM has never participated in an open IP pool, because in an open IP all your IPs are thrown in the IP pool. The way we got through this was:*
>
> - *We narrowed the scope of the specification, and*
> - *We added an escape clause in the contract, which says that once the specification is at the 0.9 level, there will be an IPR review where we can decide whether we want to throw the IP in the IP pool or do we withdraw from the SIG.*

Such strategies at the governance level have seemingly delayed rather than solved issues relating to IP. It seems clear that as products move towards commercialisation, claims and counter claims as to ownership of IP will increase.

Trends thus far within the SIG with regards to IP have seen patents granted in the areas of development and test kits, software and application profiles and hardware modules. In future, it could be expected that firms move to patent applications incorporating Bluetooth technology, changing the spirit if not the letter of the free IP environment.

The flip-side of this analysis is that firms will only be concerned with Bluetooth IP if the technology becomes viable and successful. While it is not the intention of this paper to analyse the technological success of the technology and the progress of

application development, all of these factors will combine to make the IP debates of central importance to the consortium in the future.

Interoperability – Creating Network Economies

Bluetooth, as a technology, has had a few notable teething problems. Some problems were expected – for example, Bluetooth employs spectrum that is not licensed (as opposed to GSM telephony or terrestrial television), so there is the problems of "bumping" between Bluetooth signals and others, like those emerging from hands-free telephones. Other problems were expected, though have proved to be more complex.

The Bluetooth standard was formulated at a time when data flows within IT networks were rather sedate in comparison to today's and the future's potential needs. Theoretically, Bluetooth can operate at 1 Mbps (One million bits per second). In reality, the operational capacity is between one tenth and one quarter of this rate. In comparison, the competitive technology IEEE 802.11b supports a theoretical transfer rate of 54 Mbps. Bluetooth, under its current specifications (which will not change), will never be able to handle video-on-demand data streaming, for example, nor a host of other emergent applications.

There is also a need to achieve functioning integration between Bluetooth devices. The entire system is based upon the expectation that all Bluetooth devices will operate together. In reality, this may not always be the case as different application profiles have emerged, even in the early stages of the technology's development. A problem that may emerge might be the Balcanization of the technology into competing paradigms. While perhaps overstating the potential for this problem, questions relating to functional interoperability are of central importance to the technology's future.

This latter issue drives the interconnected consideration of network efficiencies related to users' returns to scale and manufacturers economies of scale. Bluetooth devices do not operate alone, and true functionality for users only emerges as appliances utilising the technology proliferate.

Metcalfe's law notes that a network's value emerges as a square of its size, or users. At the time of writing, very few practical Bluetooth applications were in existence, though many indications point to this changing in the future.

Many supporters within the consortium argue that progress has been steady and strong in the development and commercialisation of the product. A manager within Ericsson noted in an interview for this research in response to a question as to when products will emerge:

> *Yes I still say soon, because if you think about it then USB took nearly 5 years to reach the stage where we have reached in 3 yrs and that's great, I will say. All the hype that's there in the market regarding Bluetooth was not created by the SIG, it's been created by the market itself. SIG only said what this technology is about and where we are going. It's the fast acceptance by different industries that have created this hype, and that's why people think we are very late with our products, although we are ahead of our schedule.*

Nonetheless, the slow pace of commercialisation has been a source of tension in the consortium. The Product Manager at Toshiba, interviewed for this research, noted:

> *We do have a few products coming in the near future, but they won't be any good until and unless there are lots of other Bluetooth products ot there, such as printers, access points, phones etc.*

He went on to point out that:

> *Now we just want it to happen as soon as possible. We have put in a lot of resources, and now its time we started getting some revenues out of this whole thing.*

The problems faced by Toshiba are replicated across the consortium, though they are exacerbated in smaller firms struggling with limited and contracting research and development budgets. At the early stages of the technology's development, a figure of USD 5 was mentioned as the cost per unit for a workable Bluetooth unit that may be incorporated into electronic devices by the end of 2001.

In reality, costs per unit are much higher than this, and manufacturing scale economies seem elusive and far away.

Conclusions

Bluetooth exists at a fundamentally important time of its product life cycle. The exogenous shock of the technology led stockmarket crash in the United States and elsewhere in 2000 has been shrugged off by many sections of the economy, though this has not been the case in the ICT industry.

Bluetooth's immediate future is assured by the sunk-costs of firms, large and small, who have products close to commercialisation. The eventual future success or failure of the technology rests in the hands of consumers.

Many of the projections for future profits and growth of the ICT industry while Bluetooth was in development were illusory. This has been clearly illustrated in the decline and occasional collapse of firms manufacturing and operating telecommunications equipment. It remains to be seen whether Bluetooth will ever recoup the costs involved in its development, and indeed whether it will survive as a technological solution as new and better solutions emerge with greater functionality and lower costs.

These questions relating to Bluetooth will be replicated in future throughout the ICT industry. Product life cycles are shortening and Schumpeterian processes of creative destruction are increasingly being measured in months and years rather than years and decades. This new reality is of fundamental interest across the economy, though nowhere is it better illustrated than in the study of the dynamics of inter-firm networks like Bluetooth.

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