Free-Ridership in the Standards-Setting Process: The Case of 10BaseT

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Abstract

In many cases, standards have public goods attributes. As a result, it is important to consider how the development costs are provided. It is well known that public goods, due to their non-exclusionary nature, are subject to free riders. In this paper, we consider free ridership in standardization in general, and examine the case of one standard, IEEE 802.3i (10BaseT) in particular. We show that free-ridership existed in the development of the 10BaseT standard and in the subsequent product market by specifying the criteria for the existence of free-ridership and by providing the necessary data to show that such an issue actually exists. We discuss the consequences of free ridership and consider the implications for the standards development process in general.

1 Introduction

With the increasing importance of standards in the information technology marketplace, it is important to consider the mechanisms by which standards are funded. As part of this, it is necessary to consider the ways in which the costs of standards development are distributed across the “users” of the standard. Kindleberger [8] has made the case for standards as a public good; subsequent authors [4, 9, 5] have briefly discussed the problem of free ridership in connection with standards development. Most economists recognize free-ridership as a significant problem because none of the firms in a large market has an incentive to provide the public or collective goods¹. This paper examines free-ridership in the development of voluntary consensus standards in general

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¹Free ridership earned its name from transit systems where payment is not enforced on a passenger-by-passenger basis (as municipal streetcar systems in Germany often are), where risk-averse passengers pay for the ride (even though their ticket may not be collected), while the more risk-prone passengers may attempt to ride at no charge. Free ridership can lead to market failure, which Bator [1] defines as “the failure of a more or less idealized system of price-market institutions to sustain ‘desirable’ activities or to stop ‘undesirable’ activities.”

and considers the case of the IEEE 802.3i standard (popularly known as the 10BaseT Ethernet standard) as an illustrative example.

In most voluntary consensus IT standards (10BaseT included), the standard can be considered a collective good because all companies that will produce 10BaseT products will benefit from the network externality associated with the market for products conforming to the 10BaseT standard². It is impossible for the developers of the 10BaseT standard to exclude non-developers from benefiting from this externality. If the developers of the standard find that their benefits from developing the standard cannot justify their development costs, then rationally-behaving companies lose their incentive to produce more such standards in the future.

The Institute of Electrical and Electronic Engineers (IEEE) sponsors the development of standards, along with numerous other organizations. The IEEE is a professional society that develops standards to advance the profession; it has been accredited to develop national standards by the American National Standards Institute. Beginning in the early 1980's and continuing to the present, the IEEE Computer Society undertook the development of Local Area Network (LAN) standards in its 802 Committee. This committee was later to become a framework for the development of several specific LAN standards, such as 802.3 for CSMA/CD (Ethernet) and 802.5 for Token Ring.

The IEEE has a standards process that is similar to those used by other standards developing organizations. However, as a user organization that is committed to the advancement of electrical and electronics engineering theory and practice, each member represents his or herself and does not *necessarily* represent their corporate employers, although they frequently do in practice.

2 Free Riders, Public Goods and Standards Development

In this section, we develop the concepts of free ridership and public goods in more detail and apply it to the product development process. We will use these general concepts in subsequent sections to examine the 10BaseT standard in more detail.

2.1 Free Riders

Heyne [6] describes “free-riders” as “people who accept the benefits of a public good without paying their share of the cost of providing those benefits.” In the extreme case, if no one has an incentive to pay the costs of a collective good, then the collective good will not be provided. Thus, many people are worse off because the benefits provided by the collective good will not be provided. However, if a few people pay the costs of a collective good, then everyone will gain from the benefits provided by the collective good. Rational people or firms will make that investment only if the returns on that investment are adequate [10]. If the benefits to a minority are not large enough for them to undertake the investment privately, but the benefits to society as a whole are large, then government may step in and coerce people to contribute through taxes or user fees.

More generally, Olson [10] points out that free-riders disrupt the system of providing public goods by causing a sub-optimal amount of a collective good to be provided. He describes this

²Katz and Shapiro [7] demonstrated that network externalities apply to standards. A network externality is a benefit to users that is based on the existence of compatible products. Classically, users of IBM compatible personal computers benefit from other's ownership of similar machines in the form of cheaper add-in circuit boards and software, as well as a large variety of these products. This stimulates the market, which provides a benefit to the manufacturers as well.

problem as an improper distribution of a public good, *i.e.*, public goods are under-provided because it may not be in the interest of any one company to provide the public good.

2.2 Public Goods

Public goods typically have the property of non-excludability; that is, it is impossible or difficult to exclude people from using the good once it is provided. This is the case with standards. Once a standard is developed, it is effectively in the public domain. In order for the standard to be successful, people have to use it. To facilitate its use, the details of the standard have to be widely available. Under those circumstances, it becomes difficult for the developers of the standard to recover the cost of its development³.

For privately provided public goods, free riders are those firms that take advantage of the public good without contributing to its provision; they must therefore be willing to take the benefits of a public good exactly as it is provided by the developers. They cannot dictate how these benefits will be given or what the nature of the public good will be, so an incentive exists for free riders to participate in providing it.

For standards, we define free riders as those manufacturing firms that develop and subsequently sell products conforming to the standard without having participated actively in its development⁴. In particular, we can define two types of free ridership that can occur in the standards development process. Type 1 free ridership occurs when a firm chooses not to participate in the standards development process in any way and is content to wait until the standard is complete, or nearly complete, before developing products. This type of free ridership is most easily observed in the market because one can simply compare the attendance list of the standards committee with the marketplace participants. A form of free ridership that is more difficult to detect is Type 2 free ridership, where a firm sends representatives to the committee meetings, but only for the purpose of observation and education. They do not participate actively in the process beyond observation. Type 2 free riders are content to allow the other firms to spend their resources to develop the technology, but they wish to stay informed of the process. Effectively, these firms do not care what the outcome of the process is (as long as it works); they wish to be the first to market with products that conform to this standard. Concord Data Systems was a Type 2 free rider in the development of the V.22 and V.32 modem standards [14]⁵

Table 1 summarizes the costs and benefits to standards developing firms and Type 1 free-riders as a result of their respective decisions. Type 2 free riders incur the travel costs but gain advance information about the technical content of the standard. It is clearly rational for a firm to elect

³Weiss and Spring [16] argue that US intellectual property laws provide only weak protection to standards, making recoveries based on intellectual property grounds difficult.

⁴This is a manufacturer-oriented definition is not the only one that could be used. If we were to consider the life cycle of standards, many interested parties, such as users, government agencies, *etc.*, would have to be considered. A manufacturer-oriented definition makes sense for examining 10BaseT because it is a product standard, so it will be adopted here.

⁵The case of Concord Data Systems is particularly interesting because they were the first to market with V.22 *bis* and V.32 modem products. In an interview (July 6, 1993), Ken Miller, then president of Concord Data Systems, confirmed CDS's role in these modem standards as observers of the activity, but pointed out that Concord Data Systems was very active in the development of subsequent enhancements to the V.32 modem standard. This indicates that firms may free ride on some standards and not on others, depending on the strategic importance of the standard to the firm.

	Developers	Free Riders
Costs	Travel, Lodging, and Meals	Losses due to later market entry
	Salary of standards delegates associated with meeting participation	Additional costs to create a more innovative product than the early market entrants
	Salaries of staff not attending meetings who prepare and evaluate proposals	
	Possibility of losing market share to free riders	
Benefits	Advance notice of product specifications	Savings on the cost of developing a workable standard
	Technological advantages from having preferred technologies adopted, or from detailed understanding of the adopted technologies	Opportunity to examine the market for compatible products as it develops prior to making commitments (Risk mitigation)
	Fees and royalties from the adoption of proprietary technology	

Table 1: Costs and Benefits for Developers and Free Riders

to develop a standard in some cases and to free ride in others, depending on the cost and benefit calculus.

2.3 Costs and Benefits of Free Ridership

Developers (defined as those who are neither Type 1 nor Type 2 free riders) incur the bulk of the costs of the standards development. These companies, along with Type 2 free riders, meet at various locations around the world to develop, discuss, and understand the draft standards. There are both direct and opportunity costs associated with this phase of the standards development life-cycle. The direct costs to the company include travel, lodging, meeting attendance, dues, administrative costs of developing drafts, and salary and time of the standards delegates. The opportunity costs include constraints placed by the standard on product specifications and lost market share to free riders that gain access to the market.

Most firms attend the standards meetings in order to negotiate a direction for the standard that will favor their technical or technological strengths, or their strategic direction. Weiss and Sirbu [15] consider the dilemma that negotiators within the standards meetings face. Often, several proprietary technical components are offered as alternatives in developing a standard, each component may favor a different firm. In this case, the costs and benefits for each of the different options must be considered before making a decision about which alternative to choose. The lowest cost option may not always be the best option.

The firms developing a voluntary consensus standard incur many of the same costs as the firm that develops an internal standard. Toth [12] breaks down the internal standards development costs into investment costs, running costs, and revision costs. Investment costs include: establishing consensus, publishing drafts, distributing drafts, announcing the new standard, and holding

seminars on the new standard. Running costs include: interpreting standards details, advising on applications, developing additional sources of supply, resolving problems between suppliers and manufacturing management, monitoring technological changes, and keeping current with new technologies. Revision costs include: incorporating all corrections into the standard, adding size materials, making changes, and updating references to other standards. Toth also considers the following tangible costs of an internal standards development process: documenting the standards action, monitoring and participating in the external standards, and increasing the marginal costs of each unit to cover the costs of standards development.

Another important cost incurred by many standards developing companies is the salary and the time of the standards delegate. Many companies hire standards engineers to work full-time on developing standards, but other companies send their senior engineers to the standards meetings to negotiate on their behalf. The company must send senior engineers to the standards meetings because many of the discussions tend to be highly technical, and a non-technical delegate may not be as effective in negotiating for the company. In addition to paying the salary of the senior engineer.

Opportunity Costs to Developers Another important cost of standardization is the loss of opportunity to produce new and innovative products. David [4] states that one of the opportunity costs incurred when developing a universal standard is the possible stifling of innovative processes and new approaches to problem solving. Standardization does not remove all innovation from products since each product still contains differentiation and value-added features that make the product distinctive. Since most of the design work is completed after a universal standard has been developed, the research and development activities of a firm that implements the standard would focus on incremental modifications for value-added product features, but would not produce radically new solutions for solving the same problem. Toth [12] details some of the specific ways in which research and development activities may fail to provide innovative solutions: freedom of choice constraints, restriction of design innovations, constraints placed by single solutions to different problems, differentiation loss in products.

Benefits to Developers Active developers can lobby for technologies that are favorable to them [15], which can give a production advantage in the near term. This can also result in royalties and licensing fees if patented or copyrighted technologies are included in the standard [16].

The advanced notice of product specifications is a benefit to both the vendors and users of a technology. This allows for early market entry and the opportunity to profit from leading edge users. This advantage disappears with Type 2 free riders.

Costs to Free-Riders Type 1 free riders are not concerned with direct costs because they do not pay to develop the standard. Instead, they simply purchase the standard, which define important aspects of the product, and develop their product. Sometimes, these companies can add innovative features and at the same time remain within specifications of the standard. Thus, they achieve both compatibility and added value to produce a product that could be superior the original manufacturers' (*i.e.*, the developers').

That Type 1 free riders have to catch up with early products (from the standard's developers) is an opportunity cost to them. This opportunity cost could be high with very little payback

depending on the size of the market and the time that it takes the free riders to enter the market. The costs include time and money and may include additional research and development costs to create a product that is more innovative or less costly than the earlier products.

Benefits to Free Riders The primary benefit gained by the free-riders is the cost savings avoiding the standards development process. As we will show, this can be a significant cost savings (depending on the level involvement). Another important benefit to the free-riding companies is reducing the risk of losing money by developing products for an “orphaned” technology. Free-riding companies reduce this risk because they are able to observe the viability and dynamics of the market prior to entering it. Developers have made an implicit commitment to produce products before the market exists, hence they assume a greater risk.

2.4 Social Costs and Benefits of Free Ridership

To this point, we have assumed that free ridership is undesirable. The argument in support of this case can be summarized as follows:

1. Firms invest privately to provide a public good.
2. If free ridership is a problem, firms may choose to under-invest in standards because they are giving their free riding competitors a cost advantage in the subsequent market for compatible products (especially Type II free riders).
3. This is socially undesirable, because standards are a necessary infrastructure for information systems.
4. Underinvestment in voluntary consensus standards would be accompanied by an increased investment in de facto standards for those interfaces that need to be standardized based on their inherent characteristics.
5. De facto standards often result in a market rivalry between competing technologies. In principle, one standard “wins”, leaving those manufacturers and users that backed losing standards worse off, because they are forced to switch.

This argument does not capture the true social costs of developing a standard. It is well known in political theory that divergent preferences result in either unstable outcomes (that is, the group’s decision depends on the voting dynamics instead of a well defined collective preference) or costly consensus (that is, it requires more time and, perhaps, more concessions on the part of the winning coalition to achieve consensus). Thus, by staying away from the committee, Type I free riders may actually contribute to a standard, in that it might be achieved more quickly or with fewer compromises. Type II free riders generally do not taking an active position in the committee debate. If their interest lies more in achieving a standard, regardless of the technical content, then they are more likely to vote with the majority, since a vote with the majority would meet their objective. Minority positions might be abandoned more quickly in the presence of a large alternative majority, which can accelerate the development of the standard. Consequently, Type II free riders can contribute to the completion of the standard under some circumstances by amplifying the size of the majority, much as the Electoral College votes in US Presidential elections

amplifies the difference in the popular vote, and, free ridership in general can contribute to the development of a widely accepted standard in an indirect way.

3 Free Riders and the 10BaseT Standard

As we discussed above, Type 1 free-ridership exists when there is at least one 10BaseT product manufacturer who did not attend committee meetings. Although this is the coarsest form of measurement of free ridership, it is also the most easily measured. If there are more 10BaseT product manufacturers than there are standard developing companies, then Type 1 free-ridership exists in the market for 10BaseT products. The next question that pragmatic policy analysts would ask is whether the problem is significant. This is more difficult, relying on arbitrary thresholds such as market share percentages.

3.1 Type 1 Free Ridership

In identifying the existence of Type 1 free ridership, Toyofuku [13] found 245 companies listed in the Computer Select “Hardware Specifications” database that sell 10BaseT products in 1992. He calculated the number of firms based on a list of the working group members (published with the IEEE 802.3 10BaseT standard) and the 1989 and 1990 IEEE Membership Directories (needed to identify the employers of the participants⁶). From this data, he estimated that 71 companies sponsored their employees attendance at the IEEE 10BaseT task force meetings. The number of companies that are currently producing 10BaseT products is much larger than the number of companies that helped develop the 10BaseT standard by sending delegates to the 10BaseT standard meetings. Therefore, we conclude that Type 1 free-ridership exists.

3.2 The Significance of Type 1 Free Ridership

This opens the question of the significance of Type 1 free ridership to standards developers. We define significance as impacting the future standards development activities; that is, if free ridership is significant, one or more developers would alter their participation in the development of future standards because they do not receive sufficient returns on their investment in developing the standard. Since this is difficult to measure without inside information, we propose that any of the following criteria could be used to empirically determine whether free ridership is a significant issue:

1. *When there are more companies who are free-riding than those who helped develop the standard.* This is simple, but it is not obvious that it is a reasonable criterion, because it is not weighted by sales. If the developers were in the minority, but sold the majority of products, then the developers would likely not consider the free ridership a problem.

⁶Being a professional organization, the IEEE develops standards to advance the profession, and lists the working group members, and not their employers, hence the need for cross-referencing the working group membership. This assumed that the working group members represented their employers, which need not be the case in reality. Toyofuku’s [13] list of companies was confirmed by a document from Ms. Pat Thaler, then Chairperson of the 10BaseT working group and currently Chair of the IEEE 802.3 committee.

2. *When the free-riding companies take up a significant portion of the market (above a certain threshold level, say 20%).* This measure solves the problem of the unweighted criterion, but it remains a gross measure that might be felt by the developers as a group but not individually. Since the decision to participate is made individually (not collectively) by firms, it is not clear that this measure is particularly useful. The threshold level of 20% is arbitrary, but could be refined based on further empirical studies.
3. *When a major player in the market (one company with a market share greater than a certain threshold, say 10%) did not participate in the development of the standard.* This is similar in many respects to the foregoing measure in that it addresses the group of developers as a whole. Instead of aggregating the free riders, it considers only the most successful free rider. This criterion suffers from the same problems as the previous one.
4. *When the combined market share for all free riders exceeds the market share of a developer.* This measure is more refined than the others, since it attempts to consider the impact felt by a single firm that participated in the development of the standard. Here, the free riders are aggregated and compared to one developer. A single firm may not directly perceive this because their competition is potentially dispersed across many firms. Since they are not consistently losing business to one competitor, free ridership may not appear as significant as it really is. This measure also has the advantage of not being tied to an arbitrary threshold.
5. *When the market share of a free rider exceeds the market share of a developer.* This criterion has the advantages of the previous one, except that the free riders are considered individually, not in aggregate. Thus, it might be the best measure of benefits lost. It is also the most stringent of the criteria considered here.

With each of these criteria, the time of measurement is important, and the type of standard may be important. Time of measurement is important because a firm can easily consider the investment in developing a standard as any other type of investment: it must have a benefit that exceeds their internal rate of return, otherwise it is not an economic investment. This return would be calculated over some period, but would most likely be in the early phases of the product market⁷. Thus, it may be less of an issue that free riders dominate a market 5 years after a standard was developed than if a free rider dominates the market immediately after the standard was approved. In the former case, the developers would likely perceive that they have earned an adequate return on their investment in the development of the standard so they are not concerned with free riders. In the latter case, the free ridership is more critical, because one of the important benefits to participation is an early marketplace advantage.

The type of standard is also important. The 10BaseT standard could be considered a "product" standard, along with modem standards, personal computer standards, *etc.* in that it is geared toward defining the essential features of a product in a market. Other standard, such as the OSI

⁷While this need not be the case, a firm that actively develops a standard probably has a near term application for the standard. If they did not, then either their participation was not rational, or it was made for strategic reasons. For a product standard like 10BaseT, it is likely that the near term market potential drove the development of the standard, not the strategic ones. For other standards, such as ISDN and OSI protocols, the strategic factors probably dominated, particularly as the markets for these products remain weak despite intensive development over long periods of time.

standards and ISDN standards have been considered “anticipatory” standards [3] in that they were developed well in advance of a product market, or that could not be defined by a single consumer product (like a NIC or hub). Free ridership in anticipatory standards may be measured by different significance criteria than for product standards. The criteria above are focussed on product standards.

Toyofuku [13] collected 1991 market share data⁸ for 10BaseT Ethernet hubs and network interface cards (NIC), the two critical components of a 10BaseT network⁹ (the structure of a 10BaseT network is shown in Figure 1). He found that Cabletron and SynOptics were clearly the leaders in the market for hubs with a 25% and 23% stake, respectively. Hewlett-Packard also captured a significant portion of the hub market with an 8% share. In the NIC market, the leaders were 3Com, Racal-Datcom, and SMC with a 22%, 21%, and 12% stake in the market, respectively. Also significant is the market share captured by the “other” manufacturers. Manufacturers of Ethernet hubs listed as “other” captured 44% of the market, while the market share of manufacturers of ethernet network interface cards listed as “other” was 45%. Unfortunately, more precise data were not available.

Figure 1: Structure of 10BaseT Networks

Toyofuku [13] interviewed Pat Thaler, the chair of the 10BaseT Task Force during the development of the standard, to identify the level of involvement in the standard by the major players in the 10BaseT market. Ms. Thaler stated that 3Com, Standard Microsystems Corporation (SMC)¹⁰, Racal-Datcom, Cabletron, SynOptics, and Hewlett-Packard were present for all

⁸Based on research by International Data Corporation, Framingham, Mass.

⁹The 10BaseT standard was officially approved by the IEEE 802 committee in the fall of 1989, so this data is based on the market two years following the approval of the standard. Note that several manufacturers were manufacturing products designed to draft specifications prior to the approval of the standard, so it is difficult to establish realistic date for the start of the market.

¹⁰Actually, Standard Microsystem Corporation (SMC) did not directly help to pay for the development of the 10BaseT standard. SMC acquired Western Digital’s NIC operations, which has been the primary reason for the increased market share in the NIC market. Western Digital was heavily involved in the development of the 10BaseT standard.

of the meetings. However, she noted that 3Com, SMC, and Racal-Datcom tended to be “back seat players” compared to the “active players” (AT&T, National Semiconductor, and AMD) that frequently presented their ideas on how the standard should be developed.

All of the major players in the 10BaseT market, including 3Com, Racal-Datcom, Standard Microsystems Corporation, Cabletron, SynOptics, and Hewlett-Packard, attended the 10BaseT standard meetings. However, even though the major players were all involved in the development of the 10BaseT standard, it is possible that some of the significance criteria discussed above apply. As noted, there is approximately a 45% market share of “other manufacturers” and there were only 71 companies that attended the 10BaseT meetings. Thus, there are 171 “free-riding” companies that captured part of the 45% market share of “Other” companies.

Note that National Semiconductor and AMD, two of the key developers cited by Ms. Thaler, are both primarily producers of integrated circuits¹¹. Thus, a more complete analysis of free ridership should consider the factor market, that is, as suppliers of specialized integrated circuits to NIC and hub manufacturers as well. The data on the use of specialized IC’s by NIC and hub manufacturers was not available, and so is not included in this paper.

It is worthwhile to consider the extent to which the significance criteria apply in this case. Clearly Criterion 1 applies, but that has the difficulties discussed above. Criteria 2 and 3 may apply, depending on the thresholds selected. It is possible to estimate significance based on Criterion 4 given the available data. This can be done by making the simplifying assumption that, on average, all of the “Other” companies had equal market shares¹². Since there were 245 companies selling 10BaseT hubs and network interface cards¹³ there were 239 “Other” companies ($245 - 3 - 3$), that make up the other 45% of the market not occupied by the market leaders¹⁴. Under the uniform market share assumption, each of these vendors had a 0.2% share of the market ($45\%/239$)¹⁵. The percentage of the market that belonged to the free riders can be determined by calculating the market share of the developers and subtracting that from the 45% market share of “Other” companies. The market share of the developers is the market share for each of the “Other” companies (0.2%) multiplied by the number of developers, excluding the major players for both the hub and the network interface card market ($71 - 3 - 3 = 65$). Thus, the “Other” market share attributable to developers (under the uniform market share assumption) is 13% ($65 * 0.2\%$). It follows that the market share of free riders, with the assumptions listed above, is 32% ($45\%/13\%$). Since this 32% market share was greater than the market share of any major player selling 10BaseT products in 1991 (two years after the approval of the standard), the free ridership was significant by Criterion 4 as well.

¹¹Hewlett-Packard and AT&T also have significant IC production capability. It is not known whether they use their own ICs in their products, or whether they use AMD’s or National Semiconductor’s.

¹²This assumption is somewhat problematic in that it might be more reasonable to assume that the market shares are, in fact, exponentially decreasing. If they are exponentially decreasing, it becomes important to know what the rate of decrease is (*i.e.*, the exponent) and where the participants and free riders are positioned with respect to each other. Lacking these data, we simply make the uniform assumptions.

¹³The Computer Select database actually lists the number of *vendors* of products. Some of these vendors might have Original Equipment Manufacturer (OEM) relationships with manufacturers of NICs or hubs, so the number of actual manufacturers might well be lower. The available data are not sufficiently detailed to allow this distinction, so we will assume that all 245 vendors are actually manufacturers.

¹⁴For both NICs and hubs, the market share of “other” manufacturers was about 45%, so we lump them together.

¹⁵Actually, each company may have a larger market share since some companies may only manufacture network interface cards and other companies may only manufacture hubs.

3.3 The Development Cost of 10BaseT

Another estimate which can be calculated is the total cost of developing the standard. The tangible cost, which actually underestimates the total cost, can be broken down into travel costs and engineering costs. In an interview, Mr. Don Loughry¹⁶ (then chairman of the 802.3 committee and now chairman of the 802 committee) stated that the 10BaseT standard took 24 meetings to develop, most of which took place in the US (two or three meetings took place in Europe), and that each meeting was attended by 50 to 75 people.

According to the survey reported by Toyofuku [13], the least amount spent for travel and lodging by any of the companies responding to a survey mailed to 10BaseT members was \$4200 (for three people to attend one meeting) and the highest amount spent by one company was \$42,000 (for one person to attend six meetings). From the limited results of this survey, we estimated that a US based meeting would cost an average of \$1500 for travel and lodging per attendee. The time of the employee and their development team must still be accounted for to obtain a reasonable cost estimate.

To estimate the salary of the engineer an hourly wage must first be determined. We begin by assuming that a typical engineer earns an annual salary of \$80,000 (for an hourly wage of approximately \$40). Since benefits and overhead must be included in addition to this salary, we use an hourly wage estimate of \$80. The survey indicated that a typical company representative would spend 72 hours of time in connection with one 10BaseT standards meeting, which means the total cost of the representative's time in connection with the standards meeting was $\$80 * 72 \text{ hours} = \5760 .

Thus, the total cost per meeting per representative was \$7260. Given that each meeting had 50 to 75 attendees, the total cost per meeting can be estimated to lie between \$363,000 and \$545,000. Since there were 24 meetings, the total cost of developing the 10BaseT standard was between \$8.7 million and \$13 million. Thus, the *average* company spent between \$125,000 and \$185,000 to support the development of 10BaseT. The companies that actually did much of the development work (AT&T, National Semiconductor, and AMD, according to Pat Thaler) probably spent much more than this, and the Type 2 free riders probably spent less than this. If we assume that Type 2 free riders that intended to build 10BaseT products would wish to attend every meeting to stay informed, but would minimize their costs by sending only one person, the total expenditure for these firms would be approximately \$174,000.

4 Discussion

The results presented here suggest the need to consider issues of equity in funding the standards development process. Clearly, a minority of the firms are spending significant sums to support the development of standards. As long as these developers perceive benefits to their investment in standards development, then free ridership will not be a problem. The funding question was taken up in more detail by Spring and Weiss [11].

The data presented here indicate that free ridership could escalate into a problem, since the free riders collectively had a market share larger than one of the developers. A potentially larger problem appears to be Type 2 free riders – those who attend meetings but do not actively contribute

¹⁶Personal Communication, April 20, 1993.

to the content of the standard. While developers have an advantage over Type 1 free riders in that they have early and detailed knowledge of the standard, they do not have this advantage over Type 2 free riders. The only remaining advantage they have could be in having technology favorable to them adopted in the standard and by possibly being able to collect royalties and licensing fees. These advantages may be weaker than their marketplace advantage over Type 1 free riders¹⁷.

So how should the standards process be funded? While a detailed analysis of this complex question is outside of the scope of this paper, we can suggest that more equitable approaches might exist. For example, one can imagine a fee levied on all products that is used to reimburse the developers for at least a fraction of their investment¹⁸. This will encourage developers to be more active in the standards development process than they currently are because their monetary benefits would be enhanced. One can imagine that ANSI have professional standards developers, along the model used by the European Telecommunications Standards Institute (ETSI) [2]. One can imagine a more prominent role for government as well.

5 Conclusion and Future Research

Type 1 free ridership in the market for 10BaseT products was established by comparing the number of companies that are producing 10BaseT products with the number of companies that helped to pay for the development of the standard by sending delegates to the standard meetings. However, it is still uncertain whether this issue of free-ridership is a serious problem. All of the companies with significant market share in the 10BaseT market of hubs and network interface cards were involved in the development of the 10BaseT standard so we might conclude that the free-ridership issue is not a serious problem (based on Criterion 1). Yet our calculations show that the total market share captured by all “free-riders” as a group dominated the market share of any single firm, including the market leader (Significance Criterion 4). While this criterion is not the best available for assessing the significance of free ridership, it does indicate that free ridership may be a significant problem so that the developers of the 10BaseT standard might be deterred from actively participating in standards development in the future. The response to Toyofuku’s (1993) survey was inadequate to determine whether this was actually the case among the developers. Better empirical results could be obtained if more detailed market share data were available over time, and if the participation patterns of the developers could be observed in post-10BaseT standards committees.

Identifying Type 2 free ridership is more difficult *ex post*. There is some evidence, based on the interview with the 10BaseT task force chair, that it was present among the marketplace leaders – that is, that some of the leaders did not participate actively in the development. Further analysis is necessary to determine the extent of Type 2 free ridership and its significance.

¹⁷For product standards like 10BaseT, much of the technological advantage lies in the ability to produce NICs and hubs at low cost or with value-added features. Much of the technical details of the standard, especially in this case, is contained in relatively standard integrated circuits, which explains the prominent role of AMD, a chip manufacturer, in 10BaseT. Firms whose patented or copyrighted technology is incorporated into a standard are obliged to license freely and fairly, implying that this effort would not be undertaken as a way to increase royalty revenue.

¹⁸The question then becomes what fraction is reasonable and on what basis?

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