Standard Based Monopolies and Near Monopolies: The WinTel Example

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Abstract

Standard-based monopolies and near monopolies are based on control of de facto industry standards. Usually the monopolist's product or service is a component of or comprises a network whose many components must work together to produce a useful result. Standardization of the components is required for the network to function. In such situations, customers may become locked into the network that they participate in. Even if a competing network exists, there is substantial cost and practical obstacles to converting to the competing network of products, services, and associated standards. A near monopolist can charge more than its costs and earn monopoly profits due to lock-in. Control of the de facto standards is often achieved and maintained through frequent arbitrary changes to the standards, usually marketed as technological innovation. Intellectual property rights such as patents may also be exploited. Microsoft and Intel are prominent current examples of near monopolies based on control of de facto standards.

Introduction

A monopoly is a single seller. A monopoly can earn monopoly profits because customers must either buy the product or service at the price set by the monopoly or not buy at all. In a market with many sellers, competition drives the price of a product or service down to the cost of the seller. With a single seller, the seller can charge a higher price than costs. The seller cannot charge any price because at some point the customers will simply not buy the product or service.

True monopolies are rare. Near monopolies are more common. An example of a near monopoly would be a single gas station in an isolated rural town. The nearest gas station is sixty miles away. In this situation, customers could drive to the nearest gas station. As a practical matter, the time and cost of the drive limits this choice. In this situation, the single gas station can and probably will charge a higher price for gasoline than its cost. The near monopoly can earn monopoly profits.

Monopolies and near monopolies can be based on several things. A common situation is exclusive control over a scarce resource. At the turn of the century, nearly all of the world's copper, used for copper wiring in electrical systems, came from Butte, Montana. The Anaconda Corporation gained complete control over all copper mines in the Butte, Montana area, establishing a worldwide monopoly on copper production. Quite a number of the trusts of this era secured physical control over a scarce resource. Another form of monopoly is based on a patent that grants exclusive rights to sell an invention for a period of time. Many pharmaceutical companies benefit from this type of monopoly.

Standard-based Monopoly

Another type of monopoly is a standard-based monopoly, a monopoly based on control of a de facto industry standard. Microsoft and Intel, sometimes jointly called WinTel, are examples of near monopolies based on control of de facto industry standards. Standard based monopolies require a combination of two factors. First there must be increasing returns for adoption of the standardized product or service in the market creating a strong financial reason for establishing a standard. Second there must be barriers preventing competitors from producing or marketing products or services conforming to the standard.

Increasing returns for adoption means that the value of a product or service increases with the number of customers buying or using it. This usually occurs when the product or service is part of a *network* of components that must work together to deliver a useful result. A simple example is a telephone service. A telephone service with a single subscriber has no value. The more subscribers to a telephone service, the more valuable the telephone service is to the subscribers. This creates a strong incentive for standardization of telecommunications technologies, products, and services. This situation is also known as a *network effect*.

There is considerable arbitrariness in a telephone system. Different electrical connectors may be selected for combining physical components, for example the telephone plug in the wall. The voice signals may be carried by different electrical signals. While there may be technical reasons for preferring one kind of connector over another, the most important requirement is that the many different parts of the telephone system must work together successfully. This is accomplished by standardizing the components, signals, and so forth.

By itself increasing returns for adoption does not guarantee monopoly profits. If other companies can enter the market and successfully produce and market products or services conforming to the market standard competition will eliminate any monopoly profits. Monopoly profits require a barrier or barriers to entry. A simple example of a barrier to entry is a patent on a key enabling technology for the standard controlled by the monopolist.

The most common barriers to entry are technical difficulties in implementation of the standard, a situation where the monopolist knows more about successfully implementing the standard than potential competitors. This works best if the standard is based on a fragile technology where small errors in implementation have catastrophic consequences. A system that is irreducibly complex is an example. An irreducibly complex system is a system with many parts in which removal of any part or even small modification of any part results in catastrophic failure of the system. A potential competitor must exactly duplicate the standardized product or service to compete effectively.

Technologies can be fragile by design as well as happenstance. Some devices such as locks and keys are deliberately fragile. A key must exactly fit a lock. A small error in construction of the key and the lock will not open. Similarly encryption procedures are designed so that the complementary decryption procedure must be executed exactly or decryption fails.

Additional barriers to competition are legal barriers, usually intellectual property rights: patents, copyrights, trademarks, and trade secrets. Key enabling technologies used in the standard may be patented. Specifications for the standard and other descriptive documents may be copyrighted. The name and logo of the standard may be trademarked. Critical knowledge about implementing the standard may be protected as a trade secret. Typically, a monopolist will try to exploit all forms of intellectual property.

The ideal situation for a monopolist is to have both patents on key enabling technology required to implement the standard and technical barriers to implementing the standard even if there were no patent. Potential competitors must either find a way to circumvent the patents or license the patented technology from the monopolist. A problem with patents in the United States is that a patent must provide a complete and thorough description of the invention. Technical barriers to implementing the technology, on the other hand, can be secret, may be undocumented or difficult to document, may be passed along only by word of mouth from engineer to engineer, and may be acquired only through direct experience.

Standards with strong barriers to producing products or services conforming to the standard are *closed standards*. Standards for which it is easy to produce conforming products or services are *open standards*.

Standards need not be monopolies or near-monopolies. Standards can be open standards. Traditional paper technologies for office and other tasks provide numerous examples of open standards. For example, in the United States, most paper is standardized to a size of 8 ½" by 11". This has important consequences. Since all documents are 8 ½" by 11", they can be stacked neatly on top of one another. File folders and filing cabinets are designed to hold 8 ½" by 11" documents. Envelopes are standardized to hold 8 ½" by 11" letters. Printers, copiers, and typewriters are all standardized to efficiently handle this size of paper. It is easier to store and share documents because they all use a standard size and shape. Significantly changing the size and shape of paper from 8 ½" by 11" would force massive retooling of offices: new cabinets, new folders, and new

equipment. This standard is an open standard. Any company can manufacture paper of this size.

Why Closed Standards and Standard Based Monopolies Exist

Naively customers should adopt open standards in preference to closed standards. However, closed standards are common.

Open standards are examples of what economists call a *public good*. A public good is a product or service that all customers receive if it is supplied to a single customer. Everyone benefits whether they pay for the public good or not.

A lighthouse is an example of a public good. All ships approaching a port will benefit from the lighthouse whether they pay for it or not. Every ship can see the light from the lighthouse. There is no way to prevent ships from seeing the light.

Public goods tend to be under-produced in a free market economy. In the lighthouse example, the cost of building and maintaining the lighthouse may be greater than its economic value to any one shipping company. In this case, no customer will pay for the lighthouse, even though the economic value to all customers combined may far exceed the cost of the lighthouse. A private business cannot charge each shipping company for the lighthouse because there is no way to prevent the ships from seeing the light.

In the lighthouse example, the city government of the port may impose a tax on all ships using the port to finance a lighthouse. The government can force all beneficiaries to pay for the lighthouse. Lighthouses were frequently built and maintained by government agencies.

If the lighthouse used an "invisible" light that required a special lens to see, a lens that could only be purchased from the lighthouse company, the lighthouse would be what economists call a *private good*. A lighthouse company could make money by selling or renting the lens separately to each ship. If the lighthouse was the only lighthouse for the port, the lighthouse would be a monopoly able to charge more than its costs.

Developing and establishing a standard can be very expensive. Typically a successful standard requires working examples of products or services conforming to the standard, a detailed written specification, and a substantial marketing campaign to get the standard adopted in the market. In some cases, this can cost billions of dollars. With an open standard, all of this activity is essentially given away. No single beneficiary of the standard may benefit enough to cover the cost of developing and establishing the standard. Thus an open standard may never develop despite large economic benefits to the market as a whole.

With a closed standard, the standard developer can recover the costs of developing and establishing the standard. Further, the standard developer can earn monopoly profits and capture most of the economic value of the standardization to the entire market. Because

open standards are public goods and closed standards are private goods, closed standards are much more common than one might expect.

Standard Thrashing

Standard-based monopolies are inherently unstable. The monopoly profits provide a strong incentive for competitors to reverse engineer the standard, bypass any patent protections, or otherwise break the monopoly. In most cases the standard-based monopolist must change – evolve, upgrade, or modify – the standard frequently to insure that only the monopolist can successfully implement the standard. These changes can be completely arbitrary changes to the standard. This process of frequently changing a standard to preserve a monopoly or near-monopoly will be called *standard thrashing* in this paper.

Usually some form of backward compatibility with earlier versions of the standard must be maintained. Otherwise products or services conforming to the new standard will not work with products and services conforming to the old standard. The same network effect that created the standard and the monopoly will prevent adoption of the new standard. Products or services conforming to the new standard will have no competitive advantage over non-standard products and services.

If the product or service wears out or expires, the monopolist can simply discontinue selling products or services conforming to the old standard, selling only products or services conforming to the new standard. Because of the monopoly, the customers have no choice but to adopt the new standard. If the old product or service wears out or expires before competitors can reverse engineer the old standard, the new standard will replace the old standard through ordinary product replacement or service renewal. With products or services like computer software that do not wear out, the situation is more difficult for the monopolist. Customers may have the option of sticking with the product or service conforming to the old standard. The monopolist needs to create a situation where the customers want or have to adopt the new standard.

The new standard needs some feature that is difficult or impossible for products or services conforming to the old standard to exploit. For example, the Intel 80386 CPU chip introduced 32 bit instructions. The 80386 could run programs written for early versions of the chip such as the 80286. However, programs compiled to use the 32 bit instructions would not run on previous versions of the Intel chip. Microsoft has repeatedly released new versions of the Microsoft Word file format that previous versions of the Microsoft Word application could not read. Once the new feature comes into widespread use, segments of the market that have not adopted the new standard come under strong pressure to adopt the new standard in order to work with or communicate effectively with segments of the market that have already adopted the new standard.

In general, the early adopters of a new standard have little economic incentive to adopt the new standard unless it implements a major genuine technological advance. Since everyone else uses the old standard, there is no advantage to adopting a standard not in

use. In such a situation, the standard setter may give away or sell at a loss products or services conforming to the new standard. Once momentum builds up, enough customers have adopted the new standard, the remaining customers, the late adopters, feel economic pressure to adopt the new standard. The late adopters will pay for the new standard, even if it offers no genuine improvement over the previous version of the standard. This is because the late adopters need products or services conforming to the new version of the standard to work with or communicate with the early adopters that are already using the new version of the standard.

In the United States, it is probably illegal under anti-trust laws to modify a standard solely to prevent competition. Even if technically legal, such an action would be politically unpopular and likely to lead to regulation of the market to eliminate the monopoly profits. Further, customers are likely to resist adopting an upgraded standard simply to preserve the monopoly. Thus, standard-based monopolists must present a politically acceptable reason for the frequent changes to the standard. The most popular reason is technological progress. The monopolist claims the changes are technological innovation, improvements to the product or service.

Markets dominated by standard-based monopolies exhibit frequent changes to the standard. Most of these changes are arbitrary and unnecessary. They create a barrier to entry. There is an asymmetry. It is easier to hide information than to find information. The monopolist can easily add many small details and complications to the standard which are much more difficult for potential competitors to understand and duplicate.

In a standard-based monopoly market where the monopoly is preserved through frequent changes to the standard, the pricing of products or services conforming to the standard may be extremely varied. The standard setter may give away or sell products or services cheaply to some customers while charging a high price to others. The giveaways or low price sales are used to seed the market with the changes to the standard. The higher price sales earn the monopoly profits.

Standard Thrashing and Technological Innovation

Pure standard thrashing, where the changes to the standard are completely arbitrary, like a perfect monopoly, is rare. In practice, some technological innovation, genuine improvements to the product or service, are usually incorporated in new versions of a standard.

It is probably illegal under United States law and public policies to change a standard solely to block competition. A technological innovation provides a legitimate reason to change a standard. Regardless of legality, a change solely to preserve or expand a monopoly would be unpopular with customers and the voting public. Technological innovation provides a way to market the new standard to customers and to the voting public.

Technological innovations may be covered by patents, which provides a legal barrier to producing products or services conforming to the new standard. Arbitrary changes to a standard may also be patented if the standard setter can convince the United States Patent and Trademark Office and the Federal courts to accept the changes as patentable innovations. The distinction between an arbitrary change and a new technology is a value judgement.

Genuine technological innovations provide a financial incentive to adopt the new standard. A genuine technological innovation improves the product or service. Even if the improvement is quite small, it encourages adoption of the new standard and replacement of the old standard.

Standard thrashing usually involves some technological innovation. Because of this, it is a matter of *opinion* how many of the changes to the standard are genuine technological innovations and how many are arbitrary changes to block competition.

Intel's introduction of the Single-Edge Cartridge (SEC) and the Slot 1 connector illustrates this overlap between standard thrashing and technological innovation in the real world. In 1997 Intel combined the new Pentium II processor and its Level Two Cache, a special fast memory for frequently accessed data and instructions, on a single printed circuit board, ostensibly to provide faster access to the Level Two cache. The SEC has to plug into the computer motherboard using the Slot 1 connector. The SEC and Slot 1 may be a completely arbitrary change to the hardware interfaces within a computer, but it probably has some small benefits in certain situations. Thus it can be credibly presented as a technological innovation. Intel patented certain technologies used in the SEC and Slot 1 interface. Intel initially refused to license this technology to other companies. While competitors such as Advanced Micro Devices (AMD) could legally make a processor compatible with the instruction set architecture of the new Pentium II, they would have to infringe Intel's patents to duplicate the SEC and Slot 1 mechanical and electrical interface to the motherboard. The United States Federal Trade Commission (FTC) has been scrutinizing this maneuver and Intel has begun to license the interface technology[1].

Genuine technological innovation is highly unpredictable. If a large company invests a billion dollars in genuine research and development to develop patentable new technologies with genuine benefits, the company cannot predict the results of the investment decision. It is hard to know what new technology will be developed, how long it will take to develop and bring to market, how much the new technology will cost, and ultimately how large the revenues and profits will be, even though a patented new technology also offers monopoly profits. In contrast, if the company invests the billion dollars on standard thrashing, on frequent arbitrary changes to a standard, the benefits are much more predictable, specifically preservation of the monopoly, a steady revenue stream, and large predictable profits. Since people are usually risk averse, standard thrashing tends to win out over genuine research and development in investment

[1] *Making Antitrust Fit High Tech*, Susan B. Garland and Andy Reinhardt, Business Week, March 22, 1999, p. 34

decisions. Standard thrashing wins even though both investments can earn monopoly profits, genuine technological innovations have value to society and standard thrashing does not.

Effect on the Job Market

Standard-based monopolies have a profound effect on the engineering job market that is visible in the engineering job market in the United States.

The standard setters who control the standard, the standard-based monopolies, can effectively employ cheap inexperienced labor to implement the many, frequent changes to the standard required to maintain the monopoly. These changes do not reflect particularly difficult or demanding work. There is little or no true invention, creativity, or discovery involved, despite claims to the contrary. Standard setters can and do employ large numbers of inexpensive workers. The skill required to hide information is much less than that required to find the information.

Standard followers are companies or organizations that do not set or control the standard but must use it in some way. Standard followers include customers of products or services conforming to the standard and competitors to the monopolist. Standard followers need employees who understand the standard as it currently exists. If they hire someone who does not know the standard, by the time this unskilled person has learned the standard, the monopolist has changed the standard.

In practice this is a numbers game. The monopolist must change the standard before the large majority of engineers in the market have gained an adequate understanding. If not, these engineers will be employed to create competing products and services, breaking the monopoly. Of course, some engineers will reverse engineer the standard faster due to native intelligence or specialized training. Few barriers to entry are perfect in the real world. The rule of thumb seems to be about three years. The standard must be modified significantly within three years to keep ahead of the great mass of engineers.

In a standard-based monopoly market, the standard followers will not hire inexperienced people as a general rule – at any price. There is a premium in a standard-based monopoly market for current knowledge of the standard. An employee with current knowledge of the standard permits the standard follower to participate in the monopoly profits or to avoid paying the monopolist's prices.

In engineering job markets in the United States, engineers with less than three years of experience in a standardized technology have a difficult time finding work at any pay scale. They are underpaid. Yet engineers with more than three years experience in a specific standardized technology usually seem to find jobs easily and are well paid. More generally, engineers have low salaries early in their careers, the 20's, and then suddenly ramp up to a much higher salary, on average at age 30 although individual engineers reach the high salaries earlier or later. Then there is a near plateau from 30 until about

50, with small real increases in salaries[2]. Why is three years of experience, certainly not a lot, worth so much and twenty additional years of experience worth so little? In a standard-based monopoly market, an engineer with current up to date knowledge of the standard is at a premium. At some point an engineer acquires this sought after knowledge of a monopoly standard and starts to earn a higher salary. Because the standard is frequently changing, the engineer must run to stay in place, constantly learning and reverse engineering the changes that the standard setter makes to the standard. This additional learning has no additional value, hence the salary plateau experienced by most engineers.

How does an engineer acquire the knowledge of the standard? Most often by working for the standard setter for a few years at a low salary. Some engineers work extremely hard and reverse engineer the standard before the standard setter is able to change it. A number of avenues exist. The doorway to acquiring the critical technical knowledge of the standard is small. Thus although some fortunate engineers get a job that teaches them a standard immediately out of school and earn high salaries by age 25, many others bounce around for a while until breaking into the lucrative market for knowledge of a standard. Some give up and seek other employment. As a consequence salary profiles show a sharp ramp up in salary at about 30, not 25.

The job market pays a premium over what would occur in a competitive market for knowledge of the implementation details of the standard, the many peculiarities that the monopolist has put in place to block competition. This knowledge has little to do with the inventive and creative functions often associated with engineering in the public mind.

A standard-based monopoly market usually incorporates an associated job market for engineers and technology experts whose function is to implement the frequent changes in the standard needed to preserve the monopoly. Some, often low paid, work for the standard setter. Some, usually well paid, work for standard followers. Many electronics, computer hardware, computer software, and telecommunications engineers in the United States perform this pointless but lucrative activity.

The engineering job market in the United States suggests that standard-based monopolies and near monopolies are common.

Business at the Speed of Windows

Microsoft and Intel are largely in the business of office tools. For the most part these office tools – spreadsheets, word processors, databases, electronic mail - do not replace office workers. Ostensibly they enhance the productivity of office workers. Most businesses have a number of common functions that historically were handled using people and paper-based technologies. These include order entry, order fulfillment, billing, customer support, technical support, inventory management, payroll, managing employee benefits, accounting and finance, and miscellaneous reporting. Nationwide and worldwide, companies spend hundreds of billions of dollars on these functions. They are

[2] *EE Times Salary Survey (1996, 1997, 1998)*, http://www.eet.com/

sufficiently similar, even identical, from business to business that products and services can be created for this market. Consulting firms have grown up specializing in these processes. Microsoft and Intel target these functions. Many other computer hardware, software, and networking businesses primarily target these functions as well.

Microsoft Product	**Business Application**
Microsoft Word	Reports
Microsoft Excel	Accounting and Finance
Microsoft PowerPoint	Business Presentations
Microsoft Access	This database program can be used for Order Entry, Order Fulfillment, Billing, Customer Support, Technical Support, Inventory Management, Payroll Processing, Managing Employee Benefits, Accounting and Finance
Microsoft Project	Project Management including Cost and Schedule
Microsoft Outlook	Communication (electronic mail), Scheduling, Contact Tracking
Internet Information Server	Business Applications using Worldwide Web Technology
Internet Explorer	Business Applications using Worldwide Web Technology
Windows 3.1, Windows for Workgroups, Windows 95, Windows 98, Windows NT	**No Direct Application.** The operating system is only valuable as a platform to run the applications.

Putting this in dollar terms, Microsoft divided its 1998 revenue figures into two major categories: Platform Products and Applications and Content. Platform Products, which mostly seems to be the Windows operating systems but also includes the server components of several business products such as Microsoft BackOffice, comprised $7.64 billion dollars. Applications and Content seems to be largely business applications, especially Microsoft Office and the various programs that form Microsoft Office (sometimes sold separately). Applications and Content specifically included Microsoft Office for Windows 95, Microsoft Office 97, Microsoft Word, Microsoft Excel, Microsoft PowerPoint, Microsoft Access, Microsoft Outlook messaging and collaboration client, and Microsoft Project[3].

Most businesses mimic military organization. In the military, functions are divided into line and staff. Line functions have the high status. A line officer commands troops or ships that may see combat. Many functions are classified as staff functions, generally functions categorized as support functions. Feeding the troops, which is critical, is a support function. Support functions are deemed somehow inferior, unnecessary, and un-heroic. In companies, the line functions are typically sales and marketing. The line

[3] *Microsoft Annual Report 1998*

functions are seen as directly bringing money into the organization. Most CEO's and top executives have sales and marketing backgrounds. Support functions generally include order entry, order fulfillment, billing, and so forth. These are the activities targeted by the computer industry. These activities obviously consume money, primarily in the salaries of the office workers performing the tasks. They do not directly make sales, though obviously an organization that cannot enter orders or bill customers has serious problems.

Business processes such as order entry, order fulfillment, accounting, and related functions form a communications network. All parts of the communications network must work together. Any business will benefit from standardizing its internal communications network. Adopting an incompatible standard will be expensive. In a worst case, the business's entire communication network must be converted to the new standard.

If different parts of the business's internal communication network conform to incompatible standards, communication between the parts requires expensive conversion from one standard to another. In principal, all else being held the same, conversion to a common standard for the entire business should save the costs due to conversion from one standard to another.

If a business adopts a closed standard controlled by a single supplier, there may be a large expense to converting to a competing standard. The single supplier can become a near monopoly, analogous to the single gas station serving an isolated town. The customer, the business, faces a substantial expense for converting its internal communication network to a competing standard. This is not unlike the cost of driving to the nearest competing gas station in a distant town. It is possible but difficult. The supplier and the gas station in the isolated town can both earn monopoly profits. They can charge prices well above their costs.

This phenomenon where a customer, a business, becomes dependent on products or services conforming to a – usually closed – standard is sometimes called *lock-in*. If the standard is closed, the financial cost of lock-in can be substantial.

Intel and Microsoft clearly face competition in office tools from Apple, Sun, Silicon Graphics, IBM, and other companies. Lock-in explains how they function as near monopolies and earn monopoly profits. Lock-in also explains the success of information technology consulting companies such as Arthur Andersen Consulting. Lock-in explains why consulting firms can earn large revenue and profits by employing inexpensive labor and yet charging their customers far higher rates than their labor costs. The customer's business processes, their internal communication network, are customized, locking the customer into a particular consulting organization.

As explained previously these near monopolies based on lock-in need frequent changes to the standard to preserve the near monopoly. These changes are marketed as upgrades, improvements, and technological innovations. This makes convincing or even forcing

the customer to accept the changes easier. It also evades possible legal problems under United States anti-trust laws and policies.

Businesses in the United States have been spending a huge amount of money on computer hardware, software, and networking primarily for these support activities. In the early 1990's $100 billion per year was spent on computer hardware alone in the United States[4]. The information technology sector now constitutes ten percent of the Gross National Product[5]. Most of this is spent on support functions such as order entry, order fulfillment, and so forth. How did the computer industry in general and Microsoft and Intel in particular sell the leaders of business on this huge investment in generally deprecated support activities? Primarily by claiming that computer and network technologies would dramatically cut the cost of these activities.

Computer technologies face a formidable competitor in business processes, namely traditional paper and people methods. Paper has been around for thousands of years. In modern thought, paper is not considered high technology or even technology. It is taken for granted. However, paper represents the end product of thousands of years of technological innovation. It is a far cry from the clay tablets and leaves used by early man. Paper is lightweight and flexible. It is easier to read than a computer screen. Unlike computer disks and CD's, paper does not require a special information reader, the bulky and expensive disk drive. Paper can be taken anywhere and read. Paper is robust. Spill some coffee on it and it is still readable. Many technical and user interface problems that continue to bedevil the computer were solved hundreds of years ago during the development of paper, pen, and ink.

Most paper technologies are standardized, for example the 8 ½" by 11" paper size popular in the United States. These are open standards that have been stable for decades. Many competing manufacturers exist. Unlike computer technology, a business need not worry about the paper changing size and shape every year, requiring expensive upgrades of typewriters, filing cabinets, and so forth.

Paper communications use simple, time-tested communication standards such as the English language, traditional double entry bookkeeping, and so forth. These standards do not change unlike the file formats issued by Microsoft.

There is no lock-in to a single supplier with traditional paper-based technologies. A business can buy its supplies from anyone.

Paper, of course, requires people. In fact computers require people as well. Paper is well matched to the average, moderately skilled American worker. The American educational system is designed to produce people skilled in standardized paper technologies. In contrast, computer technologies, as implemented, tend to require either a low skilled

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[4] *The Trouble with Computers: Usefulness, Usability, and Productivity*, Thomas K. Landauer, The MIT Press, Cambridge, Massachusetts, 1995

[5] *The Trouble with Computers: Usefulness, Usability, and Productivity*, Thomas K. Landauer, The MIT Press, Cambridge, Massachusetts, 1995, p. 15

worker who blindly enters data as required by a computer program or an expensive, highly skilled programmer or other technology specialist. How does one determine if the combination of the cheap low-skilled worker (sometimes they aren't cheap either) and the expensive highly skilled computer specialist is cheaper or more expensive than the old paper method? This determination is at best difficult, requiring many assumptions to allocate costs.

People, unlike computer programs, are flexible. They can talk with customers and co-workers. They can adapt to changing conditions and unexpected developments. In many cases a simple memo or briefing is all that is required to change a policy. A computer program requires expensive and time consuming reprogramming by an expensive programmer.

Paper and People	**Computer and People**
Typewriter and Typist	Computer, Word Processing Program, Printer, and frequently network between Computer and a Shared Printer, Computer Operator
Paper Documents and Files (8 ½" by 11") and Author	Data Files on Hard Disk and Author
Mail (8 ½" by 11" letter in envelope) and Author	Electronic Mail and Author
Accounting Ledger and Financial Analyst	Spreadsheet or Database and Financial Analyst
Order Entry form and clerk	Computer, Database or Spreadsheet Program, Data Entry "Form" displayed on computer, and clerk
Order Fulfillment forms	Computer, Database or Spreadsheet Program, Data Entry "Form" displayed on computer. Clerk may be omitted if system is well designed.
Hand Drawn Gantt Chart and Project Manager	Project Management Software and Project Manager
Hand Drawn PERT Chart and Project Manager	Project Management Software and Project Manager

Despite the formidable alternative of proven paper and people methods, the computer industry has been remarkably successful in getting businesses in the United States to adopt the computer technologies for business processes. Has this saved money? Ironically the huge profits and revenues of the computer companies suggest not at all. In fact, the costs may have increased, how else to account for the increased proportion of the GNP spent on these activities, repackaged as glamorous information technology. Nor is this surprising when one realizes that Microsoft and Intel, and probably a number of other major computer technology companies, are standard-based near monopolies that earn monopoly profits at the expense of their customers. Businesses have blindly replaced paper, largely an open standard, with closed standards controlled by their suppliers.

Reasons for Widespread Adoption of Information Technology in Business

1. **Advertising.** The computer industry, including Microsoft and Intel, have become major advertisers in *Forbes*, *Fortune*, *Business Week,* and other business magazines. The business press depends on advertising for the bulk of its revenues. Accordingly, the business press now contains a huge number of articles in every issue on the computer industry. The March 22, 1999 issue of *Business Week* provides an extreme example of this. The cover reads "E-Business: What Every CEO Needs to Know" and "Introducing a new Business Week quarterly supplement", *Business Week e.biz*. Information technology advertisers in this issue include Toshiba, IBM Global Services, Canon Visual Communication Systems Division, Seagate, MCI Worldcom, CDW Computer Centers, Olicom, SkyTel, Cabletron Systems, Tektronix, Vantive, UUNET (An MCI Worldcom Company), Corepoint (An IBM Company), Oracle (The Internet Engine), COMPAQ, Microsoft, Lucent Technologies, IBM, AT&T, Lawson Software, Hewlett Packard, Value America, Williams Communications Solutions, Lotus (An IBM Company), Sun Microsystems, GTE Internetworking, America Online, Deloitte and Touche Consulting Group, Rockwell Electronic Controls and Communications, Sybase, Fujitsu PC Corporation, Network Associates, IBM ThinkPad, Teligent, and 3COM. Thus the leaders of business are exposed to a steady drumbeat of propaganda both in the form of explicit advertisements and glowing articles about the "new" industry in business magazines.
2. **Product Placement in Popular Movies.** Computer technologies have been appearing in many movies with increasing regularity. Films glamorizing computer technology include *GoldenEye, Tomorrow Never Dies, The Matrix, Johnny Mnemonic,* and many others. This use of "new technologies" in movies is not a new phenomenon. During the 1940's and early 1950's, plastic was seen as a glamorous new technology. Plastic appeared as a glamorous technology in *It's a Wonderful Life* (1947), *Sabrina* (1954), and *The Day the Earth Stood Still* (1951). Illustrating the change, the 1995 remake of *Sabrina* replaced the new plastic with a new flat-screen display, plastic being distinctly mundane in the 1990's. Modern movies show these technologies used in glamorous ways by glamorous people, quite different from the rather mundane business activities for which the technology is actually used. Usually the technologies are presented in an unrealistic manner, performing much better than in real life (James Bond's high tech gadgets never crash or need rebooting) and performing remarkable feats that current computers cannot. This helps to shape an attitude that computers can achieve remarkable savings and improvements in performance if adopted.
3. **Network Effects.** Microsoft and Intel inherited a standard-based near monopoly established by IBM decades ago. The IBM PC took hold in part because of the credibility of the IBM name - "no one ever got fired for buying IBM" - but also because the PC could be counted on to work well with IBM's installed base of mainframes and other office equipment. Now, with many businesses using Microsoft and Intel based equipment for business communications, there is an incentive to standardize on these technologies despite the cost.

4. **Management Consulting.** In the 1990's major management consulting companies began hawking business process reengineering and similar ideas that relied heavily on computerizing business processes. Management consulting firms such as CSC/Index, Arthur Andersen Consulting, and many others build huge businesses around computerizing business processes. The 1990's saw a spate of management books such as Michael Hammer and James Champy's *Reengineering the Corporation* that extolled the virtues of computerization[6]. These books typically offer anecdotal tales of dramatic cost savings and improvements. The statements are general. Detailed cost analyses including costs of the computers and computer support personnel are largely absent. Nonetheless, these sales pitches seem to have been remarkably effective at some companies.
5. **Computers Are Genuinely Better for Some Tasks.** Undoubtedly computers are better for some tasks and functions than traditional paper methods. While it is often assumed that computer technologies *must* be superior to traditional paper and people methods, this is much harder to show than generally realized. For example, many studies have failed to show any measurable superiority of computer word processing over typewriters. *The Trouble with Computers* by Thomas K. Landauer presents considerable evidence of the limited or non-existent benefits from computerizing business processes[7].
6. **Lack of Awareness of Standard Based Monopolies and Near Monopolies.** Many business leaders making the decision to invest heavily in information technologies were and are simply unaware of standard based near monopolies, standard thrashing, and lock-in. While these phenomenon have a long history in telecommunications, electricity, and electronics, they are less common in other markets. They require network effects, increasing returns for adoption, that either is absent or less obvious in other markets. The final decision-makers in other business areas were and many still are unaware of the economics of information technology. They didn't realize that they were locking their business into a single supplier. Because of the prejudice against "support activities" in business, they have often not appreciated the potential and actual cost of these services. For example, if a business depends on billing customers for revenues and the business unwittingly give a supplier a monopoly on billing, the supplier can charge an exorbitant sum for the billing service, despite the mundane nature of billing.

Businesses have placed their communications and information processing, both internal and external, in the hands of standard-based near monopolies, notably the related businesses of Microsoft and Intel. They are paying high premiums for this based on an assumption of the superiority of computer technologies over traditional paper and people methods.

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[6] *Reengineering the Corporation: A Manifesto for Business Revolution*, Michael Hammer and James Champy, Harper Business, A Division of HarperCollins Publishers, New York, 1993

[7] *The Trouble with Computers: Usefulness, Usability, and Productivity*, Thomas K. Landauer, The MIT Press, Cambridge, Massachusetts, 1995

Microsoft and Intel are confronted with twin dangers. Someone may reverse engineer their standards and cut into their business. The customers, the businesses, may decide that they have spent enough money on support activities and that they need to concentrate on their core business, and refuse to pay for the upgrades.

Intel's Strategy

In 1997, Intel reported profits of $6 billion on $24 billion in revenues[8]. Intel had 85 percent of the 100 million-unit market for PC processors. It faced direct competition from Advanced Micro Devices, Cyrix, and Integrated Device Technology (IDT), which manufacture CPU's compatible with the Intel Architecture. Two start-up companies, TransMeta and Rise Technology, are reportedly developing compatible CPU's as well. Intel faces less direct competition from IBM, Motorola, Sun, and several other companies. Intel's position depends on the widespread adoption of software applications, often Microsoft products, that run only on the Intel Architecture.

When IBM established the original IBM PC standard in the 1980's, IBM sensibly did not want to be locked into a single supplier for a key component of the PC, the CPU. From the start, they arranged a multiple source licensing agreement giving Advanced Micro Devices (AMD) the right to manufacture a clone of the Intel 8080 processor as a second source.

A CPU has an instruction set architecture (ISA), a set of binary commands that it supports and executes in a certain way. All computer programs and application are ultimately translated into the binary commands. Any chip that can execute the Intel Instruction Set Architecture can replace the Intel CPU in a PC. From the earliest days of the PC, AMD produced chips that could do this. The instruction set architecture is the standard on which Intel's near monopoly has been based – until recently.

Almost no one buys the Intel CPU or any CPU for itself. Rather customers buy the CPU for the applications that can run on the CPU. As mentioned, these remain primarily business applications used for reporting, order entry, order fulfillment, and other common business tasks. To achieve monopoly profits, Intel must maintain a market where the applications can run only on their chip or a market where most customers strongly *believe* the applications will run only on the Intel chip. If the customers believe that they need the Intel chip, they will buy it and pay a premium for it.

As semiconductor processes improve, as computer aided design tools for VLSI chip design improve, as more information becomes available in the form of books, papers, and other documentation, it becomes easier and easier to produce chips supporting an instruction set architecture. While CPU's such as the Intel 8080 and the Z80 were remarkable products in their day, it is now easy to design and manufacture such chips. If Intel had preserved the original "8 bit" Instruction Set Architecture of the 8080, they would face not a small number of struggling competitors but dozens, even hundreds, of competitors mass producing clones of the 8080, albeit running at the 500 MHz speeds

[8] *Taking on Intel*, Michael Slater, Red Herring, November 1998, p. 48

enabled by current semiconductor process technologies. The competition would drive prices down to costs as it has in the market for 8080 and Z80 chips.

Intel's primary strategy until recently has been to expand the Instruction Set Architecture of the Intel series of chips, the Intel Architecture (IA). The 80286 introduced 16 bit instructions. The 80386 introduced 32 bit instructions. The 80486 integrated the floating point co-processor onto the CPU chip, effectively adding floating-point instructions to the instruction set. The P55C (Pentium with MMX) introduced the MMX instructions. The Pentium III introduced Streaming SIMD instructions. Intel is reportedly developing a 64-bit chip, Merced, with 64-bit instructions.

When Intel introduced the 80386, Microsoft and other application developers soon switched to producing software products compiled using the 32 bit instructions added to the 80386. A 32 bit application could not run on an 80286, 8086, or 8080 chip. Intel maintained backward compatibility. The 80386 could run applications using the 8-bit and 16-bit instructions of the earlier versions of the chip. Thus there was no penalty to adopting the new chip. The customer's old applications could still run on the new chip. However, once the applications were converted to 32-bit applications, customers had little choice but to upgrade to the 80386. The 80286 fell into disuse. Intel works hard to make sure that applications using the new instructions are available as soon as the new chips are brought to market.

Expanding the instruction set has two effects on competition. First, it makes the chips more complex. More complex instructions require more gates and more sophistication in the chip design. This insures that only a small number of competitors can duplicate the chip. While many semiconductor companies probably have the tools and expertise to duplicate the early designs, such as the original 8080, if they desired, far fewer can hope to duplicate the current, more complex designs. Second, Intel's few serious competitors – AMD, Cyrix, and a few others – must play catch up to modify their designs to support the new instructions. They must figure out exactly what the new instructions do to implement them in their own chips.

Perception plays an important role. So long as customers fear that applications will not run as well on the clones, they will buy and pay a premium for the Intel chip. Intel's "Intel Inside" advertising campaign has created a strong consciousness of the chip inside the PC.

In order for the strategy to work, Intel must convince application developers, especially Microsoft, to recompile their software to use the new instructions. To this end, Intel markets VTUNE, a performance analysis and enhancement tool to help developers locate code that can allegedly be improved using the new instructions, first MMX and then Streaming SIMD. Similarly, also as part of the VTUNE package, Intel markets C/C++ and FORTRAN compilers to generate code using the new instructions. Intel also *gives away* software such as Intel Indeo video compression that uses new instructions (MMX in Indeo 4.x and 5.x).

Intel Chip Generation	Instruction Set Architecture Expansion
8080	8-bit Instructions
8086/80286	16-bit Instructions
80386	32-bit Instructions
80486	Floating Point Instructions. Although math co-processors had been part of the Intel series of chips for some time, the 80486 integrated the floating-point math co-processor onto the chip. This meant that floating point support was a default part of the architecture, encouraging development of software using floating point instructions.
Pentium	Some new instructions.
Pentium with MMX/Pentium II	MMX Instructions
Pentium III	Streaming SIMD
Merced (maybe)	64-bit Instructions

This strategy of expanding the instruction set supported by the Intel chips has two major limitations. Increasingly CPU's can be implemented as a RISC (Reduced Instruction Set Computing) core executing a small set of micro-instructions. The supported instruction set, such as the Intel instruction set, can be translated into the simple micro-instructions using a relatively simple sub-system. In fact, Intel's new chips, such as the Pentium II, work this way. Thus the technology is developing to rapidly implement arbitrary additions to an instruction set. The effectiveness of the instruction set expansion strategy is dropping. The other problem is the diminishing returns of new instructions. At some point a chip has enough instructions. Control instructions such as branches have never benefited from expanding the size of the data (from 8 bit to 16 bit to 32 bit and so forth). The primary determinant of chip performance is increasingly the chip clock speed, which is determined by the semiconductor process technology, not the chip design or instruction set. There is little benefit to adding new instructions. Developers won't bother to recompile the applications using the new instructions because there is no benefit. For example the MMX instructions provide few, if any, benefits for business applications, currently Intel's main market. Only a few graphics and video applications benefit from MMX.

Probably because of the diminishing effectiveness of expanding the instruction set, Intel has expanded its standard setting activities into the communication standards between the components on the PC motherboard, notably with the PCI (Peripheral Component Interconnect) standard, the Single Edge Cartridge (SEC) and the Slot 1 interface introduced with the Pentium II.

Microsoft's Strategy

Microsoft reported a net income of $4,490 million on revenues of $14,484 in 1998[9]. Microsoft faces direct competition only in the DOS market, where several companies produce DOS compatible operating systems and DOS emulators. Microsoft does not face direct competition in the Windows operating system or its numerous application products. Microsoft has been able to use copyright protection of the look and feel of its graphical user interface (GUI) to protect against exact clones of Microsoft Windows[10]. However, Microsoft faces potential competition from the Apple Macintosh, various Unix computers and workstations, IBM mainframes, and miscellaneous other computers, operating systems, and software products. It also faces potential competition from traditional paper and people methods.

Microsoft's near monopoly relies on a collection of different standards including data file formats used by Microsoft's application software, user interface standards used by Microsoft products, and the programming interfaces exported by the Microsoft operating systems – DOS, Windows 3.1, Windows for Workgroups, Windows 95/98, and Windows NT. Most discussions of Microsoft's near monopoly focus on Microsoft's control of the operating system and the Application Programming Interfaces (API's) used by application developers. This is certainly an important factor in Microsoft's dominant position. The data file formats used by Microsoft's applications are often neglected and may play a bigger role.

Microsoft's Secret Weapon: Data File Formats

Almost no one buys Microsoft's operating systems for the operating system itself. Rather customers buy the applications that run on the operating system. For the most part this means business applications. These applications store, process, print, and share information in many forms. The information, the raw data used by the business, is stored in data files conforming to data file formats specified by Microsoft. These formats include Microsoft Word file format, Microsoft Excel file format, the Microsoft Access database format, and many others. The raw data is the "crown jewels" of the business: reports, documents, payroll records, accounting records, billing information, and so forth. Without this data the business may grind to a halt. If competing programs and computers from other suppliers can read, process, print, and share this data, then Microsoft and Intel have no monopoly.

Many office workers primary function is reading, writing, and distributing written documents in English. These documents include technical manuals, market analyses, correspondence with customers, and many other things. At one time this was done with typewriters and 8 ½" by 11" paper. Then copiers allowed broader, arguably more effective distribution of documents. Word processing programs, computers, networks, and printers have taken over many of these functions. Consider an office worker with a

[9] *Microsoft Annual Report 1998*
[10] *The Age of Software Patents,* Kenneth Nichols, IEEE Computer, April 1999, p 25

Macintosh computer. So long as this office worker can exchange documents with office workers on an IBM PC, they can work effectively. They do not need Microsoft Windows, Microsoft Word, or the Intel processors. All they need is a Macintosh program that can read, view, print, and modify the same document files used on the PC. The same is true of office workers using Unix workstations, IBM mainframes, and specialized word processing products.

In fact a great deal of business correspondence now uses the Internet Mail standard. This is a simple human-readable ASCII (American Standard Code for Information Interchange) file format. So long as this mail format is used, it doesn't matter what application or what computer is being used. The mail can be sent and read on IBM PC's, Unix workstations, IBM mainframes, and Macintosh computers.

Another class of office workers – bookkeepers and financial analysts – performs various accounting and financial functions using spreadsheets. At one time this too was done with paper. Again, Microsoft Windows, Microsoft Excel, and Intel processors are not a requirement. A program that can read, view, print, and modify the same spreadsheet file format is the only true requirement. If this exists on a Macintosh or Unix workstation, the office worker can perform his or her work.

Other office workers, such as managers, produce presentations using tools such as Microsoft PowerPoint. Here too Microsoft Windows, Microsoft PowerPoint, and Intel processors are not a requirement. Only a program that can read, view, print, and modify the presentation file format is necessary.

Programmers are the primary group directly affected by the operating system and central processor.

Microsoft Word, Microsoft's highly successful word processing program, provides an example of the role of data file formats. For example, Microsoft Word 97 can export documents in the following Microsoft formats: Microsoft Word for Windows 2.x, Word for Windows 3.0, Word for Windows 4.0, Word 6.0/95, and Word 97 (called simply Word). This illustrates the steady evolution of the Word file format. Furthermore, Microsoft Word 6.0 cannot read Word 97 file format documents. Instead of displaying the document with notations that some data is of a new type and cannot be read, the Microsoft Word 6.0 application fails to read the documents entirely.

Word 97 defaults to saving files in the Word 97 format. If the user loads a file in an earlier Word format, Word 97 will save it in the Word 97 file format. The user can change the default so that Word 97 will always save in an earlier format, such as Word 6.0/95. In this case, Word 97 pops up an annoying dialog box asking if the user wants to save in the old file format every time the user saves a file. One of the consequences of this that once a site starts using Word 97 its documents will be quietly updated to the new Word 97 file format. As more people use the Word 97 file format, perhaps unwittingly, pressure grows to buy Word 97.

The Microsoft Word file formats are extremely complex and sophisticated, far beyond what is needed for most word processing tasks. One of the most egregious examples of this is the "macro" programming language incorporated in the recent Word file formats. Almost no one has any use for this. It is best known for being used to add pernicious viruses, such as the Melissa virus, to Word documents[11].

Competing programs such as WordPerfect can read some Microsoft Word file formats. Since Microsoft frequently upgrades the file format, other word processing programs – on PC, Macintosh, and Unix platforms – will be unable to read the new file format for some period and may have difficulties even when they can. Thus, users are locked into the Microsoft Word application from Microsoft.

Microsoft has many other application data file formats that it upgrades frequently. So long as critical data is stored in data file formats that only Microsoft fully understands, customers are locked into the Microsoft products. So complex have the data file formats become that who would want to risk using a competing program that claims to support the Microsoft data file format?

The Operating Systems and Application Programming Interfaces

The other foundation of Microsoft's dominant position is its control over the Windows operating systems. An operating system is also a standard. In particular, an operating system defines a set of interfaces to the operating system that a program must use to function. These interfaces are sometimes referred to as Application Programming Interfaces (API's) or Application Binary Interfaces (ABI).

The interfaces between the application programs and the underlying operating system are quite important. Applications see only the interface between the operating system and the application. In principle, the internal implementation of the operating system can be quite different. For example, Windows NT is designed so that many Windows 3.1 applications will run perfectly on Windows NT, even though internally Windows NT is radically different from Windows 3.1

Customers would not be locked into Microsoft Windows or IBM PC compatible computers or the Intel processors if another operating system could emulate the interfaces between the operating system and the application program. There have been at least two attempts to emulate the Windows interface: Sun's Windows Application Binary Interface (WABI) and the Linux *wine* (for Windows Emulation) project.

The interface between the applications and the operating system is a de facto standard. As with the other de facto standards that it controls, Microsoft is frequently changing the standard. Because of this, customers tend to be locked into the Microsoft operating system. It also means that Microsoft has a practical advantage in applications running on the operating system, since Microsoft knows more about the interfaces to the operating

[11] *Melissa test DOD procedures,* Daniel Verton, Federal Computer Week, April 12, 1999, p. 17

system than its competitors. Microsoft has an enormous practical advantage in developing applications, such as Microsoft Office, for the Microsoft platforms.

While control over the operating system, in particular the interface between the applications and the operating system, strengthens Microsoft enormously, there are other operating systems and associated computer hardware such as the Apple Macintosh and many flavors of Unix. There are many applications written for these operating systems from companies, organizations, and individuals independent of Microsoft. It is the need to share information between systems, the data file formats, that locks customers into the Microsoft and Intel based systems.

The Threat of Network Communication Protocols

Network communication protocols are one area where Microsoft has, so far, largely failed to establish de facto industry standards under its control. Microsoft faced substantial competition from Novell Netware, IBM's SNA, the European Open Systems Interconnect (OSI) standards, and the Defense Advanced Research Agency/National Science Foundation backed Internet suite of protocols. Microsoft initially attempted to compete with its NetBIOS network communication protocols.

NetBIOS had considerable difficulty competing with Netware, SNA, and the Internet. Microsoft switched to embracing TCP/IP and the other Internet protocols. These are open standards. Although not controlled by Microsoft, they had the virtue of not being controlled by competitors such as Novell or IBM.

Application level Internet protocols such as the widely used Internet mail standard, Hypertext Markup Language (HTML) and Common Gateway Interface (CGI) pose a substantial threat to Microsoft and Intel. HTML, for example, provides a well-documented, simple, easy to learn, standardized data file format that could be used for business data. These application level Internet protocols threaten to free business data from the Microsoft applications and the underlying computer hardware as well.

Microsoft has moved to head off this threat with the Microsoft Internet Information Server and Internet Explorer. To truly eliminate this threat, Microsoft must evolve the open Internet standards into rapidly changing closed standards under Microsoft's control.

Conclusion

Standard-based monopolies and near monopolies are monopolies based on control of a de facto industry standard. Usually the monopolist's product or service is a component of or comprises a network whose many components must work together to produce a useful result. Standardization of the components is required for the network to function. In such situations, customers may become locked into the network that they participate in. Even if a competing network – products, services, and associated standards - exists, there is substantial cost and practical obstacles to converting to the competing network,

products, services, and associated standards. A near monopolist can charge more than its costs, earn monopoly profits, due to lock-in.

Microsoft and Intel are standard-based near monopolies that maintain their dominant position through frequent changes to several de facto industry standards that they control. The frequent changes insure that only Microsoft and Intel fully understand the standard to which products or services must conform. In the absence of the changes, many competitors would reverse engineer the standards and produce conforming products or services, breaking the near monopoly, driving down prices, and eliminating the large profits that Microsoft and Intel have reported over the last several years.

Microsoft and Intel are *near* monopolies, not true monopolies. Competitors such as Apple, IBM, and Sun Microsystems exist. These competitors offer competing products, services, networks, and associated standards, primarily used to form the internal business communication networks of their customers. However, customers of Microsoft and Intel are locked into the Microsoft and Intel products and services. There is substantial expense and other obstacles to converting to the products, services, and associated standards of the competitors. This allows Microsoft and Intel to earn monopoly profits. It also probably allows the competitors to earn monopoly profits as well.

Microsoft and Intel are most vulnerable to widespread adoption of truly open standards for the business data used in business processes, meaning the data file formats. This would free businesses from reliance on Microsoft applications such as Microsoft Word and indeed specific operating systems or computer hardware. Such standardization would strongly impact the information technology consulting industry as well.

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This paper reflects the opinions of the author only. It is not the opinion or policy of any current or former employer of the author. Although the paper touches on a number of legal issues, it is not and should not be considered a legal opinion.

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