ii. Dean Schmalensee conceded that, if a firm can impose a tie-in "that implies the firm has some power over price." Schmalensee, 1/19/99am, at 40:12-22. Dean Schmalensee also previously wrote that: "Evidence that competitors have conspired to fix prices or divide markets is treated as very good evidence that these competitors have market power" (GX 1514), and that such evidence "perhaps" could indicate "monopoly power." Schmalensee, 1/14/99pm, at 46:14 - 47:6.

iii. Dr. Warren-Boulton testified that "to the extent there is evidence . . . which shows that Microsoft has . . . used its position in the operating system market to exclude competitors from either that market or from markets that might facilitate the entry of a firm into that market, then that's direct evidence of the ability to exclude" and "that by itself is direct evidence of the existence of monopoly power." Warren-Boulton, 12/1/98am, at 32:3-20.

B. Microsoft's monopoly power is also demonstrated by a structural analysis

17. Microsoft's monopoly power is confirmed by a traditional structural analysis, which shows that Microsoft possesses a dominant share of a well-defined market protected by immense barriers to entry.

i. Professor Fisher testified that "Microsoft's high market share is an indication that it possesses monopoly power. The analysis of barriers to entry confirms that monopoly power exists." Fisher Dir. ¶ 65.

ii. Dr. Warren-Boulton likewise testified that Microsoft "possesses monopoly power" because it "for several years has enjoyed, and is projected for several years to retain, a market share in excess of 90%," and this share "is protected by substantial barriers to entry." Warren-Boulton Dir. ¶ 7.

17.1. The standard way to determine monopoly power is (1) to ascertain whether a firm possesses a very large share of a properly defined market and then (2) to determine whether substantial barriers to entry protect that share by impeding the ability of rivals to enter or to expand.

i. Professor Fisher testified that "the ordinary way you proceed in an antitrust case is to define a market and look at market shares" and then determine whether there are substantial barriers to entry. Fisher, 6/1/99am, at 12:2-13; see also Fisher, 6/1/99am, at 6:1-3 (explaining that this is the "standard way" to determine monopoly power); Fisher Dir. ¶¶ 32-39 (testifying that "monopoly power is conventionally addressed by defining 'the relevant market' and assessing shares in the market share"); Warren-Boulton Dir. ¶¶ 18, 42-44.

ii. Dean Schmalensee conceded that: "'The traditional and most common approach in an instance where one can define a relevant market in the antitrust sense'" is "'to first look at shares of that market and then if shares are large, to move on to consider conditions of entry.'" Schmalensee, 1/13/99pm, at 24:9-25 (quoting GX 1526 (Schmalensee's testimony in Bristol)).

17.2. A large share of a well-defined market protected by substantial entry barriers warrants an inference of monopoly power.

i. Professor Fisher testified: "A large share of a properly defined market" is indicative of the ability to exercise substantial market power, and that where "there are significant barriers to entry, monopoly power can be present." Fisher Dir. ¶¶ 32-36, 39.

ii. Dean Schmalensee conceded that, if Microsoft's Windows operating system enjoys the protection of substantial barriers to entry, then he could not conclude that Microsoft lacks monopoly power. Schmalensee, 1/14/99am, at 8:22 - 9:9.

iii. Dr. Warren-Boulton testified "that market share is an indicator of monopoly power. It is one of several indicators of monopoly power." Warren-Boulton, 11/19/98am, at 56:22-23.

1. Operating systems for Intel-compatible PCs comprise a relevant market

18. The purpose of defining markets is to determine whether substantial and durable market power can be exercised; accordingly, a properly defined relevant market should include the set of products over which a single firm, if it controlled production of those products, could exercise substantial market power.

i. Dean Schmalensee testified that a relevant market consists of the "smallest aggregate that could be profitably monopolized." Schmalensee, 6/24/99pm, at 58:15-23.

ii. Dr. Warren-Boulton testified that a properly delineated antitrust market includes the set of products over which a single firm, if it controlled production of those products, could exercise substantial market power. Warren-Boulton Dir. ¶¶ 26-32.

iii. Professor Fisher testified that the purpose of defining a market is to determine the "set of things that could constrain the power of the alleged monopolist." Fisher, 6/1/99am, at 9:17-24.

18.1. The relevant market thus should include only reasonable substitutes that in a reasonable period of time could constrain -- and thus defeat -- an attempt to exercise substantial market power.

i. Professor Fisher testified that a relevant market "should include all those products that reasonably serve to constrain the behavior of the alleged monopolist." Fisher Dir. ¶ 32; Fisher, 6/1/99am, at 9:18-21 (stating that "in defining a market and then in examining market power, you typically look at . . . things that could constrain the power of the alleged monopolist.").

ii. Dr. Warren-Boulton also testified that a relevant market should include substitute products that could prevent the exercise of monopoly power. Warren-Boulton Dir. ¶¶ 27-28. He further testified that it is "important not to define the market too broadly" by including products that are not reasonable substitutes, "for that might understate the power of the firm whose conduct is being examined." Warren-Boulton Dir. ¶ 28.

18.2. These include:

18.2.1. Demand responses. The relevant market should include products to which consumers could switch, without substantial difficulty, in response to an attempt by firms in the candidate market to exercise substantial market power.

i. Professor Fisher testified that, in defining a market, one must look at

"demand substitutability," which "concerns the question of what are the products or the firms to which the alleged monopolist's customers could readily turn in the event of an increase in price." Fisher, 6/2/99am, at 69:22 - 70:1; Fisher, 6/1/99am, at 9:21-24 ("demand substitutability" refers to "the set of products to which customers can turn in the event of an attempt to earn supernormal profits" by the alleged monopolist); Fisher Dir. ¶¶ 32-33 (same).

18.2.2. Supply responses. The relevant market should also include firms that do not presently produce the product in question or a reasonable substitute for it but which, without substantial difficulty, could do so in response to an attempt by firms in the candidate market to exercise substantial market power.

i. Professor Fisher testified that, in defining a market, one must look at "supply substitutibility," which "refers to the ability of firms who do not now produce demand substitutable products, easily to produce demand substitutable products." Fisher, 6/2/99am, at 70:9-11; Fisher, 6/1/99am, at 10:8-13 (same); Fisher Dir. ¶¶ 32, 34 (same).

19. Operating systems for Intel-compatible PCs comprise a relevant market because they lack good substitutes; that is, there are no substitutes that in a reasonable period of time could defeat -- i.e., render unprofitable -- an attempt by a monopolist over such operating systems from exercising substantial market power.

19.1. Other "platform" products, such as Internet browsers and Java, are not good substitutes for operating systems because they cannot function without an operating system.

i. Jim Barksdale testified: "I am not suggesting that the browser is a replacement for the operating system; Navigator still needs an operating system, such as Windows 98, running underneath it, but Navigator can and does serve as a platform for certain network-centric applications." Barksdale Dir. ¶ 82; Barksdale, 10/20/98pm, at 72-74 (Barksdale testified that while Netscape could serve as a substitute for certain platform chacteristics, he does not believe that Netscape could seriously substitute for all platform characteristics).

ii. James Clark, founder and former Chairman of Netscape, testified that: "Netscape is not an operating system. It's not even a networked operating system. . . . Netscape was developing a platform. A platform is not the same as an operating system. . . . The idea was to make it independent of the Microsoft operating system, but no attempt whatsoever to displace the Microsoft operating system." Clark Dep. (7/22/98) at 44:25 - 46:16 (DX 2562). Clark explained Netscape intended to provide a software layer that would run on top of otherwise incompatible operating systems and enable them to use network or web based applications, but that "layer still relied on there being some kind of machine and some kind of operating system underneath." Clark Dep. (7/22/98) at 48:5 - 49:4 (DX 2562). Clark categorically denied that Netscape intended for the browser to replace the operating systems that it relied upon. Clark Dep. (7/22/98) at 48:5 - 50:4 (DX 2562).

iii. Netscape's Richard Schell similarly testified that Netscape intended to be "operating system agnostics," (i.e., work well with all operating systems), but not to replace operating systems. When Microsoft counsel followed up by asking whether he regarded "the notion of Navigator replacing Windows [as] a slightly ridiculous assertion," Schell explained: "There are 14 million lines of code in Windows 9X. They must do something. For us to have thought that we would replace all of those would have been a stretch of the imagination. We thought we could provide functionality that enhanced not only Windows but Unix and the Macintosh and . . . for some developers and some users, that would become their primary environment, but we would never think that that meant we were replacing Windows." Schell Dep. (9/15/98), at 103:17 - 104:22 (DX 2587).

iv. Dean Schmalensee testified that he is not aware of any "software that only browses and does not do anything else and requires no other software to run." Schmalensee, 6/23/99am, at 53:2-10; id. at 57:14-17 (same for other "web-based applications").

v. Professor Fisher testified: "In the present case, the growth of the Netscape browser or the widespread use of original Java might have perfectly well have broken down the applications barrier to entry and allowed other operating systems to compete. But it would be the other operating systems that were then in the market, not . . . either Netscape, the browser market, or Sun because of Java." Fisher, 6/1/99am, at 18:5-11.

19.2. Intel-compatible server operating systems are not good substitutes for Intel-based PC operating systems because they lack the features and breadth of applications users demand and are prohibitively more expensive.

i. Sean Sanders of Novell testified that server operating systems do not compete with Windows. Sanders Dep., 1/13/99pm, at 184:13 - 185:1. He further explained that to convert Novell's server operating systems into desktop operating system would require starting "all over again" and building the operating system "from the ground up." "It is not easily transferable to" the desktop "role at all." DX 2584.

ii. Sun's Brian Croll testified that Sun's Solaris operating system does not compete with Windows. Croll Dep. (played 12/15/98pm), at 56:23 - 57:13.

iii. Ron Rassmussen, of Santa Cruz Operating Systems, testified: "People are not purchasing our operating system as a desktop as much as they did at one time" and that it is "more effective for our strategy to move into a purely server role." DX 2581 (testifying that using SCO's operating system for desktop use is prohibitively expensive for users).

iv. Paul Maritz agreed "that the applications you find on a server are different from those you find on an Intel PC acting as a desktop." Maritz, 1/27/99pm, at 28:18 - 29:1.

v. Dr. Warren-Boulton testified that "Intel-compatible operating system products that are designed . . . to operate 'servers' are not viable substitutes for a desktop operating systems" because they "are generally more expensive yet do not provide the features consumers demand when they purchase PC operating systems." Warren-Boulton Dir. ¶ 40.

19.3. Nor do other devices, which run other (non-Intel-compatible) operating systems, constrain the exercise of substantial market power over Intel-compatible PC operating systems.

19.3.1. A PC operating system accounts for only a very small percentage of the cost of a PC system; therefore, even a substantial increase in the price of a PC operating system above competitive levels will result in only a trivial increase in the cost of a PC computer system to

users.

i. Maritz testified that the Windows royalty is "less than 5% of the price of a typical new computer." Maritz Dir. ¶¶ 21, 132.

ii. Professor Fisher testified that a 10% increase in the price of a PC operating system will result in only approximately 1% increase in the price of PC. Fisher, 6/1/99am, at 27:7-25.

iii. Dr. Warren-Boulton similarly testified that "even a 10% increase in the price of the OS would result in at most a 1% increase in the price of even inexpensive PCs." Warren-Boulton Dir. ¶ 37.

19.3.2. A common-sense economic analysis, therefore, shows that users will not in significant numbers incur the substantial costs of switching away from Intel-based PCs, and hence from Windows, in response to even a large increase in the price of the operating system.

i. Professor Fisher testified that the "[q]uestion at issue in assessing Microsoft's power is not whether a change--an increase in the price of the P.C. as a whole would cause people to turn to other non-P.C. devices, or for that matter, to Apple," but rather "whether an increase in the operating system price will cause that to happen." Fisher, 6/1/99am, at 27:1-6. He then concludes that it will not because even a 10% increase in the price of the operating system would result in "less than a 1 percent increase in the P.C. price." Fisher, 6/1/99am, at 27:14-16.

ii. Dr. Warren-Boulton similarly observed that "even a 10% increase in the price of the OS would result in at most a 1% increase in the price of even inexpensive PCs," and in light of "the cost to users of switching to another platform, such a small increase in the price of the PC platform would not be expected to result in a large reduction in the demand for PCs, and thus for PC operating systems." These facts led him to conclude "that PC operating systems are a separate market." Warren-Boulton Dir. ¶ 37; see also Warren-Boulton, 11/23/98pm, at 8:20-25, 9:17-25.

19.3.3. The evidence confirms that a substantial price increase for PC

operating systems (a trivial increase in the price of the PC) will not result in switching away from PC systems, and hence PC operating systems, sufficient to make the substantial price increase in the operating system unprofitable.

19.3.3.1. OEMs. As explained, OEMs will not switch away from Windows (let alone start building other types of personal computers) in response to a substantial exercise of market power (such as increased restrictions or prices) over Intel-compatible PC operating systems.

i. See supra II.A., ¶ 15.1.

19.3.3.2. Apple. The most obvious possible substitute for users are other personal computers, such as Apple's Macintosh. But even Apple — the closest substitute to PCs — does not constrain the exercise of power over operating systems for Intel-based PCs.

i. Dean Schmalensee conceded that Microsoft's present operating system competitors, including Apple, are not "the primary constraint on Microsoft's pricing." Schmalensee, 1/14/99am, at 24:16-25.

ii. Although some users do switch from PCs to the Macintosh, Apple's Avadis Tevanian testified that Apple still cannot gain substantial share and, therefore, cannot effectively compete with Microsoft. Tevanian, 1/4/99pm, at 9:20 - 12:18.

iii. Plaintiffs' economists testified that consumers' switching from PCs to the Macintosh is not the result of the exercise of market power over PC operating systems and, therefore, does not show an effective constraint on Microsoft's ability to exercise substantial market power. Warren-Boulton, 11/23/98pm, at 6:18 - 15:12; see also Fisher Dir. ¶ 137 ("Apple represents the main potential alternative to desktop PCs running Microsoft's Windows. (Although that alternative is not sufficient to keep Microsoft from having monopoly power.)"); Warren-Boulton,

11/23/98pm, at 8:20-25 (testifying that if the cost of the Windows operating system increased "by a small but significant amount . . . not enough people are going to decide . . .to switch to the Mac platform" to include Mac in the market). Switching to the Macintosh simply means the value of Microsoft's monopoly is shifting, not that its monopoly power is dissipating. Warren-Boulton, 11/23/98pm, at 13:3 - 15:12 (testifying that the question is "'what is the constraint on the monopoly pricing of the operating system'" and that the "fact that demand for the product, as a whole, is increasing or decreasing is not the relevant question'").

19.3.3.3. Other information appliances. There is similarly no evidence that other information appliances constrain Microsoft's ability to exercise substantial market power over operating systems for Intel-compatible personal computers.

19.3.3.3.1. First, most such appliances are complements to, rather than substitutes for, personal computers, so switching is not likely.

i. Steve Case stated publicly and testified that: "It's hard to imagine that PCs won't be the dominant way people connect with the Internet for many years to come, and Microsoft has a pretty amazing lock on that business. . . . Other devices will emerge, but I doubt any will challenge Windows." Case Dep. (played 6/4/99am), at 44:17 - 45:4; Ct. Ex. 1.

ii. AOL's Barry Schuler testified:

Schuler Dep., 5/5/99, at 183:18-21 (DX 2810A) (sealed).

Schuler Dep., 5/5/99, at 183:24 - 184:12 (DX 2810A) (sealed).

iii. Professor Fisher testified that other devices are not presently good "substitutes for PC's. And you can perfectly well have a monopoly in operating systems for PC's, despite the fact that there are or may be a number of operating systems for hand-held devices, TV set-top boxes and so on." Fisher, 1/12/99am, at 7:14-16; Fisher, 1/12/99am, at 7:19 - 8:7. Professor Fisher further testified that other information appliances do not presently constrain Microsoft's behavior. Fisher, 6/2/99am, at 83:20-23.

iv. Bill Gates stated that for "most people at home and at work, the PC will remain the primary computing tool; you'll still want a big screen and a keyboard" for many applications and "you'll need plenty of local processing power for graphics, games, and so on. But the PC will also work in tandem with other cool devices. You'll be able to share your data--files, schedule, calendar, e-mail, address book, etc.--across different machines; and you wont have to think about it; it will be automatic." GX 2059 (Newsweek article dated 5/31/99). In a similar vein, the IDC forecasts that for PCs and other information appliances, there will be "some competition between these two categories of devices. However, it is more true that the two devices will help lift each other. As a rising tide raises all ships, the growth of the Internet as an important tool for communication, commerce, and entertainment will provide ample justification for both form factors." DX 2423, at 35.

v. See also infra Part VII.C.3.; ¶ 396.2.

19.3.3.3.2. Second, even if other information appliances became better substitutes for a wider range of PC functions in the future, a small increase in the price of PC systems caused by a large increase in the price of the operating system will not result in substantial switching to other information appliances. In other words, while other information appliances may affect relative ubiquity of PCs, and thus the value of Microsoft's monopoly over operating systems for Intel-based PC operating systems, those appliances do not undermine the fact that there is a market for such operating systems that is capable of being monopolized.

i. Dr. Warren-Boulton testified that a small increase in the price of the overall computer system will not induce large numbers of users to incur the costs required to switch to other devices. Warren-Boulton, 11/23/98pm, at 14:16-23; Warren-Boulton Dir. ¶¶ 37-39.

ii. Professor Fisher testified that, for this reason, the existence of other information appliances was "basically totally irrelevant" to the monopoly power analysis. Fisher, 6/3/99pm, at 65:1-7. "The fact that other devices are going to be important, too, is interesting, but we're not talking here, by the way, about a monopoly of PCs themselves. We're talking about a monopoly of operating systems for PCs, and to believe that this has something to do with eroding Microsoft's monopoly power in operating systems, you would have to believe that small changes in the price of the operating system for PCs would cause people no longer to buy PCs, but to ship" "these other devices." Fisher, 6/3/99pm, at 65:23 - 66:6. See also Fisher, 6/1/99am, at 27:14-22.

19.3.3.3.3. Third, because the issue for market definition is

whether a non-trivial increase in the price of the operating system will cause switching away from PC operating systems (to other information appliances running other operating systems or otherwise) to a sufficient extent to render that price increase unprofitable, there is no need to reach the question of whether PCs themselves comprise a relevant market (that is, whether a large price increase in the cost of a PC would be rendered unprofitable by switching).

i. Fisher, 6/2/99pm, at 30:2-13; 6/3/99pm, at 65:23 - 66:6.

20. Microsoft internal documents and the testimony at trial of its witnesses also support delineating a market for Intel-based desktop operating systems.

i. Joachim Kempin testified, Microsoft tracks the share of "[o]perating systems for Intel PC[s]." Kempin, 2/25/99pm, at 94:24 - 95:7.

ii. Microsoft internal documents analyze as "competition" other "x86 Os[s]" -- that is, other Intel-based operating systems -- but do not characterize as competition other types of operating systems. GX 401.

2. Microsoft possesses a dominant, persistent, and increasing share of the market for operating systems for Intel-compatible PCs

21. Microsoft possesses a dominant, persistent, and increasing share of the relevant market.

21.1. Microsoft presently enjoys a market share in excess of 90%.

i. Data sponsored by Professor Fisher and Dr. Warren-Boulton shows that Microsoft's share of Intel-based PC operating systems is well over 90%. GX 1.

ii. Professor Fisher testified: "Microsoft's share of personal computer operating systems is very high and has remained stable over time. Microsoft's worldwide share of shipments of Intel-based operating systems has been approximately 90 percent or more in recent years . . . . Even if operating systems for non-Intel-based computers are included in the market definition, Microsoft's share is still very high and stable." Fisher Dir. ¶ 64.

21.2. This share, which Microsoft has possessed since at least the early 1990s, has been stable through the many changes that have occurred in the computer industry.

i. Dr. Warren-Boulton testified: "This high market share has been remarkably stable." Warren-Boulton Dir. ¶ 45.

ii. Data sponsored by Professor Fisher and Dr. Warren-Boulton shows that Microsoft's share of Intel-based PC operating systems is projected to rise to 96% by 2001. GX 1.

iii. Professor Fisher testified: "Here, Microsoft's share of the P.C. operating systems business has been high and stable for some years. Further, it's expected that it will remain high for some years." Fisher, 6/1/99am, at 12:2-8.

iv. Microsoft North America FY96 Reviews, an internal financial report compiled in June 1996, reported that the

GX 402 at MS6 6001734, (sealed), GX 403, at MS6 6006356, (Microsoft North America FY97 Reviews) (sealed).

21.3. Microsoft's share is projected to rise even further in the next century.

i. Rational Software "believes its continued success will become increasingly dependent on its ability to support the Microsoft platform, including Windows 95, Windows 98, and Windows NT operating systems." GX 1663 (SEC 10-Q), at 5. Mike Devlin, a Microsoft witness, testified that Rational's "increased dependence" on Microsoft will indeed be the result of "the increasing market share of the Microsoft platform." Devlin, 2/4/99am, at 25:22 - 26:1; Devlin, 2/4/99am, at 14:8 - 15:9.

ii. IBM's John Soyring testified that Microsoft's 92% market share will "stay that high, if not get higher" in the next two or three years. Soyring, 11/18am, 71:24 - 72:4.

iii. Professor Frank Fisher testified: "Here, Microsoft's share of the P.C. operating systems business has been high and stable for some years. Further, it's expected that it's going to remain high for some years." Fisher, 6/1/99am, at

12:2-8.

iv. Dr. Warren-Boulton testified that Microsoft's share of operating systems "has been above 90% since at least the early 1990s and this dominance is forecast through at least 2001." Warren-Boulton Dir. ¶ 45; see also Warren-Boulton, 11/19/98am, at 57:24 - 58:5 (referring to GX 1, which contains the IDC's "projections of continuous and sustained and increasing market shares").

v. A report prepared for Microsoft in September 1997 states: "Win32 penetration by household primary machines is currently 70% and projected to reach 90% by December 1998." GX 447 at MS7 001195.

22. Precise calculation of Microsoft's market share or of the contours of the market is, in any event, unimportant.

22.1. Even if one included in the market other products -- such as "middleware" and other operating systems -- Microsoft would still possess monopoly power.

i. Dr. Warren-Boulton testified that "even if the market were defined more broadly to include operating system products for all personal computers--such as those offered by Apple or some vendors of UNIX based operating systems that do not use an Intel-compatible microprocessor--my conclusion that Microsoft possesses monopoly power in a relevant market would still stand." Warren-Boulton Dir. ¶ 41.

ii. Professor Fisher similarly testified that even "if operating systems for non-Intel-based computers are included in the market definition, Microsoft's share is still very high and stable." Fisher Dir. ¶ 64.

iii. Professor Fisher testified that Microsoft possesses monopoly power even if threats to its monopoly power, such as Netscape and Java, are included in the relevant market. Fisher, 6/2/99am, at 61:11 - 62:10; 6/1/99am, at 46:12 - 47:19.

22.2. Market definition and calculation of market shares are intended only to aid in determining whether a firm has monopoly power, so precise calculation is not necessary where refinement and precision will not change the ultimate determination of monopoly power.

i. As Professor Fisher testified, "there will often be no bright line between defining products as in the market" and "leaving them out while remembering that firms that do not produce them can enter fairly readily. But the lack of such a clear line will not matter, so long as one remembers that market definition need not be precise and that its purpose is to assist in analyzing the constraints on the behavior of the alleged monopolist." Fisher Dir. ¶ 36; see also Fisher, 6/2/99am, at 57:19 - 59:1 (discussing Fisher, "Microecomomics: Essays in Theory and Applications" (DX 2487)).

3. Microsoft's dominant market share reflects monopoly power because its position in operating systems is protected by high barriers to entry

23. Microsoft's dominant market share reflects monopoly power because that share is both the source of, and protected by, immense entry barriers that prevent rivals from entering or expanding.

a. Definition of barriers to entry

24. An entry barrier is any factor that permits firms already in the market to earn returns above the competitive level without inducing entry or expansion that would erode those returns.

i. Professor Fisher testified that a barrier to entry "permits the incumbent firms" to "earn supernormal profits without having their business bid away by the expansion of competitors or the entry of new firms." Fisher, 1/6/99am, at 52:20-23; Fisher, 6/1/99am, at 47:20-24.

ii. Dean Schmalensee characterized as consistent with his definition of an entry barrier "'any factor that permits firms already in the market to earn returns above the competitive level while deterring outsiders from entering.'" Schmalensee, 1/14/99am, at 6:17 - 7:19 (quoting Areeda & Hovenkamp).

b. The applications barrier to entry protects Microsoft's dominant

position in operating systems

25. The principal barrier to entry into operating systems is what has been termed in this case the applications barrier to entry.

i. Professor Fisher testified that the "dominant position of Microsoft's operating system is protected by the applications programming barrier to entry." Fisher Dir. ¶ 82; Fisher, 6/1/99am, at 48:4-11.

ii. Dr. Warren-Boulton testified that "the applications barrier to entry sustains Microsoft's dominance, critically contributes to its monopoly power, and helps explain why other Intel-compatible operating systems, such as OS/2 and Linux, have persistently small market shares." Warren-Boulton Dir. ¶ 56.

25.1. The applications barrier to entry results from a chicken-and-egg problem: Users will not in large numbers use an operating system other than Windows unless it supports a set of applications comparable to the set of applications available for Windows, but ISVs will tend not to write comparable applications for other operating systems in large numbers because those operating systems lack a large number of users.

i. Avadis Tevanian testified that Microsoft's dominant position rests in part on "a commercial symbiosis that exists between application programs and the computer operating systems on which those programs run. An application program is condemned to commercial failure if it will not operate reliably on the operating system of a sufficiently large installed base of computer systems. Similarly, the commercial viability of an operating system is critically dependent on the availability of application programs . . . ." Tevanian Dir. ¶ 15.

ii. Dr. Warren-Boulton testified that as "an operating system gains popularity, the incentive to develop software for the operating system increases because the larger number of users for the operating system product implies a greater potential market for software developers. The development of yet more applications for that operating system, in turn, increases the value of the operating system to end users who, as explained, purchase operating systems in significant part based upon the quality and variety of applications available for it." Warren-Boulton Dir. ¶ 53.

25.2. In other words, Microsoft's very large market share and installed base of users -- which create incentives for ISVs to write first and foremost to Windows rather than to other operating systems -- are themselves the source of an immense entry barrier that keeps the share of operating system rivals low and protects Microsoft's monopoly power.

i. Professor Fisher testified that "Microsoft's high market share leads to more applications being written for its operating system, which reinforces and increases Microsoft's market share, which in turn leads to still more applications being written for Windows than for other operating systems, and so on." Because of this pattern, Microsoft's "share is not likely to be eroded by new entry as long as the applications programming barrier to entry remains strong." Fisher Dir. ¶ 70.

ii. Dr. Warren-Boulton testified that "an operating system product can rise to dominate the market, and once that dominance is achieved maintain it, because of both the large number of complementary software applications available for it and the flow of new applications that are written to it." Warren-Boulton Dir. ¶ 54.

(1) Microsoft possesses a dominant market share because software developers have powerful incentives to write applications first and foremost to Windows

26. The economic factors that create incentives to write applications first and foremost to Windows, and reinforce Microsoft's dominant market share, have three aspects.

26.1. First, Microsoft has a dominant share of PC operating systems because a much greater breadth, depth, and number of applications run on Windows than on other operating systems.

26.1.1. Users demand operating systems in order to run applications; and the greater the number, variety, and quality of applications available for a particular operating system, the greater the demand for that operating system.

i. In a Microsoft marketing plan entitled "Winning @ Internet Content" dated June 22, 1996, Andrew Wright wrote, "Microsoft's success to date as a platform company has primarily been driven by the availability of compelling applications for Microsoft operating systems. Operating systems, including Windows 95, Windows NT etc, are a means to an end and not an end in themselves. End users buy computers and operating systems to run applications." GX 407.

ii. Microsoft's Chris Jones wrote in August 1995 that: "While there are many factors which determine an OS purchase, fundamentally consumers purchase the system that runs the cool applications first and best." GX 523, at MS98 0103654.

iii. Avadis Tevanian testified that "the commercial viability of an operating system is critically dependent on the availability of application programs--including well-accepted, broadly-used application programs--that are written for use on that system." Tevanian Dir. ¶ 15.

iv. Microsoft admitted in its Answer that the "popularity of an operating system is to some extent a function of the number, variety, and quality of applications available to use with that operating system . . . ." Answer ¶ 58.

v. Microsoft's pricing decisions reflect the fact that Windows is demanded precisely because of the number of applications written for Windows. Kempin testified that "competitors are producing, essentially . . . inferior-type products" because "the number of applications written for [Windows] is so huge" is an observation of the "result of the applications barrier to entry, and it's a fairly clear statement." Kempin, 2/25/99pm, 98:15 - 99:5 (quoting Kempin's deposition, 21:20-22:6, 22:19-24). This, Professor Fisher explained, is exactly what one would expect Kempin, a non-economist, to say rather than saying "I am protected by the applications barrier to entry and so, I have freedom as to pricing." Fisher, 6/1/99pm, at 5:15 - 6:5.

vi. In arguing that "the availability of a set of high-quality applications" is "what is important" for the popularity of a platform (MPF ¶ 185), Microsoft attempts to back away from both its Answer and the testimony of Microsoft's and other companies' witnesses that the number and variety of the available applications affects the popularity of the platform. See

also infra ¶¶ 26.1.3 - 26.1.4. Microsoft's implication that plaintiffs' economists view the number of applications as the sole source of the applications barrier to entry is likewise in error. Plaintiffs' economists have consistently explained that end users "purchase operating systems in significant part based upon the quality and variety of applications." Warren-Boulton Dir. ¶ 53.

26.1.2. Applications written for one operating system generally do not run on another because each operating system has its own, unique set of application programming interfaces ("APIs") to which applications are written.

i. Because operating systems have different APIs, "software applications written for one operating system will not run well on any other operating system." Barksdale Dir. ¶ 71.

ii. See also Soyring Dir. ¶¶ 6-7 ("For an application to operate properly on an operating system, it must be designed to work" with that operating systems's APIs.); Gosling Dir. ¶ 12 (testifying that applications are largely "platform-specific"); Tevanian Dir. ¶ 12 ("Application programs must be developed so that they are compatible with the APIs of the underlying operating system. For example, Microsoft's popular word processing program, Word for Windows, will run on the Windows operating system; it cannot run on the Mac OS operating system.").

26.1.3. A vastly larger number of applications are written for Windows than the number written for other operating systems.

i. There are "tens of thousands" of applications that run on Windows. Martiz, 1/25/99pm, at 22:10-13; Rose, 2/17/99pm, at 24:24 - 25:9 (testifying that there are over 70,000 applications available for Windows).

ii According to Microsoft's own economic expert, the number of applications available for other operating systems is at least an order of magnitude lower. DX 2098 at E2, (reporting that approximately 12,000 applications are available for the Macintosh, 900 for BeOs, and 250 for Linux).

26.1.4. As a result, Microsoft has a dominant share of the installed base of operating system users and of the operating system market.

i. Microsoft's Brad Chase explained, "Content drives systems. Windows won the desktop OS battle because it had more applications earlier than any other platforms." GX 510 at MS7 004130.

ii. Microsoft's Ben Slivka testified that "an advantage Windows has today in the marketplace and why customers prefer Windows today over Macintosh OS or some other operating systems is that there are a large number of applications that customers need . . . that are available primarily on Windows or have their best expression on Windows." Slivka Dep., 1/13/99, at 717:22 - 718:4.

iii. Microsoft's own witness, Compaq's John Rose, conceded that the huge number of applications available for Windows relative to other operating systems is "certainly the prime reason" why Compaq lacks a commercially viable alternative to Windows. Rose, 2/17/99pm, at 19:21 - 20:20. As Rose elaborated (Rose, 2/17/99pm, at 24:24 - 25:9):

Q: Now, is it fair to say that the absence of any other operating system that can run those 70,000 applications or any predominant chunk of them is a prime reason why you believe there is not at present commercially viable alternative to Windows?

A: Yes, that is part of it.

Q: Okay.

A: The fact that other operating environments do not support that rich set of applications which are being utilized by hundreds of millions of personal computer users.

iv. Joachim Kempin testified that he didn't consider other operating systems in setting the royalty for either Windows 95 or Windows 98 because "'the simple fact that the number of applications, peripheral devices, support on that platform, basically, is so huge that the benefits for buying into that platform is huge'" Kempin, 2/25/99pm, at 98:18 -

99:5 (quoting Kempin's deposition). As Professor Fisher testified, Kempin's testimony reflects Microsoft's perception that it is "protected by the applications barrier to entry." Fisher, 6/1/99pm, at 5:13 - 6:5.

v. Packard-Bell's Mal Ransom testified: "There are appropriate applications, be they games or education or reference that are - that work with the operating system. That's a major factor for us in the consumer business that consumers can go buy solutions that match with our operating system. And Windows has really become a worldwide standard in that regard." Ransom Dep. (played 12/16/98pm), at 69:24 - 70:10.

vi. For additional evidence, see Von Holle Dep., 1/13/99, at 298:2-23 (testifying that Gateway lacks a commercially viable alternative to Windows because "there's not enough support in the form of applications in the marketplace to-to run on alternative operating environments"); Tevanian, 11/4/98pm, at 11:12 - 12:18 (testifying that "it's still the case that the predominant number of applications in the market do not run on the Macintosh, and because of that, most people will just refuse to buy a macintosh, they'll want safety in the applications that are on Windows").

26.2. Second, because of the economic incentives they confront, ISVs tend to write first and foremost to the operating system with the dominant share, which is Windows.

i. Professor Fisher testified that the principal reason "that ISVs write for Windows first," is that "there are economies of scale and it pays to write for the system that has the most users." Fisher, 6/1/99am, at 54:2-5.

26.2.1. Software development is characterized by substantial economies of scale. The fixed costs of producing software, including applications, is very high. By contrast, marginal costs are very low. Moreover, the costs of developing software are sunk; once expended to develop software, resources so devoted cannot be used for another purpose.

i. Paul Maritz testified that "software products can be produced and distributed in vast quantities very rapidly. Once a software product is created, the cost to copy is near zero, and the product can be quickly

distributed around the block or around the world via the Internet or other networks." Maritz Dir. ¶ 115.

ii. Intuit's William Harris testified that "the economics of software development make high volume sales critical to profitability. The fixed costs of developing software -- including, among other things, research, development, programming and testing -- are very large and can only be offset by high volume sales. By contrast, the variable costs of manufacturing software once it has been developed are quite low. Thus, it is essential for profitability of most PC-based software products that the product be compatible with Windows. At Intuit, compatibility with Windows is so critical that the company will focus on such compatibility even if this requires slowing or abandoning development of software for use with other operating systems." Harris Dir. ¶ 25.

iii. Dr. Warren-Boulton testified that "operating systems in particular, and software in general, are characterized by economies of scale. The bulk of the costs are development costs" whereas the costs "of producing and marketing individual copies of the product ('the marginal costs') are, by comparison, quite small." Warren-Boulton Dir. ¶ 47.

26.2.2. The result of economies of scale and sunk costs is that applications developers seek to sell the highest number of copies; for it is only through selling a large number of copies (for which the marginal cost is low) that the large, sunk fixed costs necessary to develop software can be recovered

i. Harris Dir. ¶ 25.

ii. Professor Fisher testified that because of the "upfront costs of writing the software" and the fact that marginal costs of distributing it are "essentially zero," ISVs will have "a big incentive to write for the most popular operating system and write for it first because you have the possibility of lots of sales, and that means your costs per sale will be very low." Fisher, 6/1/99am, at 59:10-16.

26.2.3. This creates overwhelming incentives to write first and foremost for

Windows because writing for Windows -- the operating system with the dominant share -- gives applications developers by far the highest expected return for the sunk costs incurred.

26.2.3.1. An application that is written for one operating system, like Windows, will operate on another operating system only if it is "ported" to that system. As numerous witnesses testified, porting applications is both time-consuming and expensive.

i. John Soyring testified that it took IBM "about a year and a half to port Netscape Navigator from Netscape's Windows implementation to OS/2, and that was having access to the Netscape source code and having the Netscape engineers working side by side with us in their laboratories in California." Soyring, 1/18/98pm, at 65:15 - 66:18; Soyring Dir. ¶ 7 (porting "can be both costly and time consuming.").

ii. Jim Barksdale testified that "it is time-consuming and expensive, however, to take a piece of applications software developed for the Windows platform and port it to the OS/2 or Macintosh platform or to some other platform." Barksdale Dir. ¶ 75.

iii. James Gosling testified that the "tedious process, which is known as 'porting' software to other platforms, dramatically increases the cost of software programs, and consumes scarce time and resources that could otherwise be devoted to developing innovative applications." Gosling Dir. ¶ 13.

26.2.3.2. As a result of these factors, ISVs tend to write applications first and foremost for the highest volume platform, Windows.

i. Microsoft's Steve Ballmer wrote in July 1997: "It's important for us to keep developer focus. And market share is an important part of that. If you don't have good market share, you're going to lose developer interest." GX 679, at 8.

ii. Intuit's William Harris testified that "it is essential for profitability of most PC-based software products that the product be compatible with Windows. At Intuit, compatibility

with Windows is so critical that the company will focus on such compatibility even if this requires slowing or abandoning development of software for use with other operating systems." Harris Dir. ¶ 25.

iii. Jim Barksdale testified that, because of Microsoft's large market share, "if anybody wants to build a product, they build it there first. You don't start a company building for some niche operating system. You always start with . . . the current version of Windows . . . if you're going to be out there selling any product, you have to be on that year's product or you can't succeed in any reasonable way." Barksdale, 10/27/98am, at 70:18 - 71:9; Barksdale Dir. ¶ 73 (Barksdale explains that "ISVs looking at this world quite sensibly write most of the software for the platform with the widest use. That means that most applications are written for the Windows platform.).

iv. Dr. Warren-Boulton testified that "market share is, . . . overwhelmingly, the critical issue in determining . . . developers' decisions." Warren-Boulton, 11/19/98am, at 86:14-16; Warren-Boulton Dir. ¶ 53 (testifying that the development of more applications for a given operating system "increases the value of the operating system to end users" who "purchase operating systems in significant part based upon the quality and variety of applications available for it." If the operating system's market share increases, "that, in turn, is likely to cause software developers to devote yet more resources to writing applications for that operating system").

v. Ron Rasmussen, Vice-President of the Santa Cruz Operation, testified at his deposition that "all the application vendors look at market share and the cost/benefit analysis of providing that application on any operating system. So if it costs them more than they believe they're going to get in revenue or if they believe their revenue is just a trade from one operating system to another, there's no financial benefit for producing that application on other operating systems." Rasmussen Dep., (played 12/15/98am), at 58:3-9.

26.3. Third, the result of the above factors is that Windows exhibits very strong

network effects that reinforce demand for Windows.

26.3.1. A network-effect is a phenomenon in which the attractiveness of a product increases with the use of that product by others.

i. Fisher Dir. ¶ 42.

26.3.2. Windows exhibits strong network effects because each user benefits from the fact that there are a multitude of other Windows users, that Windows has a dominant market share, and that ISVs therefore write first and foremost to Windows. The fact that ISVs write first and foremost to Windows, in turn, reinforces demand for Windows and thereby augments Microsoft's dominant position and perpetuates ISV incentives to write applications principally for Windows; and so on.

i. James Gosling testified that, as a result of the incentives to write "first" and often "only" for Windows (Gosling Dir.¶ 15), "more software applications are available for Windows users, which makes that platform even more attractive for customers. This, in turn, reinforces the dominance of Windows, and leads even more developers to develop software for Windows." Gosling Dir. ¶ 18.

ii. William Harris testified: "The development of software that is compatible with the Windows operating system itself reinforces the dominance of Windows, because consumers seek to purchase the operating system that is compatible with the greatest number of software applications. In turn, software producers want their products to be compatible with the operating system that is most widely used by consumers. This creates a self-reinforcing cycle (sometimes referred to as a 'network effect'), which tends to perpetuate and enhance the dominance of the leading operating system." Harris Dir. ¶ 27.

iii. James Barksdale testified: "Because so much software is written for the Windows platform, consumers who want to take full advantage of their computers and to have the maximum number of choices of applications available continue to purchase machines with a preinstalled Windows

operating system. At the same time, the more personal computers sold with Windows operating systems, the more ISVs continue to write applications for the Windows platform. In other words, the sale of computers with Windows operating systems feeds the development of software for the Windows platform, which in turn, generates additional sales of computers with Windows operating systems." Barksdale Dir. ¶ 74.

iv. Professor Fisher summarized: "Microsoft's high market share leads to more applications being written for its operating system, which reinforces and increases Microsoft's market share, which in turn leads to still more applications being written for Windows than for other operating systems, and so on." Fisher Dir. ¶ 70.

v. Dr. Warren-Boulton testified that the development of more applications for a given operating system "increases the value of the operating system to end users" who "purchase operating systems in significant part based upon the quality and variety of applications available for it." If the operating system's market share increases, "that, in turn, is likely to cause software developers to devote yet more resources to writing applications for that operating system." Warren-Boulton Dir. ¶ 53.

26.3.3. This self-reinforcing cycle is confirmed by the observed market facts: Windows' market share has been, and remains, much larger than rivals; most ISVs develop new applications first and in the great numbers for Windows; and the continued assurance of a large, up-to-date stock of applications for Windows ensures that users demand Windows.

i. See supra II.B.3.b.(1); ¶ 26.1.3.

ii. Dr. Warren-Boulton testified that "the applications barrier to entry sustains Microsoft's dominance" and because of it "no rival has succeeded in mounting a sustained effective threat to Microsoft's market dominance." Warren-Boulton Dir. ¶ 56.

iii. John Soyring testified that "OEMs have no commercially viable choice but to license Windows." Even though other operating systems exist, OEMs "cannot reasonably base their businesses on these alternatives, due, in large measure, to the lack of applications and device support."

Soyring Dir. ¶ 11.

iv. Microsoft's own ISV witness, Gordon Eubanks (former CEO of Symantec), testified that he expected each generation of Microsoft's operating systems to maintain Microsoft's "dominant" position in operating systems for five to ten years. Eubanks, 6/16/99pm, at 89:21 - 92:24.

(2) The same factors that reinforce Microsoft's large market share inhibit other operating systems from challenging Windows

27. Just as Microsoft's high market share creates incentives for ISVs to develop applications first and foremost to Windows, the absence of a significant installed base makes it much more expensive — indeed, prohibitively so — for other operating systems to ensure the availability of a sufficient set of applications to enable those operating systems to become good substitutes for Windows.

i. Professor Fisher testified that when a firm gains a large market share due to network effects, "it will prove increasingly difficult for other firms to persuade customers to buy their products in the presence of a product that is widely used. The firm with a large share may then be able to charge high prices or slow down innovation without having its business bid away." Fisher Dir. ¶ 43.

ii. Dean Schmalensee agreed with John Soyring's testimony that part of the reason for OS/2's failure was that "IBM did not have a sufficient number of applications to compete effectively with Microsoft." Schmalensee, 1/14/99am, at 34:15-25. Similarly, Dr. Warren-Boulton observed that "IBM has found with OS/2 that it is simply impossible to effectively compete with Microsoft in the home computer market because of the problem that it doesn't have enough applications." Warren-Boulton, 11/24/98am, at 53:5-8. This competition between OS/2 and Windows illustrates the operation of network effects, in which "the firm with the largest market share becomes larger and the firm with the smaller market share becomes smaller." Warren-Boulton, 11/24/98am, 52:20-21.

27.1. First, contrary to Microsoft's contention that all it takes to create a rival to

Windows is applications in a few key categories (Schmalensee, 6/22/99pm, at 60:12-20; Maritz, 1/27/99pm, at 10:2 - 11:2), to provide a viable substitute for Windows, a rival operating system would need to offer both (1) a large, diverse, and frequently updated set of applications and (2) assurances to users that such applications will be available in the future.

i. See supra II.B.3.b.(1); ¶ 26.2.3.

ii. Although both Linux and Be OS, two relatively new Intel-based PC operating systems, support several hundred applications -- including applications in the categories users tend to use most (such as word processing, personal finance, and browsing)-- neither, as Dean Schmalensee conceded, can effectively substitute for Windows. (Schmalensee Dir. ¶ 107, 108). The reason, as Microsoft's own OEM witness, John Rose, explained, is that such "operating environments do not support that rich set of applications which are being utilized by hundreds of millions of personal computer users." Rose, 2/17/99pm, at 24:24 - 25:9.

iii. Avadis Tevanian testified that Apple -- despite having thousands of applications, including applications in all the "categories" users frequently employ -- cannot gain users from Microsoft because "it's still the case that the predominant number of applications in the market do not run on the Macintosh, and because of that, most people will just refuse to buy a Macintosh, they'll want safety in the applications that are on Windows." Tevanian, 11/4/98pm, at 11:12 - 12:18.

iv. Paul Maritz conceded that other information devices, running other operating systems, cannot "be a real competitor" unless they support "a wide range of applications." Maritz, 1/27/99pm, at 11:3-24 (quoting Maritz's deposition).

v. Professor Fisher testified that an "entrant would have to get written for it -- and show that there was an assurance that this would continue -- applications of the general number and breath for Windows, and I would suppose that for the more popular applications, the entrant would probably need the same ones." Fisher, 1/13/99am, 5:9-14; Fisher, 6/1/99am, at 56:2-9 (similar).

vi. An internal Microsoft analysis done for Brad Chase on August 10, 1994,

more than a year before the release of Windows 95, noted that "large vendors like Corel, WordPerfect, and MicroGraphix have announced they are abandoning OS/2, it appears inevitiable the OS/2 applications market is going to shrink more." The memo continued, "So aside from a few native OS/2 applications, going forward the only applications available to OS/2 users will be today's MS-DOS and 16-bit Windows applications. Since these apps most likely won't be updated once Windows 95 launches, over time the experience of the OS/2 user will become akin to eating a steady diet of stale bread." In short, "there isn't a clear future for OS/2 users" GX 465 (emphasis added).

27.2. Second, Microsoft's large installed base makes it prohibitively expensive for rival operating systems to acquire the large set of applications necessary to compete effectively with Windows.

27.2.1. The sunk costs required for an operating system vendor itself to create the necessary applications itself are prohibitively large.

i. Dean Schmalensee conceded that no operating system vendor will develop the necessary applications on its own. Schmalensee, 1/14/99am, at 15:23 - 16:9.

ii. Professor Fisher testified that an entrant faced with incurring significant sunk costs for an uncertain return "isn't going to go in" because "it's going to have to battle the incumbent and because it will have to give up these hostages to fortune." Fisher, 6/1/99am, at 50:18-25.

iii. Dr. Warren-Boulton testified that "competition between two suppliers, each with very high fixed costs and very low marginal costs, would likely result in a decrease in prices, further reducing the profitability of entry to the would-be entrant. Entry into head-to-head operating system competition with Microsoft thus would be time consuming, risky, and costly; profiting from such entry would be at best very uncertain and long in coming." Warren-Boulton Dir. ¶ 48.

27.2.2. Accordingly, in order to ensure the availability of a set of applications

comparable to that available for Windows, a potential rival would need to induce a large number of ISVs to write to its operating system.

i. Dean Schmalensee testified that the question is whether "the ISV community, can be convinced to provide applications programming for an alternative operating system." Schmalensee, 1/14/99am, at 15:23 - 16:9.

ii. Dr. Warren-Boulton testified that to "offer a product that a significant number of consumers wish to have installed on their PCs," vendors of alternative "operating systems would have to create, or induce others to create, an extensive set of compatible software applications. This would be not merely expensive, but also very risky." Warren-Boulton Dir. ¶ 57.

27.2.3. The cost to an entrant of inducing ISVs to write applications for their operating system exceeds the cost faced by Microsoft when it induced ISVs to write applications for the DOS and/or Windows operating system because Microsoft did not face a highly penetrated market dominated by a single competitor.

i. Professor Fisher testified: "After Microsoft's victory, the cost of pursuading ISV's to build such a stock rather than write for Windows has got to be much more substantial than it was for Microsoft to persuade them in the first place." Fisher, 6/1/99am, at 53:22 - 54:1.

27.2.3.1. In deciding whether to write for a particular operating system, an ISV will consider the return it expects from incurring sunk costs, and that depends on the number of users it expects the operating system will have.

i. Dr. Warren-Boulton testified that it is not the return if the firm succeeds that governs investment decisions, but rather expected return, including the risk if the venture fails. Warren-Boulton, 11/19/98pm, at 52:11 - 53:7, 70:2 - 71:10.

ii. Dean Schmalensee testified that "ISVs will not write applications software for an operating system unless they expect enough consumers to use that operating system." Schmalensee Dir. ¶ 100; Schmalensee, 6/23/99pm, at 59:10-22 (same).

27.2.3.2. ISVs will not in large numbers expect that a niche (or new) operating system will succeed in competing against Windows because ISVs face a "collective action problem": a rival operating system cannot succeed without a large number of applications, but no individual ISV can be assured that a sufficient number of ISVs will write all the applications necessary for rival operating systems to succeed. As a result, each individual ISV will continue to write first and foremost for Windows because that is what it will expect its rivals to do; and other operating systems will therefore be unable to gain appreciable share from Windows.

i. Professor Fisher testified that for a new operating system vendor to be successful, it "takes an awful lot of people" writing applications. But in assembling this critical mass, there "is a collective action problem. That is, in deciding to write for a new system, each ISV will not take into account the fact that his action" will have "some influence on the success of the new operating system." Fisher, 6/1/99am, at 58:10-18.

ii. Tevanian testified, regarding Apple's inability to persuade developers to write for the proposed Rhapsody operating system: "Developers, including Microsoft, told Apple that they were concerned that Apple would not be able to obtain a critical mass of application programs written to work with the new Rhapsody APIs and that customers, accordingly, would not buy computers containing the new operating system." Tevanian Dir. ¶ 19.

iii. Dr. Warren-Boulton summarized developer incentives: "If you think of it as a trojan horse, any individual applications writer looks at the market for operating systems, and he says, 'I'm writing to the PC platform. 90, 95 percent of the people who

are likely to use my application are using Windows; and therefore, it's worth it for me individually to make a decision to use J/Direct.' On the other hand, if you look at the interests of applications writers as a whole, if they all do that, nobody will write in cross-platform applications. So, it is a quandary. What is in the interests of individual application writers to do may not be in the interests of applications writers as a group." Warren-Boulton, 11/23/98pm, at 40:2-13.

iv. Microsoft's Steve Ballmer wrote in July 1997: "It's important for us to keep developer focus. And market share is an important part of that. If you don't have good market share, you're going to lose developer interest." GX 679, at 8.

v. William Harris explained that, because of Microsoft's dominant market share, Intuit had "abandoned development of Macintosh-compatible versions of QuickBooks and has dramatically reduced development of Macintosh-compatible versions of Quicken and TurboTax." Harris Dir. ¶¶ 25-26.

27.2.3.3. A rival operating system vendor cannot effectively solve this problem by paying the necessary number of ISVs to write for its operating system because the sunk costs of doing so are massive relative to the expected return.

i. Professor Fisher testified that one "might pay ISVs to write to your operating system. That in itself is part of the barrier to entry, that you have to pay them to turn away from Windows." Fisher, 6/1/99am, at 55:23 - 56:1. He further testified that doing so in order to challenge Windows was infeasible because of the very collective action problem that prevents ISVs from doing so on their own. He explained: "There is a collective action problem. That is, in deciding to write for a new system, each ISV will not take into account the fact that his action will have something to do with the success of . . .some influence on the success of the new operating system, because he won't reap all the rewards from that. It takes an awful lot of people doing this to make it a go." Fisher, 6/1/99am, at 59:2-18.

ii. John Soyring testified that "Microsoft's enormous installed

base, along with the wealth of applications and hardware device support for Windows, noted above, makes it difficult for IBM or any other company to successfully offer a new operating system for desktop and mobile PCs. Any company that attempted to do so would have to spend an enormous amount of money and time on development, marketing, and support." He further observed that this "task would be easier if there were some reasonable way to ensure that all the applications now on Windows would run on the new product. Unfortunately, there is not." Soyring Dir. ¶ 13.

iii. MCI's David Limp testified that "it would be hard to get into the PC space" because: "There's a lot of home-grown application development, which has been written directly to Windows and Win--not to the languages of the Web but Windows languages, that unseating that is--you know, I tried it for eight years of my life at Apple. It's just a very hard problem, and it takes a lot of resources, and nobody has been successful, so, I mean, just putting on your business hat, you kind of veer to the easier problem, right? And that's a hard problem. IBM couldn't do it. Sun is having a tough time. Apple basically couldn't do it, so it's an uphill battle and, and we chose to fight our competition in an area that was more wide open that we could define ourselves, that was--that we could redefine the playing field." Limp Dep., 7/30/98, at 143:6-25 (DX 2576).

iv. James Gosling testified that "it's very difficult for a developer to financially justify developing software for a platform like Solaris which has very low volume. The differential between Solaris and Windows is something like a hundred to one, which would mean the financial return would be about a hundred to one different, and yet the engineering effort is about the same." Gosling, 12/10/98pm, at 26:16 - 27:3.

(3) The persistence of Microsoft's huge market share is itself evidence of high entry barriers

28. That Microsoft's monopoly is protected by high entry barriers is reflected in the fact that,

for the last several years, Microsoft has possessed a dominant share of the market and other operating systems have gained no more than a trivial share of the market.

i. Dr. Warren-Boulton testified that "the applications barrier to entry sustains Microsoft's dominance, critically contributes to its monopoly power, and helps explain why other Intel-compatible operating systems, such as OS/2 and Linux, have persistently small market shares." Warren-Boulton Dir. ¶ 56.

(4) The testimony of Apple and IBM illustrates the strength of the applications barrier to entry

29. The experience of Microsoft's most significant operating system rivals in the middle and late 1990s, IBM and Apple, confirms the strength of the applications barrier to entry.

30. IBM's inability to gain widespread developer support for its OS/2 Warp operating system illustrates how the massive Windows installed base makes it prohibitively costly for a rival operating systems to attract applications sufficient to substitute for Windows.

30.1. IBM in 1994 introduced its Intel-based OS/2 Warp operating system, targeted at the consumer market, and spent tens of millions of dollars in an effort to attract ISVs and in an unsuccessful attempt to clone part of the Windows API set.

i. Soyring testified that IBM "spent tens of millions of dollars working with ISV's around the world . . . to try to convince them to develop" for OS/2. Soyring, 11/18/98pm, at 58:20 - 60:1, 66:19 - 67:8.

ii. Soyring further testified that IBM devoted substantial resources in an ultimately unsuccessful attempt to clone part of the Windows API set. Soyring, 11/18/98pm, at 61:15 - 62:1.

30.2. Despite these efforts, IBM could obtain neither significant market share nor ISV support for OS/2 Warp.

i. Soyring testified that, even when "it would have made economic sense for an

ISV to port their application to OS/2, many times they felt those programmers could be better spent building new functions or new applications for Windows because it provided a potential for greater economic return for them" and because "of the larger number of . . . Windows application users." Soyring, 11/18/98pm, at 67:11-24.

ii. As Soyring summarized, IBM found that it was caught "in a vicious cycle. First, the limited number and type of OS/2 applications has resulted in a limited demand for OS/2. That, in turn, has meant that relatively few PCs are shipped with OS/2, and that the installed base of OS/2 is relatively small. This relatively small installed base of OS/2 installations has further reduced the incentive for application developers to spend the resources necessary to port their existing applications to OS/2 and to then offer and support them on OS/2." Soyring Dir. ¶ 9.

iii. OEMs -- including IBM's PC business -- will not preinstall OS/2, and the reason is the absence of applications. Romano Dep. (played 12/16/98pm), at 33:4-19 (Hewlett Packard has "not seriously" considered installing OS/2); Ransom Dep. (played 12/16/98pm), at 70:11 - 71:8 (OS/2 was "trying to make a push at the consumer market. And the big problem with it is we needed OS/2 plus Windows because OS/2 did not have the compatibility. OS/2 was an operating system and worked fine on the systems, but you needed Windows for the compatibility of all the applicants. So it didn't make any sense resource-wise -- and by resource, I don't mean just double charging, but the resources of the machine to have two operating systems on it."); Romano Dep. (played 12/16/98pm), at 72:5-23 (because of the lack of applications compatible with OS/2, it was not a viable choice for Packard Bell.).

30.3. Thus, although at its peak OS/2 ran approximately 2,500 applications and had 10% of the market, IBM determined that the applications barrier to entry was too severe to compete against Windows in the consumer segment of the market and, for that reason, in 1996 stopped trying to convince ISVs to write to OS/2.

i. Soyring Dir. ¶ 5; Soyring, 11/18/98pm, at 61:2-4.

ii. Soyring testified that IBM determined that it "would not be able to compete" against Windows because the "application barrier was just too high for us to be able to compete" by promoting "OS/2 Warp 3 to consumer users." Soyring,

11/18/98pm, at 99:22 - 100:5. Thus, he explained, in 1996 IBM stopped trying to induce developers to write for OS/2's APIs altogether because of it's inability to compete against Windows. Soyring, 11/18/98pm, at 93:19-21.

iii. Dean Schmalensee agreed with Soyring's testimony that part of the reason for OS/2's failure was that "IBM did not have a sufficient number of applications to compete effectively with Microsoft." Schmalensee, 1/14/99am, at 34:15-25.

iv. Dr. Warren-Boulton testified that "IBM has found with OS/2 that it is simply impossible to effectively compete with Microsoft in the home computer market because of the problem that it doesn't have enough applications." Warren-Boulton, 11/24/98am, at 53:5-8. This competition between OS/2 and Windows illustrates the operation of network effects, in which "the firm with the largest market share becomes larger and the firm with the smaller market share becomes smaller." Warren-Boulton, 11/24/98am, at 52:20-21.

30.4. Microsoft's contention that OS/2's failure was a consequence of IBM's own mistakes is misplaced because it confuses the reasons for the failure of early versions of OS/2 with the reason -- the applications barrier to entry -- that OS/2 Warp cannot gain substantial market share today.

i. As Soyring testified, IBM rectified many of OS/2's problems by the time of OS/2 Warp's release. Soyring explained that "the reductions in size that we made in the operating system program were such that it made it very competitive in terms of the amount of memory that was required, so it turned out to be quite suitable, and we had a fair amount of success initially selling the products at least to a particular subset of the home users." Soyring 11/18/98pm, at 58:25 - 59:7.

ii. Microsoft suggested that OS/2 Warp failed because IBM didn't spend enough to attract developers. Soyring, 11/18/98pm, at 92:20 - 93:1. This, however, is entirely consistent with the applications barrier to entry. As Soyring testified, because of Microsoft's installed base, the cost to IBM of attracting significant developer interest was prohibitive. Soyring Dir. ¶ 13.

31. The inability of Apple effectively to compete with Windows also evidences the operation of the applications barrier to entry.

31.1. Although Apple's Macintosh operating system supports more than 12,000 applications, that stock of applications is not sufficient to enable Apple to substitute for Windows for a large number of users.

i. Avadis Tevanian testified that "the predominant number of applications in the market do not run on the Macintosh, and because of that, most people will just refuse to buy a Macintosh. They'll want safety in the applications that are on Windows. Or in some cases they'll be required to run Windows. For example, in almost every corporation in the world, they have to run some specific applications that are only on Windows." Accordingly, despite the fact that the iMac is selling well, "in the grand scheme of things, there is still the Windows monopoly, that it's a situation where people need to run Windows applications, and they buy Windows computers." Tevanian, 11/4/98pm, at 11:21 - 12:13.

ii. Dr. Warren-Boulton testified that there are approximately 12,000 applications available for users of the Macintosh operating system, but that Apple cannot constrain Microsoft's ability to exercise market power. Warren-Boulton, 11/23/99pm, at 16:7-13.

31.2. The absence of a large installed base, in turn, reinforces the disparity between the applications available for the Macintosh operating system and those available for Windows, further inhibiting Apple sales.

i. Microsoft's Paul Maritz conceded that "fewer software developers create products for the Apple Macintosh because there are fewer Apple Macintosh customers to buy such products." Maritz Dir. ¶ 179.

ii. Apple's Avadis Tevanian testified that an "application program is condemned to commercial failure if it will not operate reliably on the operating system of a sufficiently large installed base of computer systems. Similarly, the commercial viability of an operating system is critically dependent on the availability of application programs--including well-accepted, broadly-used application programs--that are written for use on that system." Tevanian Dir. ¶ 15. Consequently, "Apple has learned through experience" that "the symbiosis between operating system[s] and application programs creates significant barriers to the introduction and growth of competing operating systems." Id. at

¶ 16.

31.3. Also illustrative is Apple's inability to gain developer support for its Rhapsody operating system in 1997.

31.3.1. Rhapsody offered users new, attractive technologies; but taking advantage of these technologies would have required ISVs substantially to rewrite their applications, a process requiring a substantial investment and, therefore, a significant volume of sales to recoup.

i. Avie Tevanian testified that "the biggest reason" ISVs would not write Rhapsody applications was that "they needed to have an economic incentive, they needed to know that they could sell a lot of copies of their applications; and to sell a lot of copies of their applications, they needed to know that there were going to be lots of copies of the operating system, and they just didn't believe that Apple had any chance of selling a lot of copies of this operating system." Tevanian, 11/4/98pm, at 44:5-13.

31.3.2. Developers refused to make this investment because they did not believe that Apple could gain significant volume against Windows to make the additional sunk costs worthwhile.

i. Tevanian testified that developers "didn't see that Apple would ever get sufficient volume on Rhaspody so that they thought they would have an economic return on their investment." Tevanian, 11/4/98pm, at 83:20-23.

ii. Tevanian explained that the Windows installed base was the reason why developers thought Apple "had no chance of achieving any significant volume with a new operating system." Tevanian, 11/4/98pm, at 85:19-23.

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31.3.3. Other reasons may have contributed to Rhapsody's failure -- Apple's

financial difficulties and Microsoft's refusal to support its ability to work with Windows NT -- do not detract from the illustration Rhapsody provides of the applications barrier to entry.

i. The very document Microsoft introduced in support of its assertion that Apple's financial distress hurt Rhapsody shows, in fact, developer concern as to whether Apple could gain sufficient share to make their investment worthwhile. DX 1769 ("For Developers, the ramp for Rhapsody is not irrelevant."); see also Tevanian, 11/4/98pm, at 96:23 - 99:23.

ii. The force of the applications barrier to entry is demonstrated by the steps Apple took following Rhapsody's initial failure. Apple incorporated some of the Rhapsody technology into its new Macintosh operating system in a way that did not require ISVs significantly to rewrite their applications. As Tevanian testified, this greatly reduced the costs to developers of supporting Rhapsody because: "The economic model for them is very simple. They just keep their existing investment." Tevanian, 11/4/98pm, at 91:13-21. In short, ISVs are willing to develop for Apple when they can recoup their past investments. But because of the Windows installed base, they are generally unwilling to make substantial investments required "to go into new areas." Tevanian, 11/4/98pm, at 83:2-7.

31.3.3A. Although Microsoft argues that Apple's planned Rhapsody operating system was not "a casualty of the 'applications barrier to entry'" (MPF ¶ 207), the evidence that it cites proves the opposite.

i. Rhapsody failed as a replacement for the Mac OS partly because, according to Microsoft, "Apple had informed ISVs that Rhapsody would be largely incompatible with existing Macintosh applications, making the benefits of the new platform unclear." MPF ¶ 209. Because Rhapsody was not compatible with the Mac OS (MPF ¶ 207), it could not take advantage of the existing base of applications and users. As Microsoft acknowledges, "ISVs could not get 'excited' about Rhapsody because it would have required them to rewrite all of their existing Macintosh applications. (DX 1760 at 6)" MPF ¶ 210.

ii. Further, Microsoft argues, Rhapsody failed as a replacement for the Mac OS partly because ISVs were concerned that Apple as a company might fail and leave their investments stranded, with no operating system on which to run. MPF ¶¶ 207, 208, 210. As explained, the large sunk costs involved in writing software -- particularly software as complex as an operating system -- mean that ISVs are reluctant to make such investments unless they believe the base of available and future purchasers is large. See supra II.B.3.b.(2); ¶ 27.2.3**.**

iii. Ultimately, Microsoft concedes, "ISVs were relatively content with the Mac OS and did not want to spend time and money rewriting their Macintosh applications for a new operating system. Nov. 4, 1998 P.M. Tr. at 85-89 (Tevanian)**;** DX 1769**.)" MPF ¶ 211.**

c. Other entry barriers reinforce the applications barrier to entry

32. Although the applications barrier to entry is an important factor that prevents other operating systems from developing into reasonable substitutes for Windows, other factors also inhibit the ability of other operating systems to enter or expand.

32.1. Switching costs. Switching to a new operating system requires users of existing systems to scrap existing investments in applications, training, and certain hardware.

i. Dr. Warren-Boulton testified that computer users "are reluctant to switch from Windows to another operating system, even another PC operating system, because to do so requires them to replace application software, to convert files, and to learn how to operate the new software. Often, switching also means replacing or modifying hardware. Businesses can face even greater switching costs, as they must integrate PCs using the new operating systems and application software within their PC networks and train their employees to use the new software." Warren-Boulton Dir. ¶ 49; id. ¶ 36.

ii. James Gosling testified that a Windows user switching to the Apple iMac would "have to buy every piece of software all over again." Gosling, 12/10/98pm, at 19:15 - 20:1.

iii. **Microsoft and Dean Schmalensee recognize the importance of switching costs when they note the advantages to being the "first mover" in a software category . Schmalensee Dir. ¶ 111; Schmalensee, 6/22/99pm, at 57-58; MPF ¶ 178.**

32.2. Other network effects. In addition to augmenting ISVs' incentives to write for Windows, Microsoft's high market share increases the value of Windows in other ways. These include, among other things, common file formats and low training costs because of user familiarity.

i. Professor Fisher testified that the ubiquity of Windows "may enable firms to avoid training costs when personnel are moved within the firm or new personnel are hired from outside. This gives firms an incentive to have the same user interface throughout its own computers and the same interface that is widely used by other firms. Other network effects include the ease of exchanging files and the opportunity to learn from others." Fisher Dir. ¶ 67.

ii. Dr. Warren-Boulton testified that switchers to another platform would "need to expend time and money learning how to use a computer designed for a different processor. And both switchers and new users would have to bear costs resulting from any incompatibility or impaired compatibility between their computer and PCs used by colleagues or others with whom the users may wish to communicate or share files." Warren-Boulton Dir. ¶ 17.

iii. Dr. Warren-Boulton also testified that the applications barrier to entry "is supplemented by other barriers to entry that derive from network effects. Books, publications, training, user groups, and news groups for the incumbent operating system product provide a large sense of community for its users. Users can exchange files, and perhaps more readily use their computers to communicate, with other members of the group. Finally, when the incumbent operating system is installed at work, it leads users to select the same operating system product for use at home." Warren-Boulton Dir. ¶ 55.

iv. "It's important for them to be able to leverage one web browser class -- for example, a training session -- among all the various users of that browser, so

that, to the extent it's possible, you want the features of that browser to look and feel and act and work the same, regardless of whether the employee is running a Unix work station or an Intel-based PC." Weadock, 11/17/98am, 19:25 - 20:6 (discussing GX 217, at MS98 0109146) (corporations "want a common platform for web apps, basic end user feature similarity, simship, and it is the number one reason corps and ISPs wait or don't go with IE as std. browser")

32.3. Sunk costs of developing an operating system. Like other software, developing an operating system requires incurring significant sunk costs (although actual production costs are low), and the significant sunk costs that must be incurred to develop an operating system deter entry.

i. Dr. Warren-Boulton testified: "If you build an operating system and you fail, you can't take the OS and do much else with it. That money is gone. And that makes it into a very risky business. And economists generally recognize that the higher the share of costs that are sunk, the greater the barrier to entry into that business, which really makes good sense." Warren-Boulton, 12/1/98am, at 31:2 - 31:8.