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November 7, 1989

Mr. Russell Werner
General Manager of Dos/Windows
Microsoft Corporation
16011 NE 36th Way
Box 97017
Redmond, WA 98073-9717

RE: Lotus 1-2-3 3.0 and Windows 386 Enhanced Mode

Dear Russ:

Your 10/24 phone call including Bill Gates, Marc Wilson and Carl Young and your letter to me dated 10/30 clarified to me where some of ~~the~~ your confusion lies regarding our proposal for VCPI/1-2-3 Release 3.0 support under Windows 386 Enhanced Mode.

Carl, Ben and I got together recently to produce the attached memo, which should clarify our earlier proposal to make 1-2-3 Release 3.0 work in this environment. One new observation is worth mentioning: while 1-2-3 is running in foreground, we believe there is no need to suspend other background tasks.

I hope to speak with you after you have had time to digest our proposal.

Sincerely,

David P. Reed
Vice President
Chief Scientist/Spreadsheets

cc: Frank King
Frank Ingari
Carl Young
J. Ben Williams
Bill Gates

Making 1-2-3 3.0 and Windows 386 Enhanced Mode Coexist

By David P. Reed
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Lotus Development Corporation
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1 Introduction

We have reviewed the Microsoft technical paper that summarizes the difficulties that Microsoft believes exist in supporting a VCPI based application such as 1-2-3 Release 3.0. In the following sections, we will describe in some detail why we feel that many of these difficulties either do not exist, or can be minimized for most of our customers.

We feel strongly that the primary customer benefit of Windows 386 is that it provides a platform for running multiple *existing and installed* DOS and Windows applications on a single machine. We believe that a few relatively minor extensions to the existing Windows 386 enhanced mode software will allow 1-2-3 Release 3.0 and other important commercial applications to be added to this set of applications. Requiring these applications to run in standard mode places unnecessary restrictions on users that wish to take advantage of enhanced mode features (paging and background execution) in running other applications on their machines. We are certain that Microsoft and its Windows OEMs share our concern that omitting support for these VCPI-based applications will cause unnecessary confusion in the market and will slow acceptance of Windows 386.

In this document, we propose a compromise in which some easily documented limitations on the use of 1-2-3 Release 3.0, combined with a few extensions to Windows 386, would allow these products to coexist in a very powerful way. 1-2-3 will operate exactly the same as any other DOS application, with the exception that its execution will be suspended when not in full screen mode. 1-2-3 will have acceptable performance when it is running, its memory management will interact smoothly with Windows 386, and the user will have full hot key access to other DOS and Windows applications.

The sections below correspond to their counterparts in the Microsoft document.

2 Philosophy

This section makes two main points. The first applies to the benefits of virtualization in supporting multiple DOS applications on a single computer, and it implies that the design goals of Windows 386 and VCPI are in conflict in this regard. The second point seeks to impute a greater degree of inter-application security to Windows 386 without VCPI.

In fact, the design goals of Windows 386 and of VCPI are orthogonal. Windows 386 is designed to allow the multiplexing of multiple DOS applications on a single machine, and this is the reason that it has become a popular platform. Virtualization of system resources is one technique that help Windows to provide this service. VCPI, on the other hand, is a protocol that allows a single DOS application to gain access to the protected mode of the processor and to directly access extended memory. While we grant that the presence of a VCPI application makes virtualization difficult or impossible in some cases, we have repeatedly stated that we are willing to give up virtualization in those cases. For example, we will not require that the VCPI application be able to use demand paged memory, nor that it be able to share the screen with other DOS virtual machines. Neither will we require that the VCPI machine be able to run as a background task.

While it is true that the Windows 386 control program is not protected from a VCPI client that is running in ring zero, there are two important points that should be noted. First, the Windows 386 control program is no more exposed to a VCPI client than the Windows kernel is to a Windows application in the Windows DOS machine. Second, the INT 31 interface that Microsoft has proposed as a replacement for VCPI exposes the control program to the client to exactly the same degree. Finally, all existing VCPI applications (which are the only ones that we are concerned with) have been extensively proven in the field. To summarize, we feel that VCPI support does not present a significant security exposure beyond what Windows already tolerates and what Microsoft has proposed for the future.

3 1-2-3 Running in Various Modes of Windows 3.0

We are somewhat baffled by the table in this section. Taking it line by line, we have the following comments:

• Relative Speed.- We have no reason to believe that 1-2-3 Release 3.0 will be any slower when it runs under the 386 Enhanced mode.

• 3270 TSRs. The table says they are not supported, but there is no backup to this in the rest of the document. 1-2-3 routinely runs with 3270 TSRs in ordinary DOS machines.

• Hot Key to Windows. We will explain in a later section why this can be supported.

• Background Application. We will explain in a later section why background applications can continue to execute when 1-2-3 is in the foreground.

• Relative Memory Size. Several reasons are given for why the VCPI application will have less memory available. One reason is that Windows support for paged virtual memory will not be available. While this is true, it ignores the fact that the VCPI application may have its own memory manager (which 1-2-3 does), which may be no less efficient than Windows'. A second reason that less physical memory is available is that the Windows kernel is not paged out while the VCPI machine is running; we don't understand why this needs to be true.

The footnote to this section contains a warning that EMS virtual memory would not be supported. This is irrelevant, since 1-2-3 Release 3.0 does not use EMS memory in a VCPI environment.

4 Implementation

This section makes the point that "Since the VCPI application cannot be paged out, even when it is not running, it must remain in physical memory until it is exited." We do not agree. First, 1-2-3 Release 3.0 is insensitive to the physical addresses that are in it's page tables, which means that the tables can be modified by the control program when switching to and from the VCPI application. Second, the VCPI application's page tables are at a fixed location that is communicated to the control program; this would allow the control program to page the memory image to and from any available physical memory locations. The only requirement is that when the VCPI application is in control, all of its pages must be resident.

Finally, the section states that Windows PIC mapping is incompatible with VCPI. While this may be true for some applications, 1-2-3 Release 3.0 does not reprogram the PIC, so we feel that this is not an issue.

5 Implementation Details and Implications

This section make some sweeping statements about the difficulties of solving the problem of hardware virtualization in general. While these difficulties are real, we do not require a general solution to support 1-2-3. In order to support 1-2-3's use of VCPI, it possible to divide devices to be virtualized into two classes: the screen and everything else.

We have already stated that we don't require a virtualized screen. When 1-2-3 is running in the foreground, it will run as a full screen application. When it is in the background it is dormant. So the only thing that the Windows control program needs to do is capture and restore the state of the screen when switching to and from the VCPI machine; this is technology that the current version of Windows already has, so we assume that this is not a problem.

For all other devices, there are two communication paths: interrupts and port I/O. The only time that 1-2-3 does port level I/O is when the user attempts to directly control a local printer or communication port; however, 1-2-3 contains alternate mechanisms to control these devices that utilize the DOS file system to access LPTx and COMx. We will insure through documentation and support that our users understand how to use these options.

In 1-2-3 Release 3.0, all interrupts are immediately reflected to "real mode" via the VCPI; this means that the control program can support virtualization with a minimum of latency. Either the "switch to V86 mode" VCPI call (code DE0Ch) can be used to trap the interrupt, or it can be done in the control program provided "real mode" interrupt handler itself.

This section makes a great deal of the need to re-program the PIC on every protect to real mode switch; since 1-2-3 neither reprograms the PIC nor has any dependency on its contents, we see no need to do this. Our only requirements are that interrupts 9 and 1C are signalled to our "real mode" hooks at the correct times, and that the 1C interrupt is signalled at approximately 18Hz. Note that although 1-2-3 hooks the keyboard interrupt, it does not do any port I/O to the keyboard controller (we use the interrupt only to note that a key might be present).

Finally, it is stated that it will be impossible to hot key from 1-2-3 to Windows, and that the only way to switch away from the application will be to exit. Based on the fact that 1-2-3 does not interfere with keyboard interrupts in any way, we see no reason that this should be true. It should be possible use the standard hot key to freely switch between 1-2-3 and other virtual machines. If 1-2-3 is in protected mode when the hot key is pressed, the interrupt is immediately reflected to "real mode", and Windows can run the VKD's interrupt handler at that time; note that this process is independent of whether the VKD is provided by Microsoft or some OEM.

Note that the use of page faults to handle context switching is irrelevant to the VCPI. We have already stipulated that the VCPI machine need not be run in the background. We see no reason why other virtual machines would be impaired in their operation while the VCPI machine is in the foreground; an interrupt that occurs while the VCPI machine is in protected mode is reflected immediately to the control program; the latency between the interrupt and it's reflection to the VxD could be as little as 10 microseconds if it is intercepted by the DE0C call, or up to 75 microseconds if it is delayed until the machine is in V86 mode.

6 Summary

We believe that with a small number of extensions to Windows 386 enhanced mode, the users of 1-2-3 Release 3.0 will be able to run in a Windows 386 virtual machine with the following three restrictions:

- 1-2-3 will only run as a foreground, full screen application. When another application is switched to the foreground, the operation of 1-2-3 will be suspended.

- 1-2-3 memory will not be demand paged by Windows while 1-2-3 is running. However, its memory can be swapped to disk when it is not in the foreground. Note that the PIF file can be used to limit the maximum amount of memory that is available to 1-2-3, in order to guarantee that enough memory will be available to other applications running in the background.

- 1-2-3 users will have to use DOS file naming to access serial and parallel printers.

In order implement this support, Microsoft would have to do the following:

- Implement support for a subset of the VCPI; the subset includes calls DE00, DE01, DE04, DE05, DE06 and DE0C. Typical implementations have taken from 2 to 6 programmer weeks; however, we realize that the Windows version may be more complex. Note that because we use only a subset of the VCPI, and because 1-2-3 is a well behaved client, there are a variety of programming shortcuts and conveniences that can be used to ease the implementation.