Applying Distributed Computing Technology to MSC Software Applications

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Abstract

This paper describes ways in which MSC product users can enhance their productivity and efficiency through the use of distributed computing environments. These environments consist of protocols, interfaces, and services that permit both users and their applications to access data and resources across a heterogeneous network. Several components of distributed computing environments and their relevance to MSC product users are discussed. Sample distributed configurations are described along with their comparative benefits. A table is also provided that denotes four levels of "interoperability" attainable between MSC/XL platforms and selected MSC/NASTRAN platforms.

Introduction

The MacNeal-Schwendler Corporation historically has provided tools to facilitate the sharing of MSC/NASTRAN[1] results data between different types of computers. However, one important benefit of modern distributed technology is that users can now eliminate many of the intermediate steps that were previously required when transferring MSC/NASTRAN data across a network of heterogeneous computer types. As this paper will show, computer vendors are increasingly adopting common standards for data representation and file exchange. Accordingly, users can now send and receive MSC/NASTRAN output more easily and efficiently.

In the timesharing environments of the early 1970s almost all programs were batch oriented. They were typically invoked using an interactive command interpreter. Besides the interpreter, only a few other programs such as editors and mail programs needed to be interactive. In contrast, the personal workstations used today, with their graphics displays and mice, encourage a different structure in which interactive programs execute within a windowing environment and can be manipulated directly using a mouse. The ability to have several interactive applications that are active simultaneously is attributable directly to the substantial increase in processing power of today's workstations.

Workstations have been designed to be stand-alone devices but also capable of networking with other workstations, mainframes, and PCs. Advances in network technology during the 1980s have made it possible for workstation users to have transparent and localized access to data residing on other computer systems at remote locations. The fact that different computer hardware and operating systems are present on the network is of little consequence because each device recognizes common communication protocols and common formats for file exchange and data transmission. For MSC software users, the ability to control applications resident on other computers and view, retrieve, and manipulate data across a heterogeneous network can streamline the design-analysis cycle in two major areas.

The first benefit is that, thanks to distributed systems such as Network File System (NFS), a finite element model produced by MSC/XL[2] on one computer can be read transparently by MSC/NASTRAN residing on another computer without the need to manually move the file. MSC/NASTRAN results data can be retrieved and read back into MSC/XL in an equally transparent fashion. The second benefit of distributed technology is that many (although not all) MSC/NASTRAN and MSC/XL platforms—both workstations and mainframes—now adhere to the IEEE floating point format for the representation of data in files. For IEEE machines, it is usually not necessary to run MSC/TRANS and MSC/RECEIVE in order to convert results databases from one machine-specific format to another. As this paper will show, implementing distributed technology to eliminate the need to manually move files and the necessity of translating files into machine-specific formats can simplify the analyst's job significantly.

The Design–Analysis Cycle

Typically, once the finite element model is created within MSC/XL, the user prepares an input file for MSC/NASTRAN. (An equivalent MSC/EMAS[3] input file is prepared when electromagnetic analysis is involved.) The MSC/NASTRAN input file is a text file that defines the model's finite element mesh (grid points and element connectivity), its physical characteristics (material properties), and boundary specifications (loads and constraints). MSC/XL Version 2A supports the majority of Executive control statements, Case Control commands, and Bulk Data entries. For unsupported statements, commands and entries, the user can use the MSC/XL Edit Exec, Edit Case, and Edit Bulk commands, respectively, to specify any additional data.

The MSC/NASTRAN input file produced by MSC/XL must be "moved" somehow to the computer on which MSC/NASTRAN resides. This text file is then read into MSC/NASTRAN and finite element analysis is performed. Once the analysis run is completed, MSC/NASTRAN produces a results database (an XDB file) which has a binary machine–specific format.

In order to process these results on the MSC/XL computer, the XDB file must first be converted into a neutral format via the MSC/TRANS utility. This neutral results file is then "moved" back to the computer on which MSC/XL resides. The MSC/RECEIVE utility is executed to convert the neutral results file into a XDB file readable by the computer on which MSC/XL resides. Once the XDB file is read by MSC/XL, the results can be displayed in a variety of formats.

The cycle described above is highly iterative, but, in general, seven major processes can be identified which characterize the interface between MSC/XL and MSC/NASTRAN:

1. MSC/XL – Preparing the finite element model for analysis.
2. Move File – Moving the MSC/NASTRAN input file from the MSC/XL computer to the MSC/NASTRAN computer.
3. MSC/NASTRAN – Performing finite element analysis and producing the XDB file containing analysis results.
4. Convert the XDB file into a neutral format.
5. Move File – Moving the neutral results file back to the MSC/XL computer.
6. Convert the neutral file into an XDB file readable by the MSC/XL computer.
7. MSC/XL – Reading the XDB file back into MSC/XL and processing/displaying the results.

Figure 1 provides an expanded view of how these seven processes figure in the traditional design–analysis cycle.

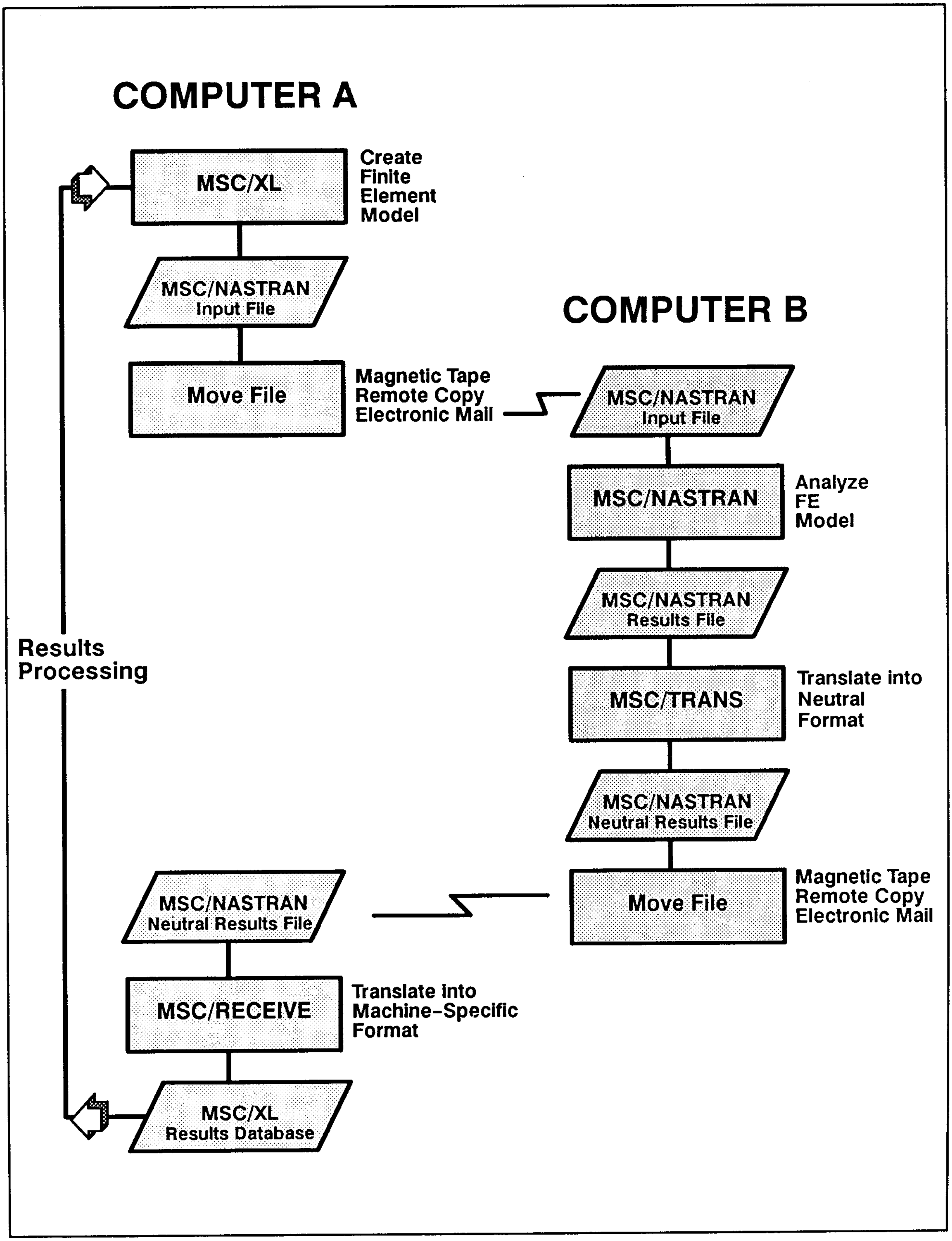


Figure 1. Design-Analysis Cycle

Improving Data Access

Because MSC/XL was designed to exploit the graphics features of workstations and MSC/NASTRAN can operate on both workstations and mainframes, the two programs can be networked together in a variety of possible configurations. These configurations can often entail different hardware and operating system environments. In the traditional scenario depicted in Figure 1, whenever MSC/XL and MSC/NASTRAN reside on different computers some method of moving each program's output files must be present.

The different methods of transferring MSC/NASTRAN and MSC/XL files can be summarized as follows in a hierarchy of least sophisticated to most sophisticated:

1. Copying the file from one computer onto a magnetic medium (tape, cartridge, or diskette) and loading it onto the second computer.
2. Transferring the file using an electronic mail utility.
3. Using a manual file transfer program such as FTP.
4. For UNIX machines, using a Remote Copy Procedure (rcp); for DEC VAX/VMS computers, using a DECNET copy command.
5. Using a transparent network file access method such as NFS, Apollo Domain File System or DEC VAX Clusters.

Of these five options, network file access (method 5) is easily the most efficient and dynamic method of importing and exporting MSC/NASTRAN and MSC/XL data, especially given the highly iterative interface between these applications. NFS (Network File System) is commonly recognized as one of the most sophisticated technologies available for file access. Although the initial setup can be challenging, the chief virtue of NFS is that it makes all the dissimilarities between hardware and software virtually invisible. NFS enables a set of computers to cooperatively access each other's files in a transparent manner. Other distributed computing technologies are available on the market, but NFS is the only standard for file access recognized by a majority of computer vendors.

Exploiting File Compatibility

Historically, computers have had their own proprietary, vendor–specific ways of representing data. During the last decade vendors began collaborating on several standards for representing data. One important development in this regard was the emergence of IEEE–754, developed by the Institute for Electrical and Electronic Engineers. This standard describes a method for representing floating point values in binary format and was subsequently adopted by many leading computer manufacturers. As a consequence, binary data can now be shared amongst machines adhering to the IEEE standard.

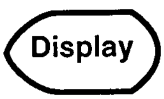
Since all MSC results databases are binary in format, XDB files produced by MSC/NASTRAN on computers that support the IEEE standard need not undergo conversion to and from a neutral format prior to their being read by MSC/XL, assuming that the latter program also resides on a computer supporting IEEE.

Some Sample Distributed Configurations

Four sample network configurations (A through D) are described on the pages that follow, each of which illustrates a different method of implementing distributed technology and streamlining the interface between MSC/XL and MSC/NASTRAN. The configurations are listed in an ascending hierarchy of sophistication. Each configuration has its own merits and challenges.

The following conventions are used in the sample configurations:

Denotes a process that is executed.



Denotes where the MSC/XL window is being displayed. With X windows, a process may run on one computer, but the "window" can be displayed and manipulated on another computer.

Denotes where the files associated with a process are located. These may be a combination of system, input and output files.

Denotes a communications interface.

In Configuration A, a small workstation is configured with a large, non–UNIX mainframe. MSC/TRANS and MSC/RECEIVE can be bypassed assuming that both MSC/XL and MSC/NASTRAN operate on the workstation with MSC/NASTRAN files stored on the mainframe. Assuming the mainframe supports NFS (see Table 1), files can be accessed transparently across the network. If not, other modes of file access can be utilized.

Configuration B entails networking a large UNIX workstation (with maximum memory and disk resources) to an X terminal. (See the Appendix for a listing of selected X terminal vendors.) MSC/XL runs on the workstation but is actually displayed on the X terminal. This arrangement can be a cost–effective alternative to purchasing an additional workstation. MSC/TRANS and MSC/RECEIVE are not required simply because both MSC/XL and MSC/NASTRAN operate on the workstation and their files are stored on the workstation's local disk.

Configuration C is identical to Configuration B, with one significant variation. Rather than using an X terminal device to display MSC/XL, the UNIX workstation uses a DOS–based PC or a Macintosh running X server software. This enables the user to run DOS or Macintosh applications if desired. It should be noted, however, that these X server devices do not offer as wide a range of colors as workstations do, nor is the screen resolution quite as sharp. (The Appendix lists several X server packages available for PCs and Macintoshes.)

Of these four configurations, Configuration D provides for the most seamless interface between MSC/NASTRAN and MSC/XL. Two UNIX machines, a small workstation and a large mainframe, are networked together with MSC/XL running on the workstation and MSC/NASTRAN operating on the mainframe. MSC/XL files can be stored locally on the workstation, remotely on the mainframe, or on both machines, depending on preference or user requirements. MSC/NASTRAN can be invoked from the workstation via remote execution commands, and MSC/NASTRAN files can be easily accessed via NFS. Since both machines are IEEE compliant, MSC/TRANS and MSC/RECEIVE are not required when processing MSC/NASTRAN results files.

Configuration A

Small workstation configured with a large, non–UNIX mainframe.

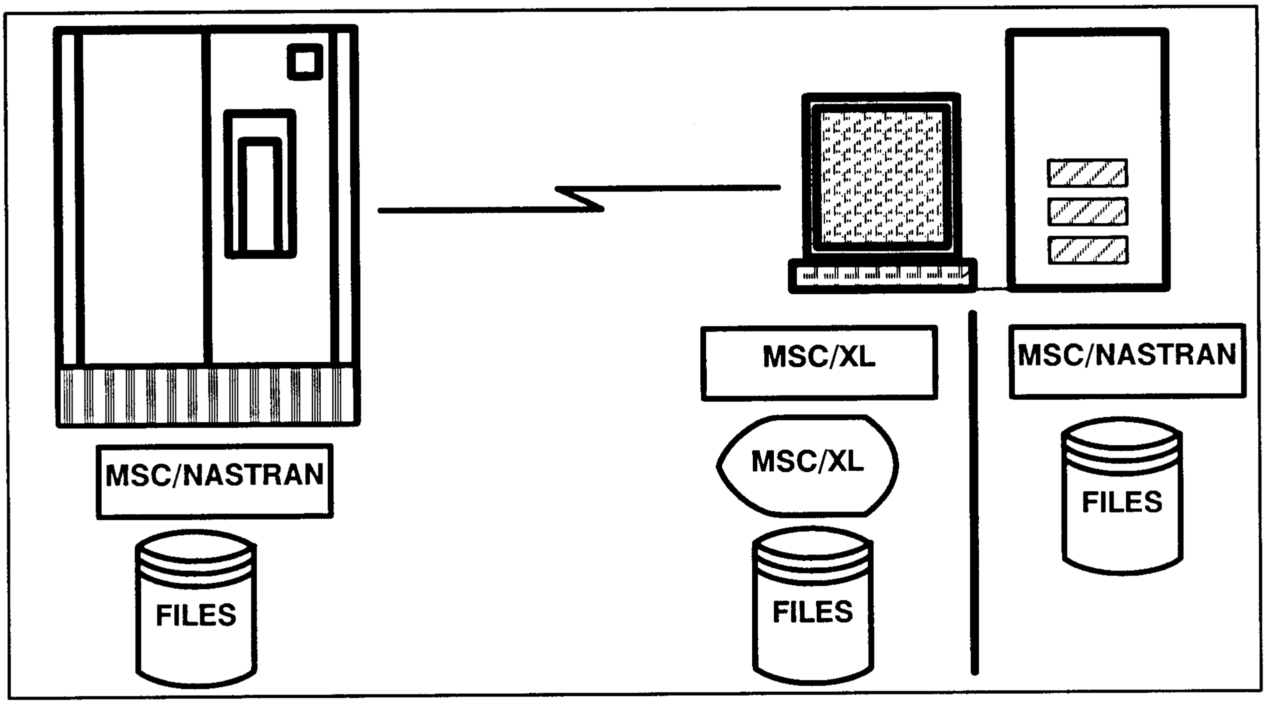


Figure 2. Configuration A

MSC/XL

- Runs on the workstation.
- Files located on workstation.

MSC/NASTRAN

- Runs on either the mainframe or workstation.
- Files located on either the mainframe or the workstation.

MSC/TRANS

- Not required if MSC/NASTRAN is executed on workstation.
- Required if MSC/NASTRAN is executed on mainframe.

MSC/RECEIVE

- Not required if MSC/NASTRAN is executed on workstation.
- Required if MSC/NASTRAN is executed on mainframe.

File Access Method

- May range from manual moving of files to network file access, such as NFS.

Benefits

- Multiple interactive applications can run on the same system at the same time.
- Flexibility, depending on machine loads, user preferences, and desired analysis.

Configuration B

Large UNIX workstation (with maximum memory and disk resources) networked to an X terminal.

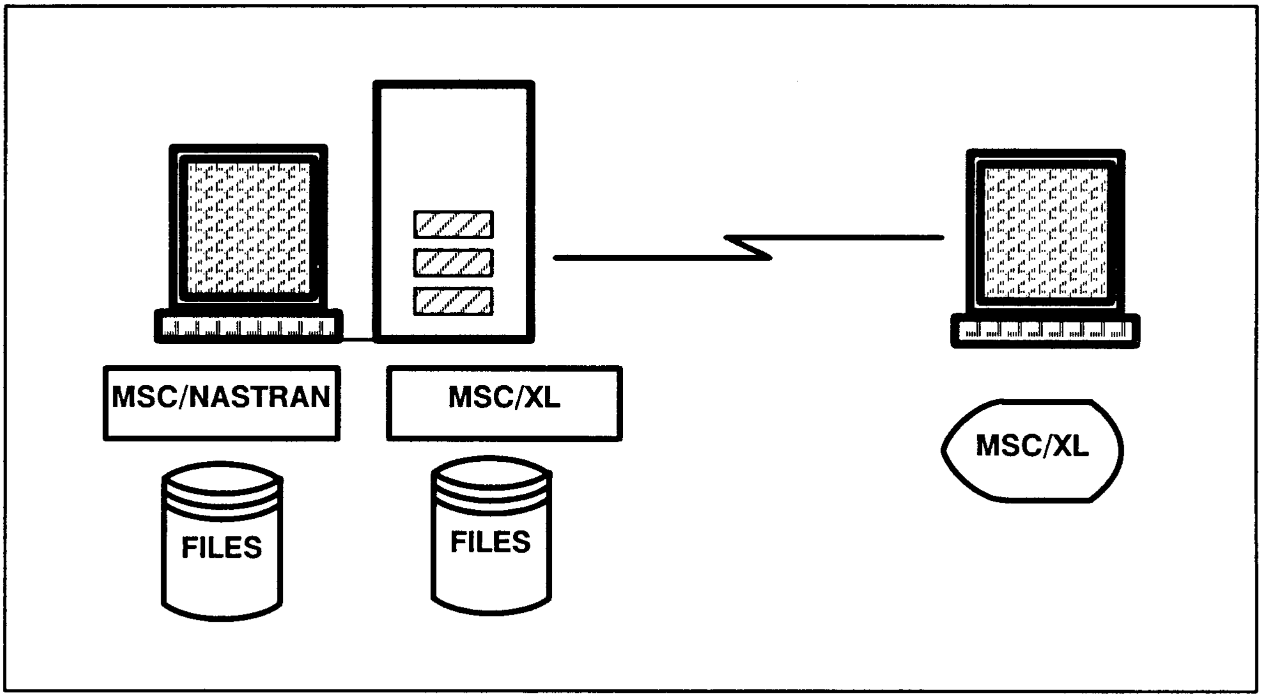


Figure 3. Configuration B

MSC/XL

- Runs on workstation but displayed on the X terminal.
- Files located on workstation.

MSC/NASTRAN

- Runs on the workstation.
- Files located on workstation.

MSC/TRANS

- Not required.

MSC/RECEIVE

- Not required.

File Access Method

- All files are located on the workstation's local disk.

Benefits

- In general, X terminals are cheaper than workstations.
- Centralized system administration.

Configuration C

A large UNIX workstation networked to a DOS–based PC or Macintosh running X server software.

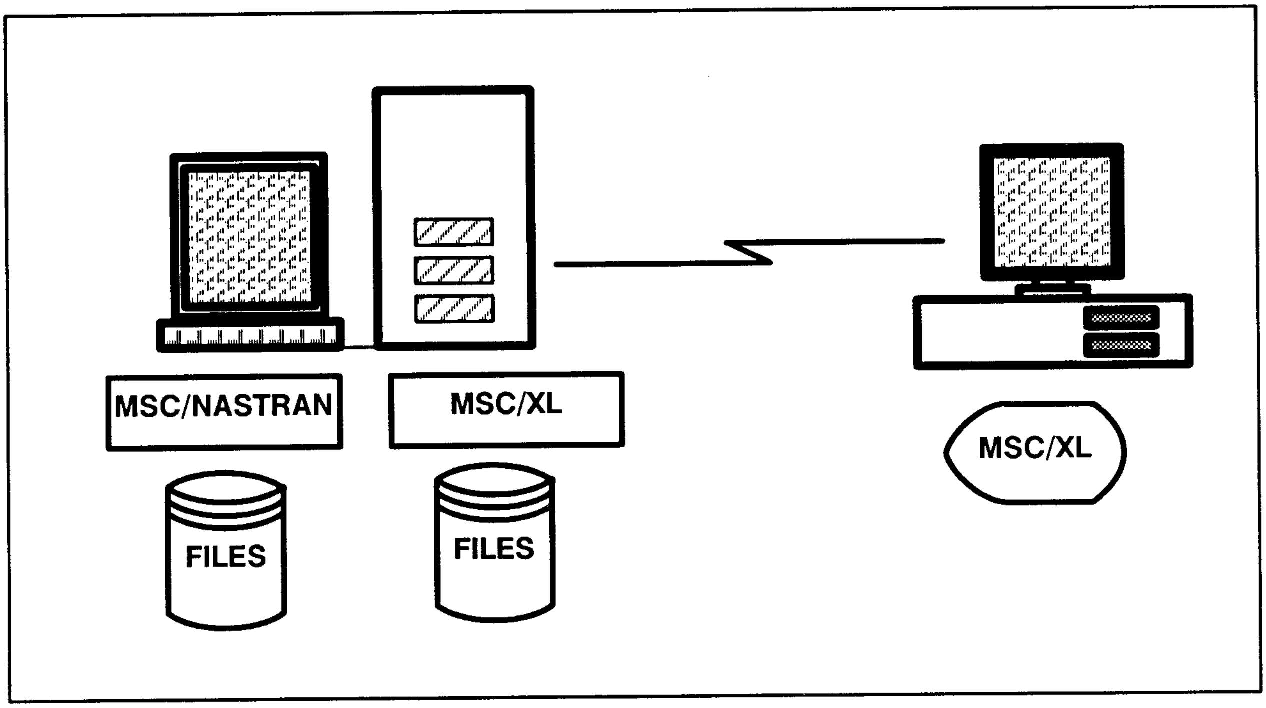


Figure 4. Configuration C

MSC/XL

- Runs on workstation but displayed on the PC.
- Files located on the workstation.

MSC/NASTRAN

- Runs on the workstation.
- Files located on the workstation.

MSC/TRANS

- Not required.

MSC/RECEIVE

- Not required.

File Access Method

- All files are located on the workstation's local disk.

Benefits

- Similar to using an X terminal, but DOS and Macintosh applications can also be run.
- Allows access to any X–based application running on the workstation.

Configuration D

A small UNIX workstation networked to a large UNIX mainframe, both IEEE compliant.

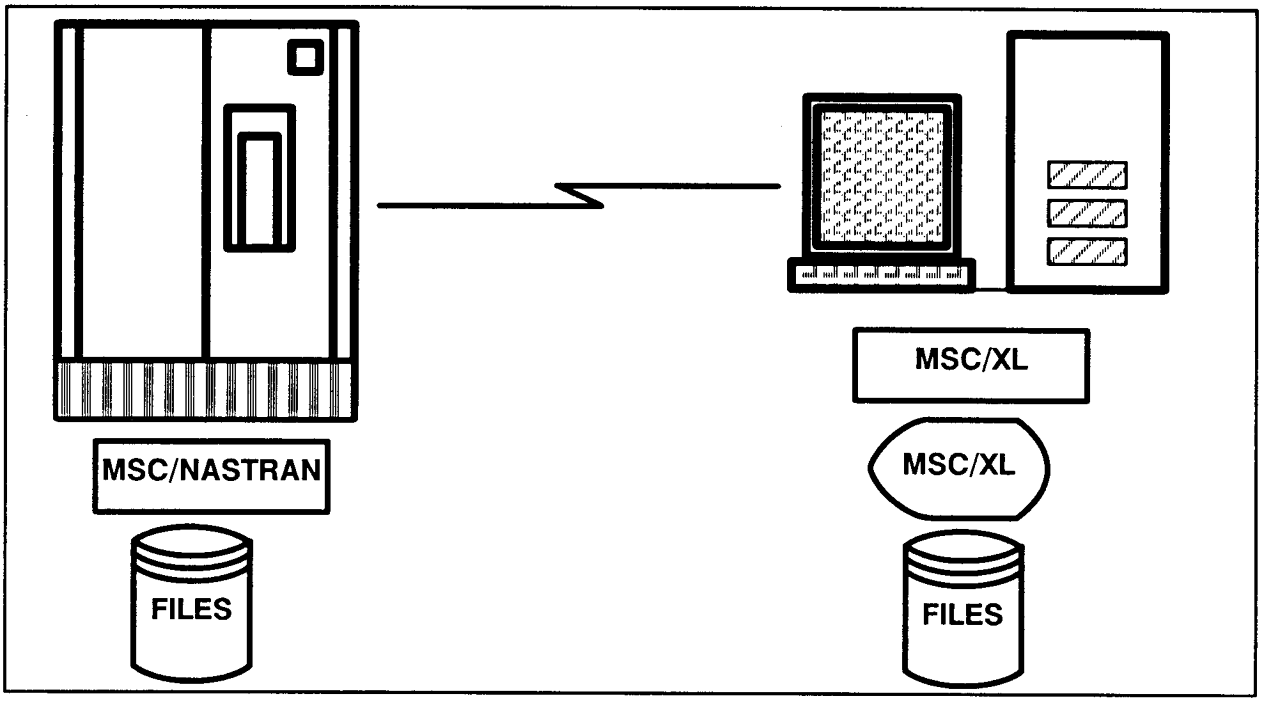


Figure 5. Configuration D

MSC/XL

- Runs on the workstation.
- Files located locally and/or on the mainframe.

MSC/NASTRAN

- Runs on the mainframe.
- Invoked from workstation via remote execution commands.

MSC/TRANS

- Not Required.

MSC/RECEIVE

- Not Required.

File Access Method

- Files accessed by shared network file systems (e.g. NFS). Not necessary to copy files.

Benefits

- Disk files on the mainframe can be accessed by the workstation via NFS.
- Mainframes are best equipped to handle MSC/NASTRAN's numerically intensive computing requirements.
- MSC/XL is specifically tailored to exploit the capabilities of today's workstations.

Implementation Considerations

When implementing distributed technology for each configuration, the following issues should be noted:

1. The cost per user associated with implementing any of these configurations—or upgrading to them—should be considered relative to the possible gains in overall efficiency.
2. The initial setup of these configurations may be challenging and will usually require the expertise of an experienced system administrator. Day–to–day troubleshooting and system maintenance requirements should also be evaluated.
3. New procedures will need to be developed—both at the administrative level and the end user level—in order to structure the design– analysis cycle to exploit the new configuration.
4. Applying distributed technology usually results in an increase in overall traffic and network overhead, which in turn can diminish the computing resources available to certain software applications.
5. System availability and resources diminish as the network traffic increases.
6. Allocation of memory and disk resources is always a consideration, however, these issues are complicated with the introduction of distributed client and servers.
7. User response time is a constant consideration. The load on a particular machine must be weighed against the degradation in response time that the user will experience.
8. Any valid assessment of the performance of a given configuration should take into account the end user's unique design–analysis requirements.

Levels of Interoperability

"Interoperability" is a term popular in publications and technical forums devoted to discussions of distributed technology. The term is somewhat general but can be defined as the extent to which data can be cooperatively shared, manipulated, and updated by multiple applications running concurrently at different locations within a network, which itself is comprised of different hardware and operating systems.

Interoperability has three components:

1. Common Communications Protocols
2. Common Applications
3. Common Interchange Formats

For MSC software applications, “interoperability” means transparency of access, the ability to easily manipulate, send, receive, and update data output by MSC/XL and MSC/NASTRAN.

Table 1 denotes levels of interoperability for MSC/XL V2A supported platforms as they interface with selected MSC/NASTRAN platforms. Five levels (0 through 4) are defined. As described in the legend, each level denotes the location of MSC/XL and MSC/NASTRAN as well as the interface. Level 0 means that both programs are resident on the same machine; accordingly, the type of interface is irrelevant. Levels 1 and 2 indicate that MSC/TRANS and MSC/RECEIVE are required. Level 2 is more sophisticated since NFS is utilized. Levels 3 and 4 represent IEEE compatibility; however, Level 4 is the only level which signifies both IEEE compatibility and the use of NFS.

Two additional columns indicate those machines which are IEEE compatible and support NFS. “Yes” in the IEEE column means that the computer complies with the IEEE standard and also shares binary-level compatibility with the other “yes” machines. “Yes” in the NFS column means that NFS is available for the indicated computer either from the manufacturer or from a third party software vendor.

MSC/XL VERSION 2A

MSC/NASTRAN	IEEE	NFS	Apollo 68000	Apollo DN10000	Compaq 386/486	DEC DECstation	DEC VAX	HP 9000/300	IBM RS6000	SGI Iris	Sun SPARC
Apollo 68000	Yes	Yes	Level 0	Level 4	Level 2	Level 4	Level 2	Level 4	Level 4	Level 4	Level 4
Apollo DN10000	Yes	Yes	Level 4	Level 0	Level 2	Level 4	Level 2	Level 4	Level 4	Level 4	Level 4
Compaq 386/486	No	Yes	Level 2	Level 2	Level 0	Level 2	Level 2	Level 2	Level 2	Level 2	Level 2
CDC NOS/VE	No	Yes	Level 2	Level 2	Level 2	Level 2	Level 2	Level 2	Level 2	Level 2	Level 2
Convex C1	Yes	Yes	Level 4	Level 4	Level 2	Level 4	Level 2	Level 4	Level 4	Level 4	Level 4
Cray X-MP Unicos	No	Yes	Level 2	Level 2	Level 2	Level 2	Level 2	Level 2	Level 2	Level 2	Level 2
DEC DECStation	Yes	Yes	Level 4	Level 4	Level 2	Level 0	Level 2	Level 4	Level 4	Level 4	Level 4
DEC VAX	No	Yes	Level 2	Level 2	Level 2	Level 2	Level 0	Level 2	Level 2	Level 2	Level 2
HP 9000/300	Yes	Yes	Level 4	Level 4	Level 2	Level 4	Level 2	Level 0	Level 4	Level 4	Level 4
HP 9000/800	Yes	Yes	Level 4	Level 4	Level 2	Level 4	Level 2	Level 4	Level 4	Level 4	Level 4
IBM MVS/XA	No	No	Level 1	Level 1	Level 1	Level 1	Level 1	Level 1	Level 1	Level 1	Level 1
IBM RS6000	Yes	Yes	Level 4	Level 4	Level 2	Level 4	Level 2	Level 4	Level 0	Level 4	Level 4
SGI Iris 4D	Yes	Yes	Level 4	Level 4	Level 2	Level 4	Level 2	Level 4	Level 4	Level 0	Level 4
Sun SPARC	Yes	Yes	Level 4	Level 4	Level 2	Level 4	Level 2	Level 4	Level 4	Level 4	Level 0

Table 1. Levels of Interoperability

LEGEND		
Level 0	Location	MSC/XL and MSC/NASTRAN on the same machine.
	Interface	Not applicable.
Level 1	Location	MSC/XL and MSC/NASTRAN on different machines.
	Interface	MSC/TRANS ⇒ copy ⇒ MSC/RECEIVE
Level 2	Location	MSC/XL and MSC/NASTRAN on different machines.
	Interface	MSC/TRANS ⇒ NFS ⇒ MSC/RECEIVE
Level 3	Location	MSC/XL and MSC/NASTRAN on different machines.
	Interface	copy ⇒ IEEE Compatibility
Level 4	Location	MSC/XL and MSC/NASTRAN on different machines.
	Interface	NFS ⇒ IEEE Compatibility

Conclusion

MSC has been working closely with major hardware and software manufacturers and participating in standard setting groups trying to arrive at common methods of data exchange. This effort will continue as MSC strives to offer robust and consistent data management tools for its entire line of software products.

Future capabilities planned for MSC/XL and MSC/NASTRAN illustrate this commitment. For example, future versions of MSC/NASTRAN will permit users to automatically convert databases to and from machine-specific binary file formats. In addition, future versions of MSC/XL will feature an external programmer's interface module that will enable users to more tightly couple their engineering design and analysis utilities with related applications such as report generators and other CAD/CAM software.

References

[1.]MSC/NASTRAN User's Manual, Version 66, The MacNeal–Schwendler Corporation, Los Angeles, CA, November 1988.

[2.]MSC/XL User's Manual, Version 2, The MacNeal–Schwendler Corporation, Los Angeles, CA, July 1990.

[3.]MSC/EMAS User's Manual, Version 1, The MacNeal–Schwendler Corporation, Los Angeles, CA, September 1989.

Appendix

Vendors - X Terminals

AT&T	(800) 247-1212
C. Itoh	(714) 660-1421 or (800) 347-2484
DEC	(800) 343-4040
Peripheral Design, Inc	(404) 263-0067
GraphOn	(800) 472-7466
Hewlett-Packard	(800) 752-0900
Human Design Systems	(800) 437-1551
IBM	(619) 565-7373
Jupiter Systems	(415) 523-9000 or (508) 836-4400
Labtam Information Systems	Australia +61 3 587-1444
Micronics	(415) 651-2300
Network Computing Devices	(415) 694-0650
NCR	(513) 445-2033
Northwest Digital Systems	(206) 524-0014
Princeton Graphic Systems	(800) 221-1490
Qume	(408) 942-4000
Samsung Software America	Not listed.
Spectragraphics	(619) 450-0611
Tektronix	(203) 877-1494
Visual Technology	(800) VISUALC or MA (508) 836-4400

Vendors - X Server on a PC running DOS

AGE	(619) 565-7373
Bell Technologies	(415) 659-9097
PC DECwindows	(800) DIGITAL
Hewlett-Packard	(800) 752-0900
Hummingbird Communications	Canada (416) 470-1203
Information Network Solutions	Australia +61 2 412-2079
Integrated Inference Machines	(714) 978-6201
Intelligent Decision, Inc.	(408) 734-3730
Locus Computing	(800) 955-6287 or (213) 670-6500
Pericom TeemTalk-X	+44 0908 560022
Quarterdeck DESQview/X	(213) 392-9701
VisionWare XVision	(612) 377-3627
Nth Graphics, Ltd. Xnth	(800) 624-7552

Vendors - X Server on a Macintosh running MacOS

White Pine Software eXodus	(603) 886-9050
Apple MacX	Not listed.