Contents

List of Examples xv

List of Figures xvii

List of Tables xix

About This Manual xxi
What This Manual Contains xxi
What You Should Know Before Reading This Manual xxii
Other Useful References xxii
Conventions Used in This Manual xxiii

1. Process Address Space 3
Defining the Address Space 3
Address Space Boundaries 4
Page Numbers and Offsets 5
Address Definition 5
Address Space Limits 6
Delayed and Immediate Space Definition 7
Page Validation 9
Read-Only Pages 10
Copy-on-Write Pages 10
Interrogating the Memory System 10
Mapping Segments of Memory 11
The Segment Mapping Function mmap() 12
Describing the Mapped Object 13
Describing the New Segment 13

Mapping a File for I/O 16
Mapped File Sizes 16
Apparent Process Size 17
Mapping Portions of a File 17
File Permissions 18
NFS Considerations 18
File Integrity 18
Mapping a File for Shared Memory 19
Mapping a Segment of Zeros 20
Mapping Physical Memory 20
Mapping Kernel Virtual Memory 21
Mapping a VME Device 21
Choosing a Segment Address 22
Segments at Fixed Offsets 22
Segments at a Fixed Address 23
Locking Pages in Memory 24
Locking Functions 24
Locking Program Text and Data 25
Locking Mapped Files Into Memory 26
Reducing Cache Misses 26
Locality of Reference 27
Cache Mapping in Challenge and Onyx Systems 27
Multiprocessor Cache Conflicts 28
Detecting Cache Problems 28
Additional Memory Features 29
Changing Memory Protection 29
Synchronizing the Backing Store 30
Releasing Unneeded Pages 30

2. Interprocess Communication 33
Types of Interprocess Communication Available 34
IRIX IPC 35
Initializing a Shared Arena 36
Configuring an Arena 36
Creating an Arena 37
Joining an Arena 38
Allocating in a Shared Arena 39
Exchanging the First Datum 40
Using IRIX Semaphores 45
Creating Normal Semaphores 45
Creating Polled Semaphores 46
Using Semaphores 46
Using Locks 47
Using Barriers 49
System V IPC 50
System V IPC Overview 51
System V Messages 51
Message Structures 52
Message Operations Overview 53
Getting Message Queues With msgget() 55
Message Queue Example Program 57
Controlling Message Queues: msgctl() 60
Example Program 60
Operations for Messages: msgsnd() and msgrcv() 65
Sending a Message 65
Receiving Messages 66
Example Program 67
Example Use of msgsnd 69
Example Use of msgrcv 70

System V Semaphores 75
Using Semaphores 77
Getting Semaphores With semget() 80
Example Program 83
Controlling Semaphores With semctl() 86
Example Program 87
Operations on Semaphores: semop() 95
Example Program 97
System V Shared Memory 101
Using Shared Memory 102
Getting Shared Memory Segments With shmget() 104
Example Program 107
Controlling Shared Memory: shmctl() 110
Example Program 111
Operations for Shared Memory: shmat() and shmdt() 116

3. Models of Parallel Computation 123
Parallel Hardware and Programming Models 123
Parallel Programs on Uniprocessors 124
Memory Systems 125
Single Memory Systems 125
Multiple Memory Systems 126
Types of Parallel Models 126
Statement-Level Parallelism 127
Thread-Level Parallelism 128
Process-Level Parallelism 129
Portable, Abstract Models 130
Message-Passing Interface (MPI) Model 130
Portable Virtual Machine (PVM) Model 131
Remote Procedure Call (RPC) Model 131

Using Statement-Level Parallelism 132
Creating Parallel Programs 133
Managing Parallel Execution 134
Controlling the Degree of Parallelism 134
Choosing the Loop Schedule Type 135
Using Process-Level Parallelism 137
Parallelism in Real-Time Applications 137
Process Synchronization and Share Groups 138
Process Communication and Coordination 138
Process Creation 138
Process Scheduling Features 141
Process Management Features 142
Using MPI and PVM 142
Choosing Between MPI and PVM 142
Porting From PVM to MPI 143

4. File and Record Locking 147
Overview of File and Record Locking 147
Terminology 148
Record 148
Cooperating Processes 148
Read (Shared) Lock 148
Write (Exclusive) Lock 148
Advisory Locking 149
Mandatory Locking 149
Lock Promotion and Demotion 149
Using File Permissions 150
Using Record Locking 151
Opening a File for Record Locking 151
Setting a File Lock 152
Setting and Removing Record Locks 154
Getting Lock Information 158
Deadlock Handling 161

Selecting Advisory or Mandatory Locking 161
Record Locking Across Multiple Systems 163

5. Working With Fonts 167
Font Basics 167
Terminology 168
Typography 168
Character 169
Font 169
Font Family, or Typeface 169
How Resolution Affects Font Size 169
Font Names 171
Writing Programs That Need to Use Fonts 172
Using Fonts With the X Window System 173
Listing and Viewing Fonts 173
Getting a List of Font Names and Font Aliases 173
Viewing Fonts 174
Getting the Current X Font Path 176
Changing the X Font Path 176
Installing and Adding Font and Font Metric Files 177
Locations of Font and Font Metric Files 177
Conventions for Bitmap Font File Names 178
Creating Font Aliases 179
Adding Font and Font Metric Files 179
Adding a Bitmap Font 180
Adding an Outline Font 182
Adding a Font Metric File 185
Downloading a Type 1 Font to a PostScript Printer 186

6. Internationalizing Your Application 191
Overview 192
Some Definitions 193
Locale 193
Internationalization (i18n) 193
Localization (l10n) 193
Nationalized Software 194
Multilingual Software 194
Areas of Concern in Internationalizing Software 194
Standards 195
Internationalizing Your Application: The Basic Steps 195
Additional Reading on Internationalization 197
Locales 198
Setting the Current Locale 198
Category 199
Locale 200
The Empty String 200
Nonempty Strings in Calls to setlocale() 201
Location of Locale-Specific Data 201
Locale Naming Conventions 201
Limitations of the Locale System 203
Multilingual Support 203
Misuse of Locales 203
No Filesystem Information for Encoding Types 204
Character Sets, Codesets, and Encodings 204
Eight-Bit Cleanliness 205
Character Representation 206

Multibyte Characters 207
Use of Multibyte Strings 207
Handling Multibyte Characters 208
Conversion to Constant-Size Characters 208
How Many Bytes in a Character? 208
How Many Bytes in an MB String? 209
How Many Characters in an MB String? 209
Wide Characters 210
Uses for wchar Strings 210
Support Routines for Wide Characters 210
Conversion to MB Characters 210
Reading Input Data 211
Cultural Items 211
Collating Strings 211
The Issue 212
The Solution 213
Specifying Numbers and Money 213
Using printf() 214
Using localeconv() 214
Using strfmon() 214
Formatting Dates and Times 214
Character Classification and ctype 215
The Issue 215
The Solution 216
Regular Expressions 216
Locale-Specific Behavior 216
Overview of Locale-Specific Behavior 217
Local Customs 217
Regular Expressions 217
The ANSI X3.159-198X Standard for C 218

Native Language Support and the NLS Database 219
Configuration Data 219
Collating Sequence Tables 220
Character Classification Tables 220
Shift Tables 221
Language Information 221
Using Regular Expressions 222
Internationalized Regular Expressions 223
Cultural Data 225
NLS Interfaces 227
NLS Utilities 227
NLS Library Functions 228
XSI Curses Interface 228
Strings and Message Catalogs 229
XPG/4 Message Catalogs 229
Opening and Closing XPG/4 Catalogs 229
Using an XPG/4 Catalog 230
XPG/4 Catalog Location 231
Creating XPG/4 Message Catalogs 231
Compiling XPG/4 Message Catalogs 232
SVR4 MNLS Message Catalogs 233
Putting MNLS Strings Into a Catalog 233
Using MNLS in Shell Scripts 233
Specifying MNLS Catalogs 234
Getting Strings From MNLS Message Catalogs 234
Using pfmt() 235
Labels, Severity, and Flags 235
Format Strings for pfmt() 236
Using fmtmsg() 236
Internationalizing File Typing Rule Strings With MNLS 237
Variably Ordered Referencing of printf() Arguments 238

Internationalization Support in X11R6 240
Limitations of X11R6 in Supporting Internationalization 240
Vertical Text 241
Character Sets 241
Xlib Interface Change 241
Resource Names 242
Getting X Internationalization Started 242
Initialization for Toolkit Programming 242
Initialization for Xlib Programming 242
Fontsets 243
Example: EUC in Japanese 243
Specifying a Fontset 243
Creating a Fontset 244
Using a Fontset 245
Text Rendering Routines 245
New Text Extents Functions 245
Internationalization Support in Motif 247
User Input 248
About User Input and Input Methods 248
Reuse Sample Code 249
GL Input 249
About X Keyboard Support 249
Keys, Keycodes, and Keysyms 250
Composed Characters 250
Supported Keyboards 251
Input Methods (IMs) 252
Opening an Input Method 252

IM Styles 254
Root Window 254
Off-the-Spot 255
Over-the-Spot 255
On-the-Spot 256
Setting IM Styles 256
Using Styles 256
Input Contexts (ICs) 257
Find an IM Style 257
IC Values 259
Pre-Edit and Status Attributes 259
Creating an Input Context 260
Using the IC 261
Events Under IM Control 262
Using XFilterEvent() 262
Using XLookupString(), XwcLookupString(), and XmbLookupString() 262
GUI Concerns 265
X Resources for Strings 265
Layout 266
Dynamic Layout 266
Constant Layout 266
Localized Layout 267
IRIS IM Localization with editres 267
Icons 267
Popular Encodings 267
The ISO 8859 Family 268
Asian Languages 270
Some Standards 270
EUC 271
ISO 10646 and Unicode 271

A. ISO 3166 Country Names and Abbreviations 275

B. Converting PVM Applications to MPI 281

Differences Between PVM and MPI 282

Comparing Library Routines 285

Comparable Routines 285

Nonportable PVM Functions 288

Converting a PVM Program to an MPI Program 289

Initial Environment Setup 289

Pure SPMD Program 289

General SPMD Model 290

MPMD Model 290

Common Environment Setup Changes 291

Task Environment Cleanup 291

Group Management Functions 292

Intertask Communication 292

Utility Functions 293

Example Programs 294

Example 1: SPMD Program 294

SPMD Program in PVM Version 294

SPMD Program in MPI Version 296

Example 2: MPMD Example 298

MPMD in PVM Version—Master Task 298

MPMD in PVM Version—Slave Task 299

MPMD in MPI Version—Master Task 301

MPMD in MPI Version—Slave Task 302

Index 305