US 20050132104A1

(19) **United States**
(12) **Patent Application Publication** (10) **Pub. No.: US 2005/0132104 A1**
Brown (43) **Pub. Date: Jun. 16, 2005**

(54) **COMMAND PROCESSING SYSTEMS AND METHODS**

(76) Inventor: **David W. Brown**, Bingen, WA (US)

Correspondence Address:
SCHACHT LAW OFFICE, INC.
SUITE 202
2801 MERIDIAN STREET
BELLINGHAM, WA 98225-2412 (US)

(21) Appl. No.: **10/991,905**

(22) Filed: **Nov. 17, 2004**

Related U.S. Application Data

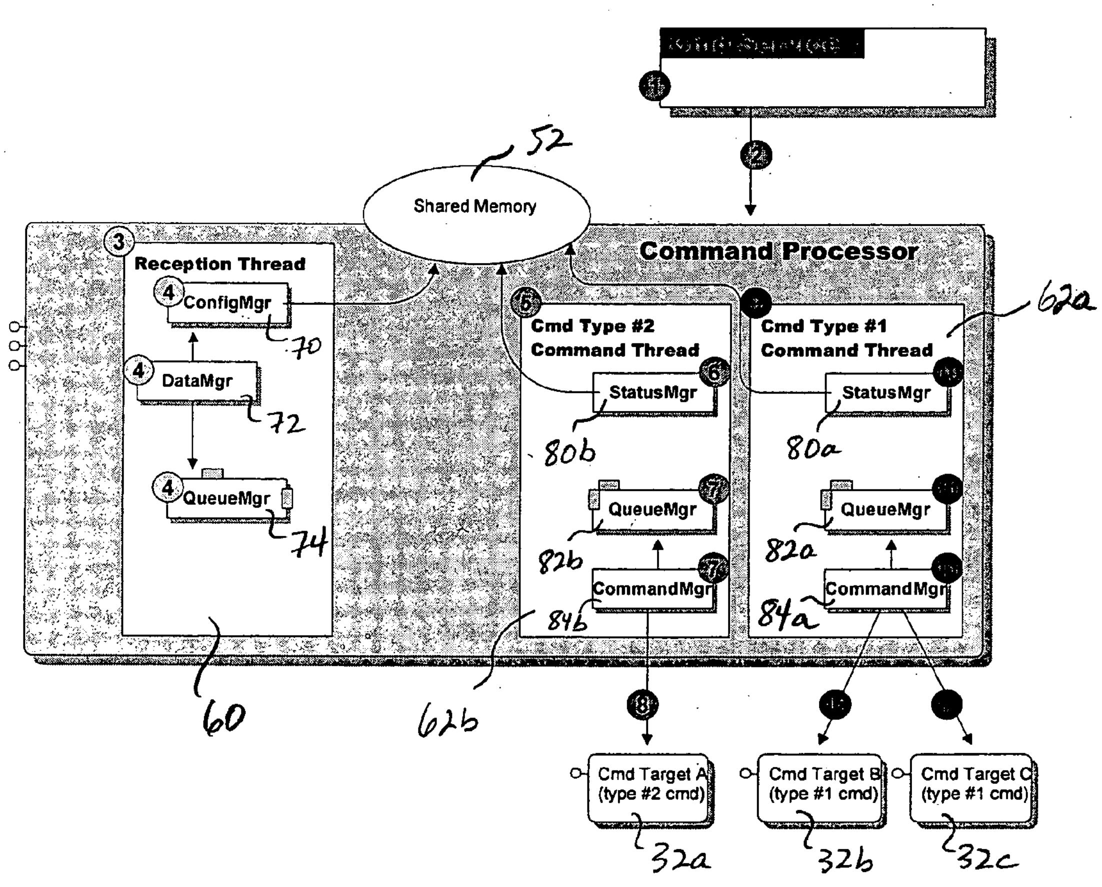
(60) Provisional application No. 60/520,918, filed on Nov. 17, 2003.

Publication Classification

(51) **Int. Cl.**^{7} **G06F 3/00**
(52) **U.S. Cl.** **710/36**

(57) **ABSTRACT**

A command processing system for transferring commands from at least one command source to at least one command target of at least one command target type. The command processing system comprises at least one service client associated with each command source; a command processor in communication with the at least one service client; and a command thread associated with each command target type. The command thread is in communication with the command processor. The command thread is in communication with the at least one command target. The command thread transfers commands from the command processor to the command target.



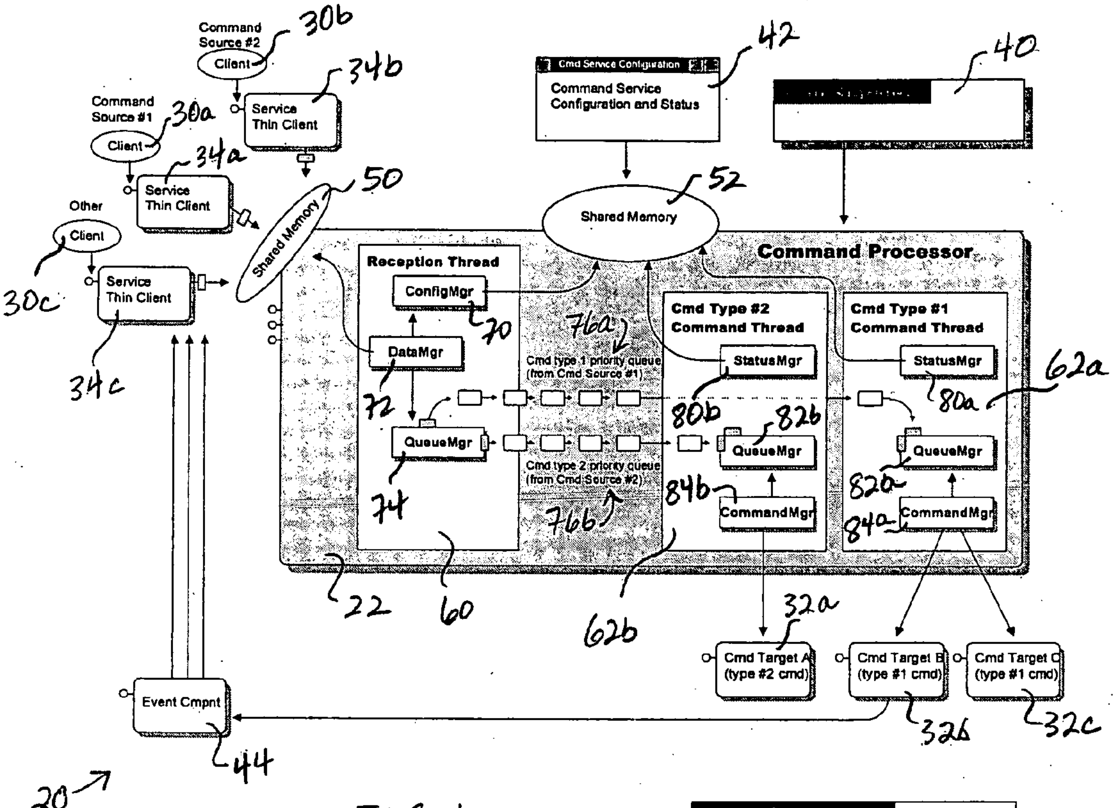

Command Source #2
Client
30b
Service Thin Client
34b
Command Source #1
Client
30a
Service Thin Client
34a
Other
Client
30c
Service Thin Client
34c
Shared Memory
50
Cmd Service Configuration
Command Service Configuration and Status
42
40
Shared Memory
52
Command Processor
Reception Thread
ConfigMgr
70
DataMgr
72
QueueMgr
74
76a
Cmd type 1 priority queue (from Cmd Source #1)
Cmd type 2 priority queue (from Cmd Source #2)
76b
Cmd Type #2 Command Thread
StatusMgr
80b
QueueMgr
82b
CommandMgr
84b
Cmd Type #1 Command Thread
StatusMgr
80a
QueueMgr
82a
CommandMgr
84a
62a
62b
22
60
Cmd Target A (type #2 cmd)
32a
Cmd Target B (type #1 cmd)
32b
Cmd Target C (type #1 cmd)
32c
Event Cmpnt
44
20

FIG. 1

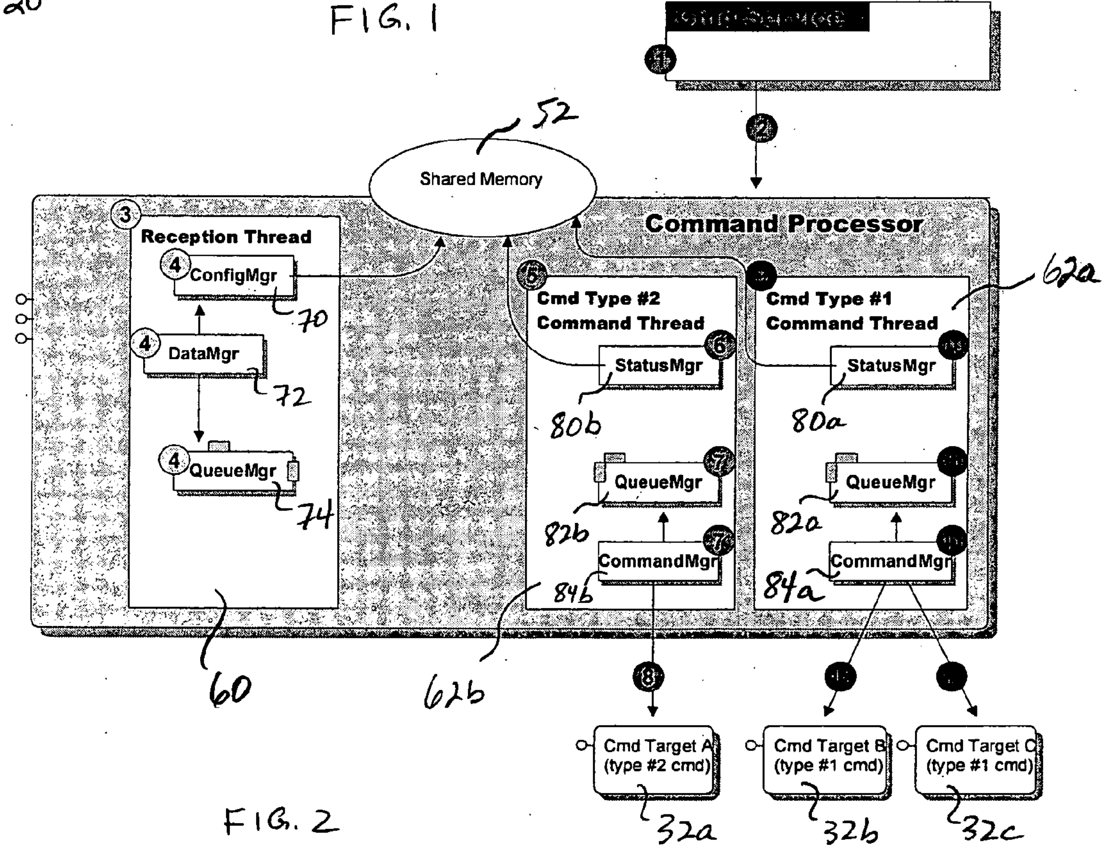

1
2
52
Shared Memory
Command Processor
3
Reception Thread
4 ConfigMgr
70
4 DataMgr
72
4 QueueMgr
74
5
Cmd Type #2 Command Thread
6
StatusMgr
80b
7
QueueMgr
82b
7
CommandMgr
84b
Cmd Type #1 Command Thread
62a
StatusMgr
80a
QueueMgr
82a
CommandMgr
84a
60
62b
8
Cmd Target A (type #2 cmd)
32a
Cmd Target B (type #1 cmd)
32b
Cmd Target C (type #1 cmd)
32c

FIG. 2

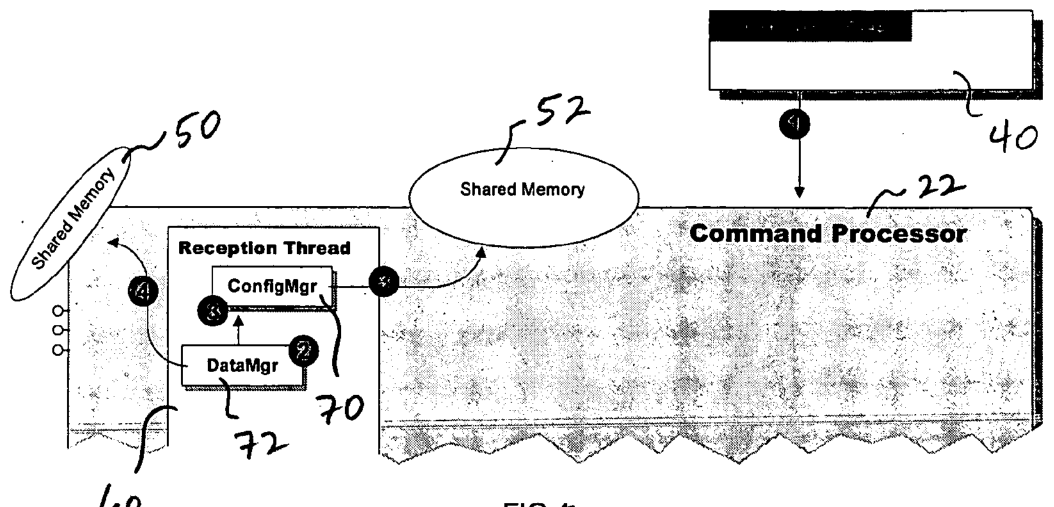


FIG. 3 ~~FIG 4~~.

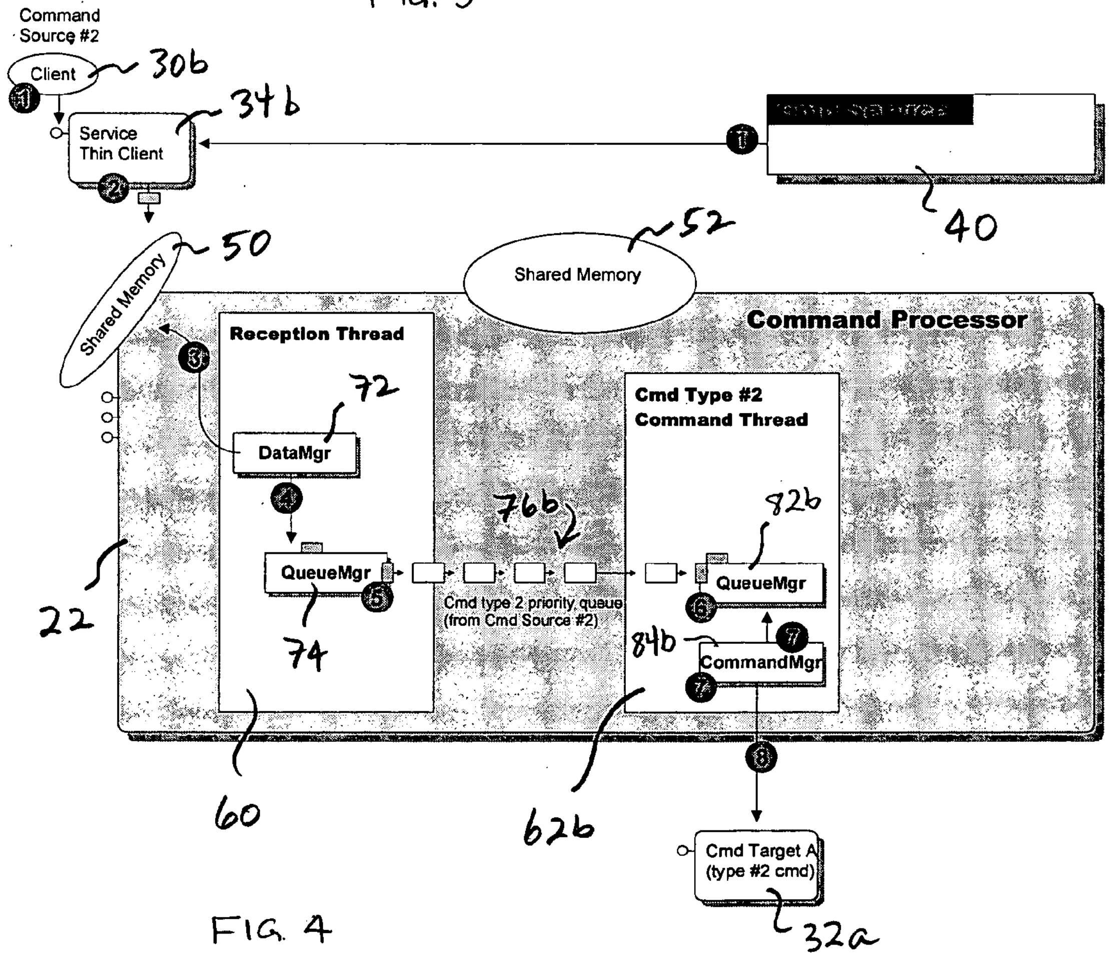


FIG. 4

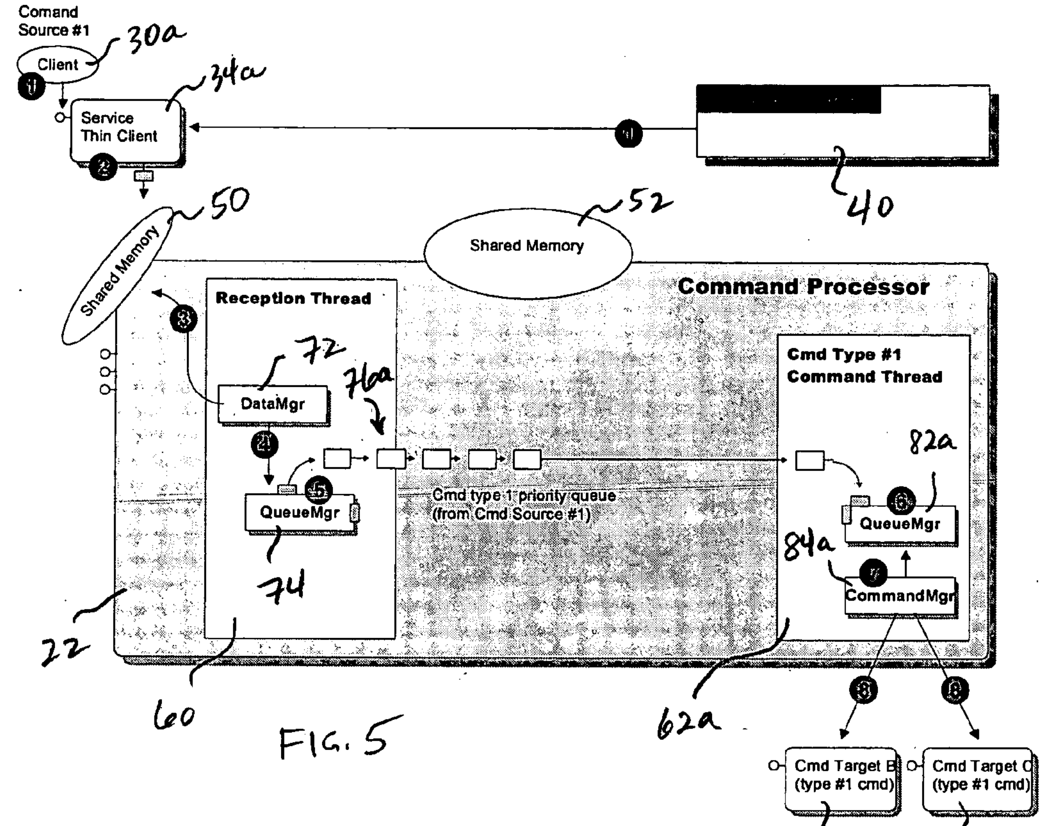

Comand Source #1
Client
30a
1
34a
Service Thin Client
2
40
50
Shared Memory
52
Shared Memory
Command Processor
Reception Thread
3
DataMgr
72
76a
4
QueueMgr
5
Cmd type 1 priority queue (from Cmd Source #1)
74
Cmd Type #1 Command Thread
82a
6
QueueMgr
84a
7
CommandMgr
22
60
62a
8
8
Cmd Target B (type #1 cmd)
Cmd Target C (type #1 cmd)
32b
32c

FIG. 5

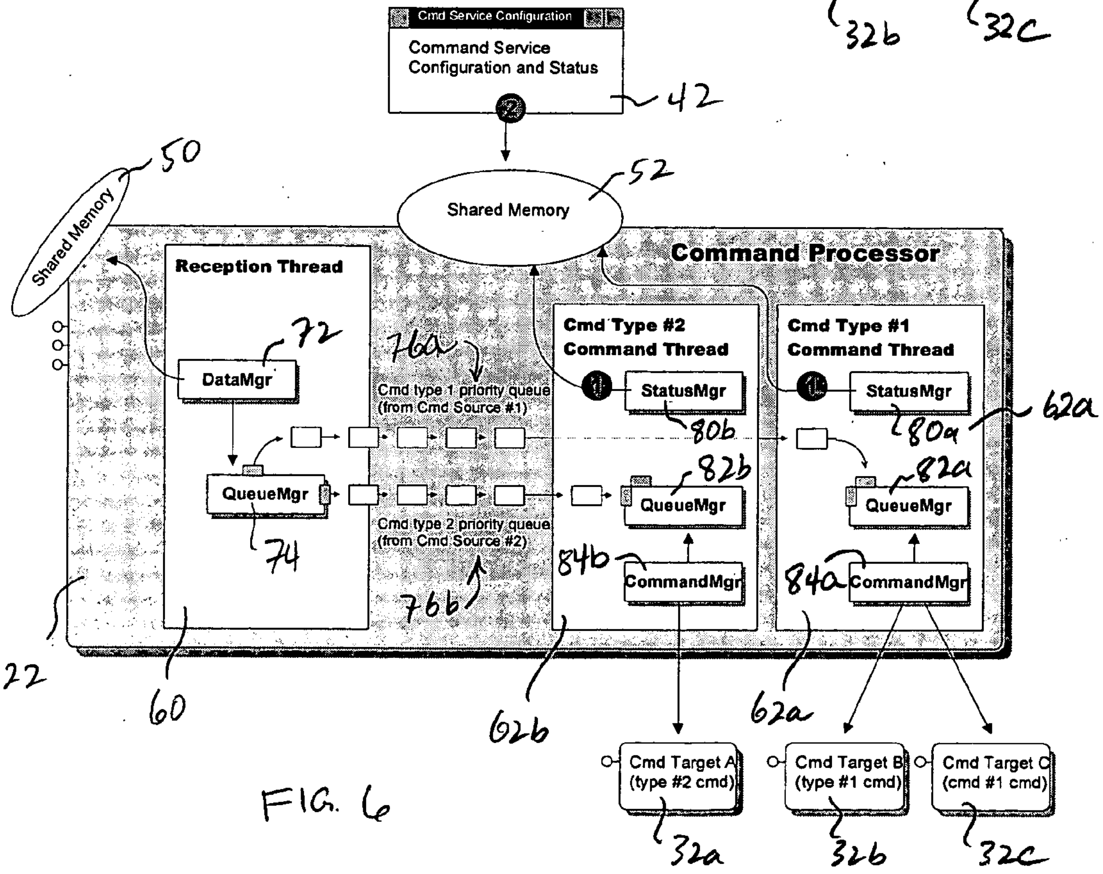

Cmd Service Configuration
Command Service Configuration and Status
2
42
50
Shared Memory
52
Shared Memory
Command Processor
Reception Thread
DataMgr
72
76a
Cmd type 1 priority queue (from Cmd Source #1)
QueueMgr
74
Cmd type 2 priority queue (from Cmd Source #2)
76b
Cmd Type #2 Command Thread
1
StatusMgr
80b
82b
QueueMgr
84b
CommandMgr
Cmd Type #1 Command Thread
1
StatusMgr
80a
62a
82a
QueueMgr
84a
CommandMgr
22
60
62b
62a
Cmd Target A (type #2 cmd)
Cmd Target B (type #1 cmd)
Cmd Target C (cmd #1 cmd)
32a
32b
32c

FIG. 6

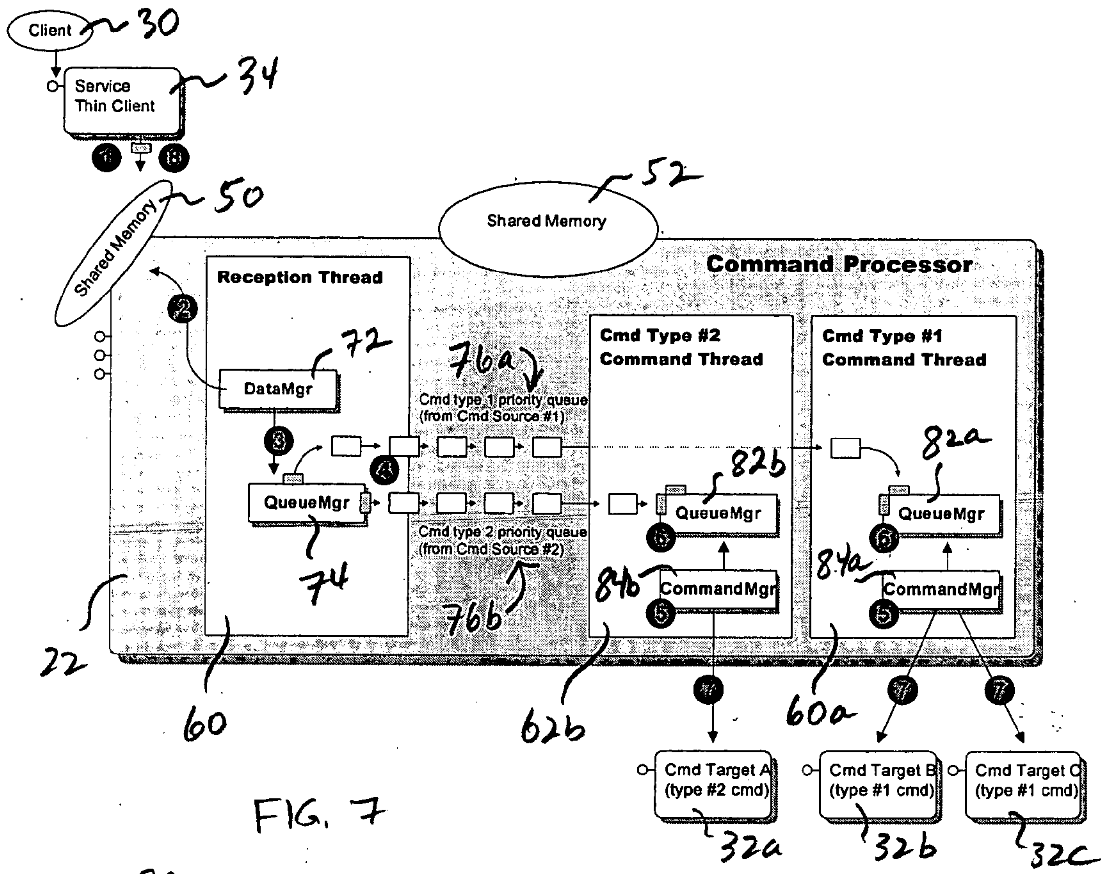

Client
30
Service Thin Client
34
1
8
Shared Memory
50
Shared Memory
52
Command Processor
Reception Thread
2
DataMgr
72
3
QueueMgr
74
4
76a
Cmd type 1 priority queue (from Cmd Source #1)
Cmd type 2 priority queue (from Cmd Source #2)
76b
Cmd Type #2 Command Thread
82b
QueueMgr
6
84b
CommandMgr
5
Cmd Type #1 Command Thread
82a
QueueMgr
6
84a
CommandMgr
5
22
60
62b
60a
7
7
7
Cmd Target A (type #2 cmd)
32a
Cmd Target B (type #1 cmd)
32b
Cmd Target C (type #1 cmd)
32c

FIG. 7

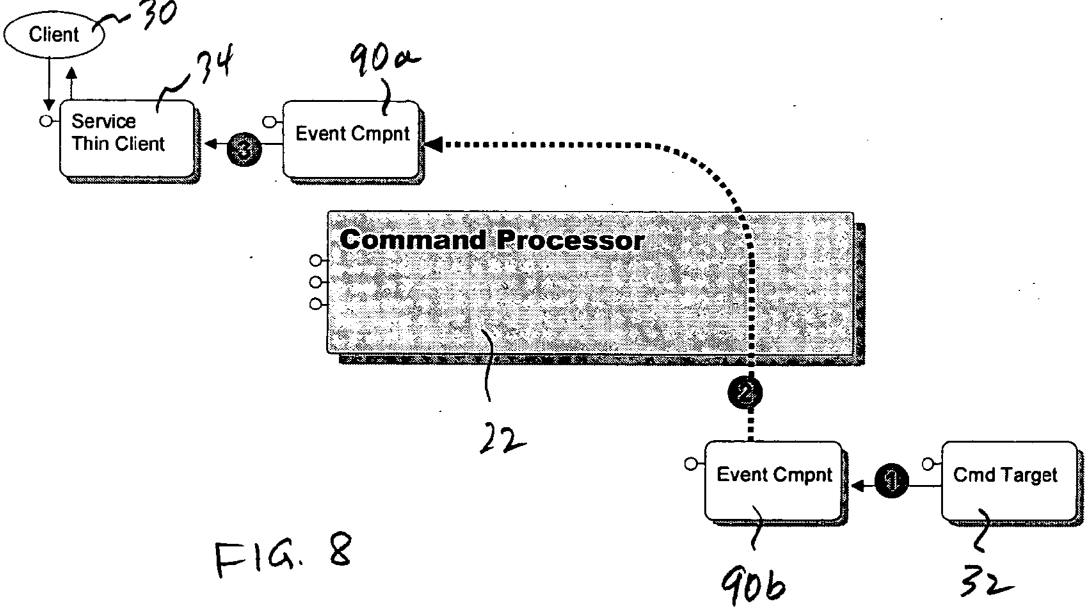

Client
30
Service Thin Client
34
3
Event Cmpnt
90a
Command Processor
22
2
Event Cmpnt
90b
1
Cmd Target
32

FIG. 8

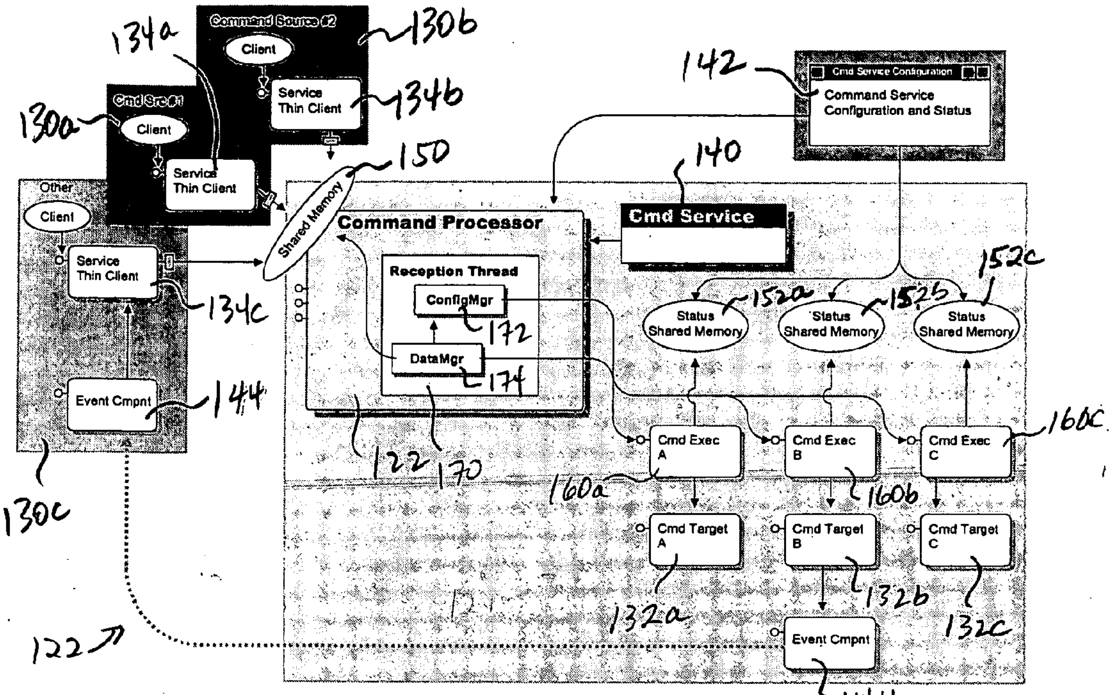

Command Source #2
Client
Service Thin Client
130b
134a
134b
Cmd Src #1
Client
Service Thin Client
130a
Other
Client
Service Thin Client
134c
Event Cmpnt
144
130c
150
Shared Memory
142
Cmd Service Configuration
Command Service Configuration and Status
140
Cmd Service
Command Processor
Reception Thread
ConfigMgr
172
DataMgr
174
122
170
152c
Status Shared Memory
152a
Status Shared Memory
152b
Status Shared Memory
Cmd Exec A
160a
Cmd Exec B
160b
Cmd Exec C
160c
Cmd Target A
132a
Cmd Target B
132b
Cmd Target C
132c
Event Cmpnt
144
122

FIG. 9

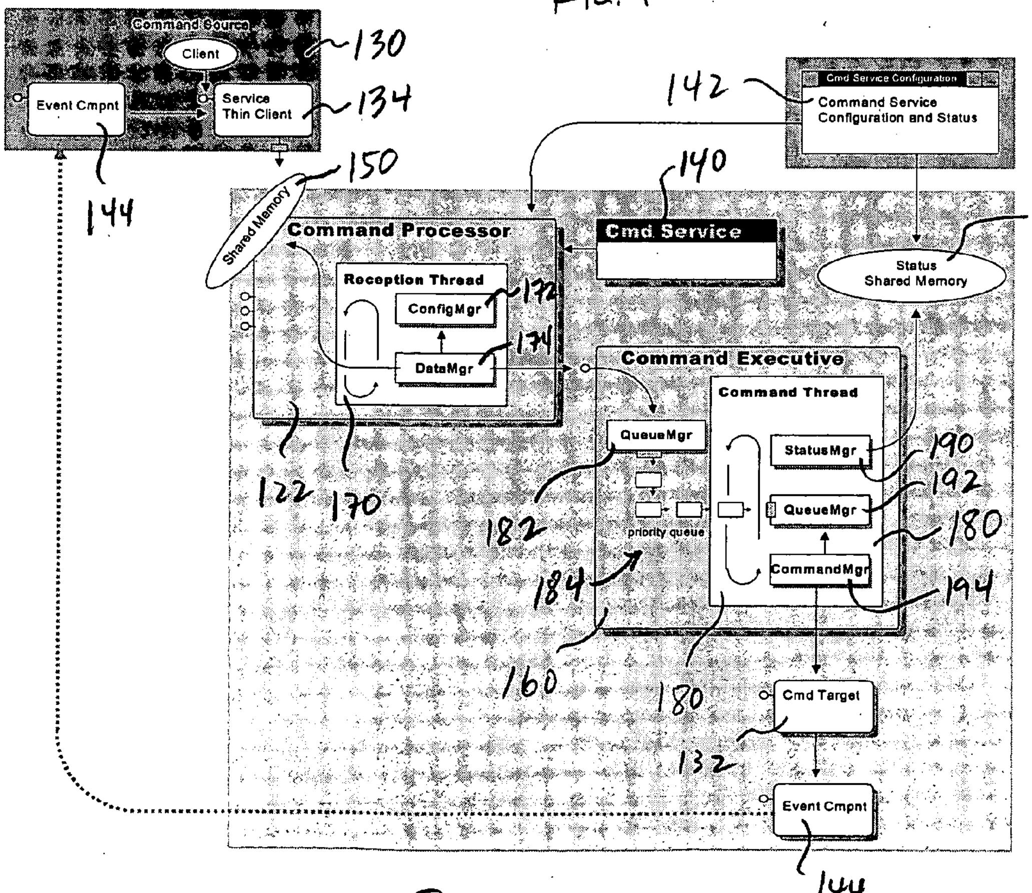

Command Source
Client
Event Cmpnt
Service Thin Client
130
134
144
150
Shared Memory
142
Cmd Service Configuration
Command Service Configuration and Status
140
Cmd Service
152
Status Shared Memory
Command Processor
Reception Thread
ConfigMgr
172
DataMgr
174
122
170
Command Executive
Command Thread
QueueMgr
priority queue
182
184
StatusMgr
190
QueueMgr
192
CommandMgr
180
194
160
180
Cmd Target
132
Event Cmpnt
144

FIG. 10

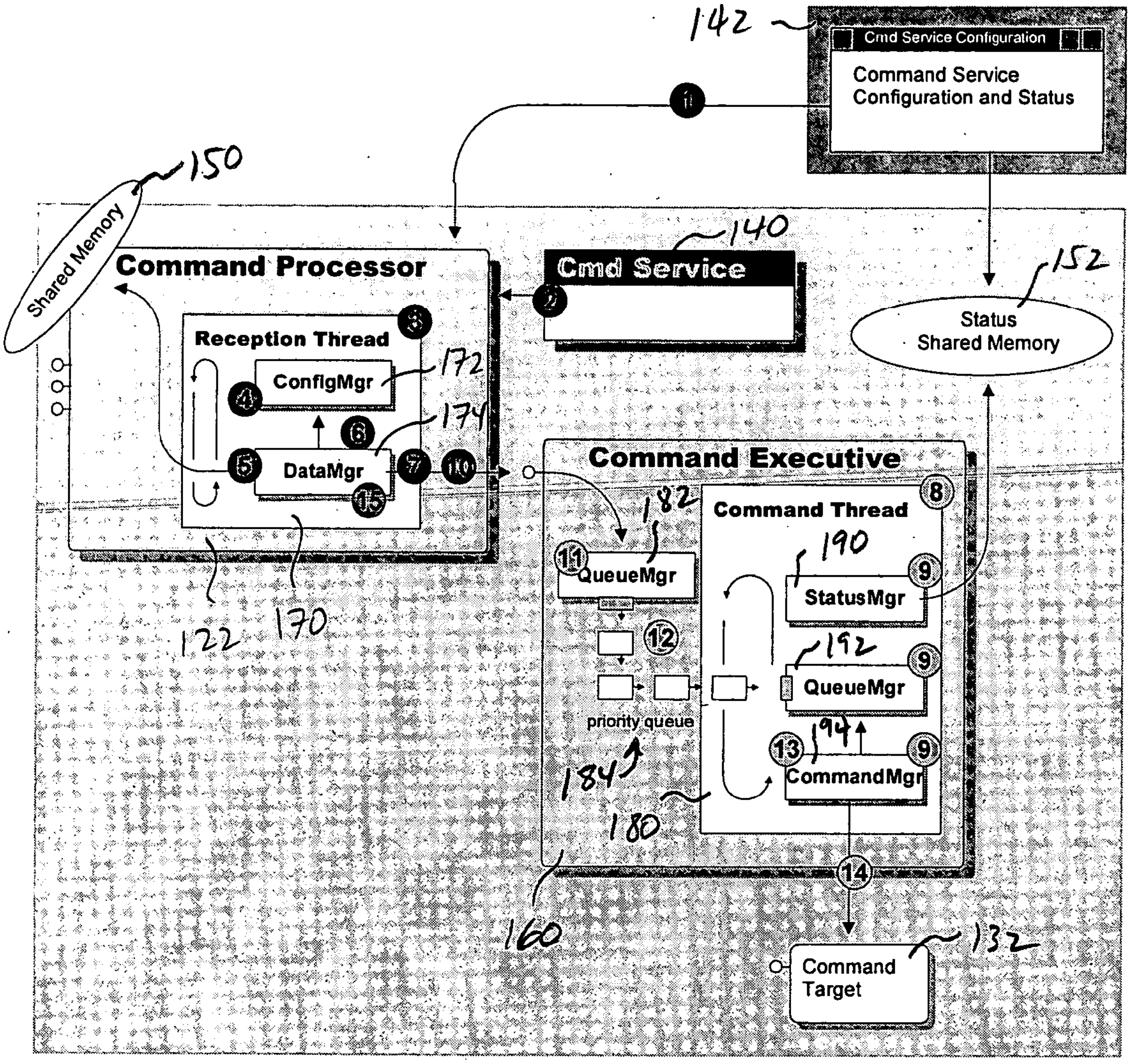

142
Cmd Service Configuration
Command Service Configuration and Status
1
150
Shared Memory
Command Processor
140
Cmd Service
2
152
Status Shared Memory
Reception Thread
3
ConfigMgr
4
172
174
6
DataMgr
5
7
10
15
Command Executive
182
Command Thread
8
11
QueueMgr
190
StatusMgr
9
12
192
QueueMgr
9
priority queue
13
194
9
CommandMgr
184
180
122
170
14
160
Command Target
132

FIG. 11

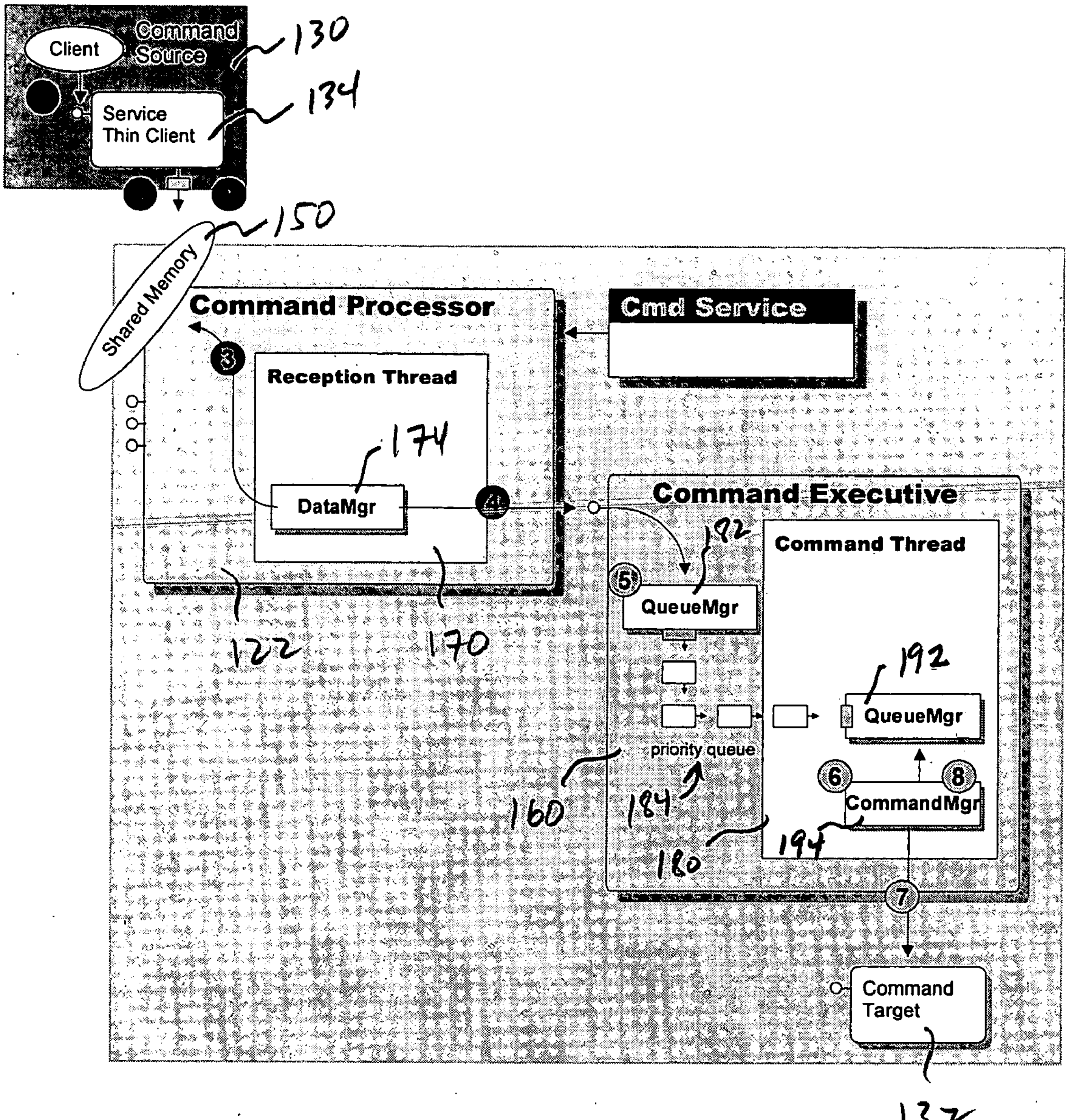

Client
Command Source
130
Service Thin Client
134
150
Shared Memory
Command Processor
Cmd Service
3
Reception Thread
174
DataMgr
4
Command Executive
182
Command Thread
5
QueueMgr
122
170
192
QueueMgr
priority queue
160
184
6
8
CommandMgr
180
194
7
Command Target
132

FIG. 12

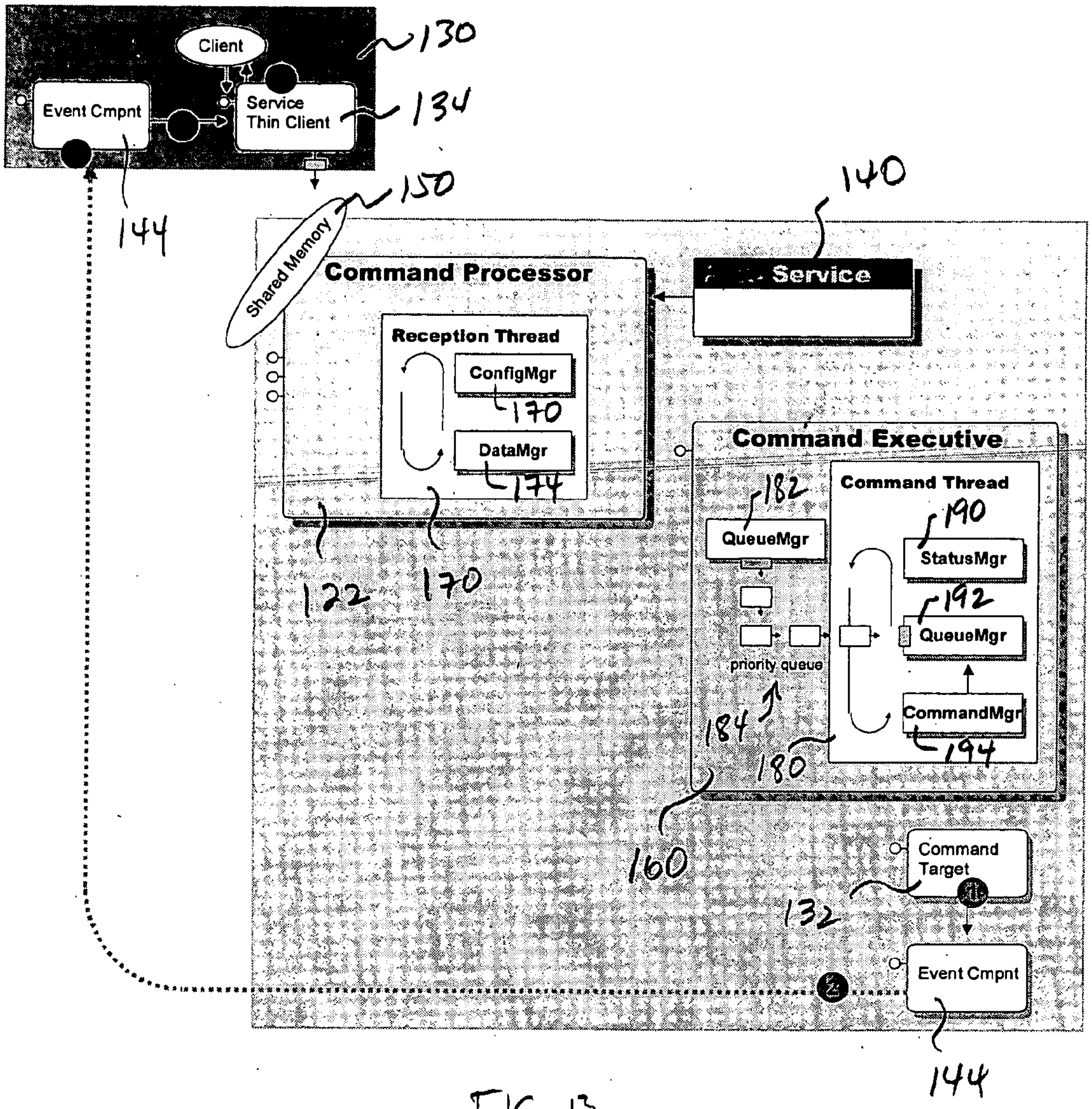

Client
130
Event Cmpnt
Service
Thin Client
134
144
150
Shared Memory
140
Command Processor
Service
Reception Thread
ConfigMgr
170
DataMgr
174
122
170
Command Executive
Command Thread
182
QueueMgr
190
StatusMgr
192
QueueMgr
priority queue
CommandMgr
194
184
180
160
Command
Target
132
Event Cmpnt
144

FIG. 13

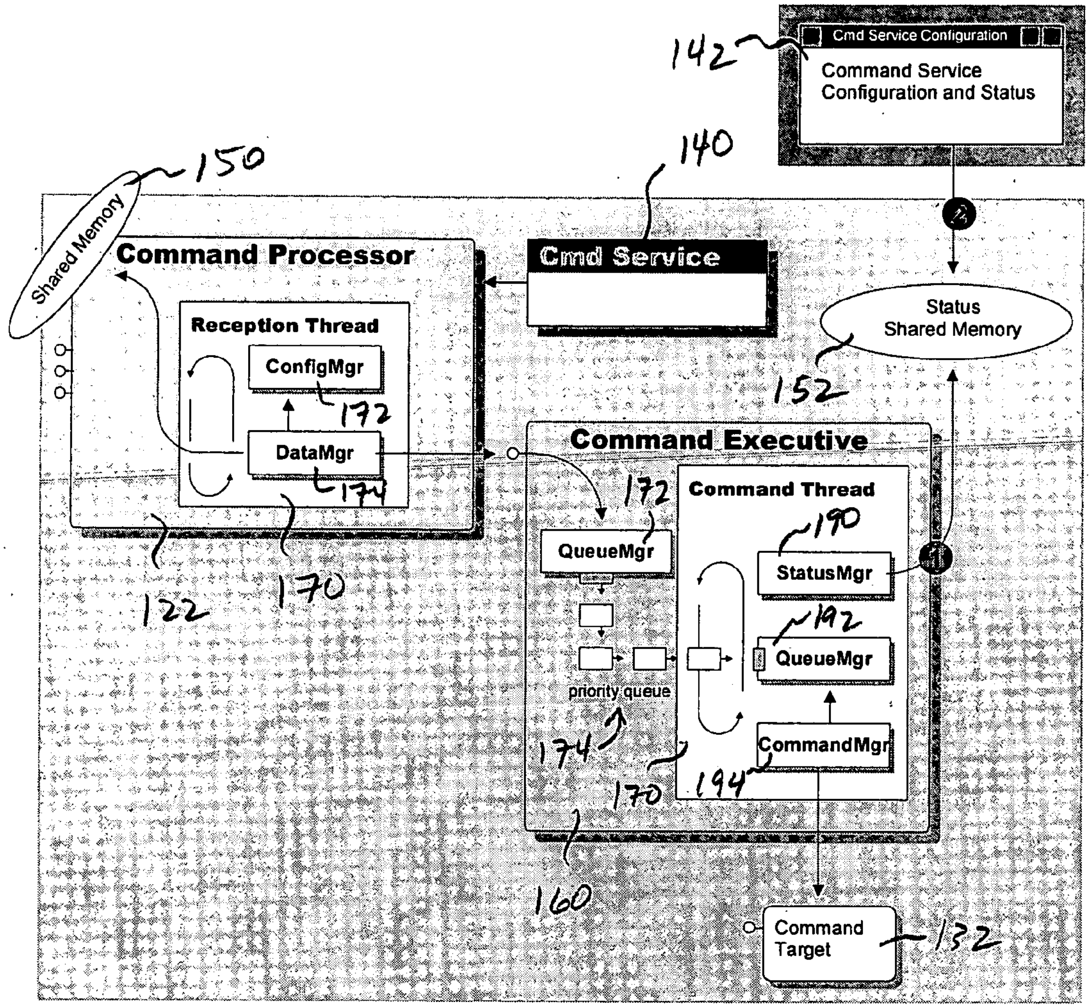

142
Cmd Service Configuration
Command Service
Configuration and Status
150
140
Shared Memory
Command Processor
Cmd Service
Reception Thread
ConfigMgr
172
DataMgr
174
122
170
Status
Shared Memory
152
2
Command Executive
172
Command Thread
190
QueueMgr
StatusMgr
1
192
QueueMgr
priority queue
174
170
CommandMgr
194
160
Command
Target
132

FIG. 14

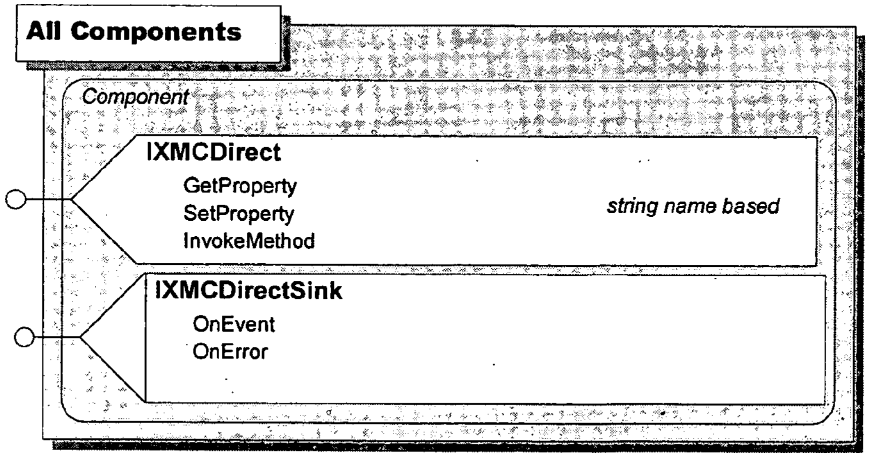

All Components
Component
IXMCDirect
GetProperty
SetProperty
InvokeMethod
string name based
IXMCDirectSink
OnEvent
OnError

FIG. 15

COMMAND PROCESSING SYSTEMS AND METHODS

RELATED APPLICATIONS

[**0001**] The present application claims priority of U.S. Provisional Patent Application Ser. No. 60/520,918 filed on Nov. 17, 2003.

FIELD OF INVENTION

[**0002**] The present invention relates to systems and methods of distributing software commands and, more specifically, such software systems and methods for distributing commands from one or more command sources to one or more command targets.

BACKGROUND OF INVENTION

[**0003**] The present invention is of particular significance in the field of motion control systems and methods, and that application of the present invention will be described in detail herein. However, the present invention may have broader application to other systems and methods in which commands from one or more command sources must be distributed to one or more command targets.

[**0004**] In the context of motion control systems, control commands are transmitted to motion control devices such as computer numeric control (CNC) systems, general motion control (GMC) automation systems, and hardware independent data engines for motion control systems. The destination motion control device will be referred to herein as a command target. In some situations, these control commands come from a variety of sources, which will be referred to herein as command sources.

[**0005**] The need exists for systems and methods for organizing the distribution of control commands form a variety of types of command sources to a variety of types of command targets.

SUMMARY OF INVENTION

[**0006**] The present invention may be embodied as a command processing system for transferring commands from at least one command source to at least one command target of at least one command target type. The command processing system comprises at least one service client associated with each command source; a command processor in communication with the at least one service client; and a command thread associated with each command target type. The command thread is in communication with the command processor. The command thread is in communication with the at least one command target. The command thread transfers commands from the command processor to the command target.

DETAILED DESCRIPTION OF THE DRAWINGS

[**0007**] **FIG. 1** is a module interaction map depicting the interaction of modules of a command processor system of a first embodiment of the present invention;

[**0008**] **FIGS. 2-8** are use case maps illustrating common uses cases that occur during operation of the example command processing system of **FIG. 1**;

[**0009**] **FIG. 9** is a module interaction map depicting the interaction of modules of a command processor system of a second embodiment of the present invention;

[**0010**] **FIGS. 10-14** are use case maps illustrating common uses cases that occur during operation of the example command processing system of **FIG. 9**; and

[**0011**] **FIG. 15** depicts a component interface implemented by all components of the example command processing system of **FIG. 9**.

DETAILED DESCRIPTION OF THE INVENTION

[**0012**] The present invention relates to systems and methods for processing various types of commands transmitted between one or more command sources and one or more command targets forming part of a larger command system. The present invention is of particular significance when the command system is part of a motion control system, and that application will be referred to on occasion below. As used herein, the term “command” refers to information that allows an operation to be executed on a command target.

[**0013**] The present invention may be implemented using any one or more of a number of different system designs. A self contained system **20** of the present invention will be described below with reference to **FIGS. 1-8**. The self contained system **20** describes a command processor component that implements all command processing functionality within a single component. A modular design will be described with reference to **FIGS. 9-14**. The modular design describes a a command processor system made up of the command processor component and one or more command execution components. The example self contained and modular designs are described below with reference to a module interaction description and a set of use cases that describe how the modules interact with one another when carrying out common operations.

[**0014**] In the present application, the term “module” is used to refer to a binary block of computer logic that contains functions, objects, components, ActiveX components, .NET source, HTML, XML and/or other computer code that can be executed in real-time or in script form. Several examples of a module include an executable EXE, a dynamic link library DLL, an OLE component or set of components housed within a DLL or EXE, an ActiveX Control, an HTML or XML based Control, a VB script source file, a Java Serverlet, Java Control, Java Object, NET Package, etc. The term “component” as used herein refers to a logical organization of computer logic designed to perform a set of operations. Several examples of a component are an OLE Component, an ActiveX Control, an HTML or XML based Control, an HTML or XML based object, a .NET object, a Visual Basic based object, etc.

[**0015**] Referring now to **FIG. 1** of the drawing, depicted therein at **20** is a command processing system constructed in accordance with the principles of a self contained system **20** of the present invention. The self contained system **20** comprises a command processor **22** implemented such that all command processing takes place within a single component. The self contained system **20** may allow for faster command processing than command processing systems using alternative designs.

[0016] The command processor **22** is designed to run as an individual COM+ Component either in a stand alone manner under COM+. In the context of a motion system, the command processor **22** may be designed to operate under a Windows NT Service application for providing motion services (e.g., XMC Service). When run under COM+, the command processor **22** may receive commands in various forms, including SOAP (simple object architecture protocol), Web Services, COM method calls, and by monitoring a section of shared memory for command requests. Various other command input methods may also employed.

[0017] The example command processing system **20** comprises the command processor component **22**, one or more command source components **30**, and one or more command target components **32**. The example command sources **30** are each associated with a service client **34**. The example command processing system **20** further comprises a command service module **40** and a command service configuration and status module (configuration and status module) **42**. In some situations, the command processing system **20** may further comprise an event component **44**.

[0018] The example command processor **22** receives, runs, and responds to commands received through first and second areas **50** and **52** of shared memory in the system **20**. The command processor may optionally run as a COM+ component that services SOAP or other Web Service requests directly or via COM+. The command processor **22** may optionally communicate with the command target components **32** across a network, depending on the overall system architecture. As used herein, the term "network" refers to a link between two or more computer systems and may be in the form of a packet based network, a streaming based network, broadcast based network, or peer-to-peer based network. Several network examples include a TCP/IP network, the Internet, an Intranet, a wireless network using WiFi, a wireless network using radio waves and/or other light based signals, etc.

[0019] If the sent commands relate to a command operation that must run as a set of commands or not at all, the command processor **22** may employ command 'framing' to ensure that the commands are run as a set. U.S. Pat. No. 6,480,896 to the present Applicant describes a system of command framing in the context of a motion control system.

[0020] The example service clients **34** are thin service components associated with specific clients or types of clients that interface with the shared memory used to communicate command requests to the command processor **22**. Each service client **34** may also relay input to the command processor **22** by receiving commands via some other protocol such as TCP/IP, SOAP Messaging, or the like that is transferred either locally or across a network. Once received, the command is then converted into the appropriate shared memory format to direct the command processor **22** that a new command is ready for processing. Optionally the service client **34** may communicate either locally or across a network using OLE/COM interface methods of the command processor **22**. This method is typically not as fast, but can allow for architectural flexibility.

[0021] In the context of a motion control system, the command sources **30** may be formed by an application programming interface for motion systems **30***a* (e.g., XMC API), a system for processing data **30***b* (e.g., XMC Data Router), and/or other clients **30***c*.

[0022] The command targets **32** are sets of components used to monitor devices or machines. Each of the command targets **32** may be created for particular device or machine or class of devices or machines. The terms "device" or "machine" as used herein refer to a physical asset used to perform a specified task. For example, a machine may be a CNC Mill used to shape metal, a pick-n-place machine used to position parts on a circuit board, a robotic machine used to perform surgery, a medical data input device used to collect the vitals from a human being (i.e. blood glucose meter, asthma meter, etc), a gaming device used when playing a game, a robotic toy, an animatronics figure, a robotic machine used to deliver goods to a warehouse or to people, an automobile, truck or farm vehicle, a boat or ship that maneuvers in water, a airplane, jet, helicopter and/or spacecraft. Basically any self powered machine or device (mobile or not) that is either directly controlled by humans or automatically controlled via a computer based system.

[0023] In the context of a motion control system, the command targets may be formed by a system of transmitting data to a motion system (data engine) **34***a* (e.g., XMCDE Data Engine system), a system for automating control of a CNC motion system (CNC control system) **34***b* (e.g., XMC CNC Automation system), and/or a system for automating control of a GMC motion system (GMC control system) **34***c* (e.g., XMC GMC Automation system).

[0024] The configuration and status module **42** allows the user to configure the service and gain status on how the application is running. The example command service module **42** is a very thin Windows NT Service that optionally hosts the command processor **22**, thereby allowing the command processor to run even while the current user is not logged into the system.

[0025] The event component **44** sends event data received from one of the data sources formed by the target components **32** to one or more 'listening' client components **34** associated with the command sources **30**. The term "data" as used herein refers to any numeric or string data values collected from a target machine or device in an analog or digital format that is made compatible for computer systems. Examples of data types that represent data items include BIT, BYTE, WORD, DWORD, LONG, REAL, DOUBLE, FLOAT, STRING, ASCII STRING. Data may be collected from data sources using various methods such as reading register values on the data source, reading shared memory provided by the data source, sending commands to the data source for which a data response is given containing the data requested, reading variables provided by the data source, reading and writing to variables in a sequence necessary to produce data values, querying data using a proprietary or standard data protocol, and/or calling a function provided by the target data source.

[0026] As shown in **FIG. 1**, the example command processor **22** comprises several C++ objects and Windows NT threads that interact with one another to route the commands received to the appropriate target components that ultimately carry out the specifics of the command requested. In particular, the example command processor **22** comprises a reception thread **60** and one or more command threads **62**.

[0027] The reception thread **60** is responsible for receiving commands placed in the shared memory **52**. The reception thread **60** continually scans the shared memory **52** for new commands triggered by the use of global events.

[0028] In the context of a motion control system, the command threads **62** are of two types, where a first command thread **62***a* processes commands associated with the data engine **34***a* and the second command thread **62***b* processes commands associated with the CNC motion system **34***b* and the GMC motion system **34***c*.

[0029] The following C++ objects are used to implement portions of the example command processor **22**.

[0030] The reception thread **60** comprises a ConfigMgr object **70**, a DataMgr object **72**, and a QueueMgr object **74**. The ConfigMgr object **70** accesses configuration information placed in the shared memory area **52** by the configuration and status module **42**. The DataMgr **72** pulls commands from the memory area **50** shared with the service clients **34**. The example QueueMgr object **74** manages one or more priority queues **76** servicing the command threads **62**.

[0031] The command threads **62** each comprise a StatusMgr object **80**, a QueueMgr object **82**, and a CommandMgr object **84**. The StatusMgr object **80** is manages and updates the status area **52** of the shared memory used by the configuration and status module **42**. The status information managed and updated by the StatusMgr object **80** may be displayed to provide a user with visual feedback on what the command threads **62** are actually doing at each point in time, as well as the number of elements in the command queues. The CommandMgr object **84** carries out each command by calling the appropriate target components **32**.

[0032] The interaction of the objects, threads and components forming the command processor **22** will now be described in several common use cases. The following use cases will be described below: Initialization, System Start, Command Processing (First Command Thread), Command Processing (Second Command Thread), Receiving Data, and Receiving Events. The steps making up each use case are described in the order in which they occur.

[0033] Referring now to **FIG. 2**, the Initialization use case will first be described. Initialization takes place when an application, such as the command services application **40**, first starts up and loads the command processor **22**. During this process each of the threads are started and all C++ objects are initialized.

[0034] The following steps take place when initializing the command processor **22**. In step **1**, the application hosting the command processor **22**, such as the XMC Windows NT Service or COM+DLLHOST, starts up. In step **2**, the host application creates the component forming the command processor **22**. When first created, the component forming the command processor **22** creates and starts the reception thread **60** in step **3**. In step **4**, ConfigMgr, DataMgr and QueueMgr objects **70**, **72**, and **74** used by the reception thread **60** are created and initialized.

[0035] In step **5**, the second command thread **62***b* is created and started. In step **6**, an instance of the StatusMgr object **80***b* is created and initialized. Once created, this component **80***b* may be used to update status information on the overall initialization process. In step **7**, instances of the QueueMgr and CommandMgr objects **82***b* and **84***b* are created and initialized. In step **8**, the CommandMgr object **84***b* creates an instance of its associated target component **32***a*.

[0036] In step **9**, the command thread or threads **62** are created and started. In step **10**, an instance of the StatusMgr object **80***a* is created and initialized, allowing status information on the initialization progress of the command thread **62***a* to be set. In step **11**, an instance of the CommandMgr and QueueMgr objects **82***a* and **84***a* used by the thread **62***a* are created and initialized.

[0037] At step **12**, the CommandMgr creates an instance of the command targets **32***b* and **32***c*. In the context of a motion control system, a multi-system configuration may optionally use separate threads to process CNC and GMC commands respectively.

[0038] After completing the initialization, the reception thread **60** places itself in the 'paused' state so that it will not process any commands until resumed. At this point the command processor **22** is initialized and ready to be started.

[0039] Once initialized, the reception thread **60** must be resumed from its paused state prior to use of the system **20**. No commands are processed until the reception thread **60** is resumed.

[0040] Referring now to **FIG. 3**, the following steps occur when starting the command processor **22**. In step **1**, the hosting command service application **40** calls a method on the command processor **22** component to 'start' the command processing. In step **2**, upon receiving the 'start' call, the command processor **22** component resumes the reception thread **60** causing the DataMgr object **72** to first query for any configuration changes.

[0041] In step **3**, the DataMgr object **72** queries the ConfigMgr object **74** for any configuration changes such as a new priority for the reception thread **60**, etc. The ConfigMgr object **70** queries the configuration shared memory for any settings. Once started as shown at step **4**, the DataMgr object **72** resumes normal operation and continually checks for new commands in the shared memory.

[0042] At this point all commands received are processed normally. The following sections describe how two of the main command types are processed; namely the example command threads **62***a* and **62***b*.

[0043] Referring first to **FIG. 4**, depicted therein is the processing implemented by the second type of command thread **62***b*. In general, all commands associated with the command target **32***a* are processed are routed to the first command target **32***a*. Examples of the commands sent to the command target **32***a* are 'Start' or 'Pause' and these commands will be referred to as first type commands.

[0044] The following steps occur when processing commands destined for the command target **32***a*. In step **1**, the command source **30***b* calls the service client **34***b* requesting that a given first type command be run. As generally discussed above, some commands may be initiated by the host itself, a user interface application, or even a protocol listener used to convert and route command **30** requests using the service client **34***b*.

[0045] In step **2**, the service client **34***b* packages the command into an area within the shared memory area **50** specifically allocated for that instance of the service client **34***b*. Within the command processor **22**, the reception thread **60** is continually monitoring the shared memory **50** for new commands as shown in step **3**. Upon detecting a new command, the DataMgr object **72** extracts the command information from the shared memory area **50**.

[**0046**] In step **4**, the DataMgr object **72** passes the command information to the QueueMgr object **74**. In step **5**, the QueueMgr object **74** packages the command information into a queue command element and places the command in the priority queue **76***b*. The element may be placed at a location in the queue based on the element's priority so that high priority commands are processed sooner than low priority commands.

[**0047**] Within the command threads **62**, the QueueMgr object **74** implicitly receives the queued command (i.e. it is the same queue accessed in the reception thread **60**) as shown in step **6**.

[**0048**] As shown in step **7**, the CommandMgr object **84***b,* which continually checks for new commands to run in the command thread **62***b,* detects a new command and pulls it from the QueueMgr object **82***b*. And finally in step **8**, the CommandMgr object directs the command to the command target component **32***a,* which carries out the requested command.

[**0049**] At this point the command is complete. However, the mechanism just described does not allow notification back to the service client **34***b* that requested the command. This type of command is known as a 'broadcasted' command, where the command is sent without sending back status on the results of the command carried out.

[**0050**] As shown in **FIG. 5**, the first command thread **62***a* operates in a manner similar to that of the second command thread **62***b,* except that commands routed through the first command thread **62***a* are routed to one of the command targets **32***b* and **32***c* instead of the command target **32***a*.

[**0051**] The following steps occur when processing commands destined for the command targets **32***b* and **32***c*.

[**0052**] In step **1**, the service client **30** calls the Service Thin Client requesting to run a given first type command. Again, some commands may be initiated by the host itself, a user interface application, or even a protocol listener used to convert and route command requests using the service client **34**.

[**0053**] In step **2**, the service client **34***a* packages the command into the area within the shared memory area **50** specifically allocated for that instance of the service client **34***a*.

[**0054**] Within the command processor **22**, the reception thread **60** is continually monitoring the shared memory for new commands as shown in step **3**. Upon detecting a new command, the DataMgr object **72** extracts the command information from the shared memory.

[**0055**] As shown in step **4**, the DataMgr object **72** passes the command information to the QueueMgr object **74**. At step **5**, the QueueMgr object **74** packages the command information into a queue command element and places the command in the priority queue **76***a*. The element may be placed at a location in the queue based on the elements priority so that high priority commands are processed sooner than low priority commands.

[**0056**] As shown at step **6**, within the command thread **62***a,* the QueueMgr object **82***a* implicitly receives the queued command (i.e. it is the same queue accessed in the reception thread **60**).

[**0057**] At step **7**, the CommandMgr object **84***a,* which continually checks for new commands to run in the command thread **62***a,* detects a new command and pulls it from the QueueMgr object **82***a*.

[**0058**] And finally at step **8**, the CommandMgr object **84***a* directs the command to the command target component **32***b* and/or **32***c* which carries out the requested command.

[**0059**] At this point the command is complete. Again, no notification is sent back to the service client **34** who requested the command. This example command is known as a 'broadcasted' command where the command is sent without sending back status on the results of the command carried out.

[**0060**] While running the command processor **22**, often it is important to display visual feedback on what the command processor **22** is actually doing. For example, the user may want to know whether the command processor **22** is currently processing a command or how many commands are in the various command queues. The use case illustrated in **FIG. 6** illustrates how such user feedback can be attained while running the command processor **22**.

[**0061**] The following steps occur when updating status while processing each command.

[**0062**] In a step **1**, the StatusMgr objects **80***a* and **80***b* collect status information while each of the command threads **62***a* and **62***b* run. All status information is saved to the status/configuration shared memory area **52**.

[**0063**] In step **2**, each application requesting status information reads the shared memory area **52** where the status information was placed.

[**0064**] The service client **34** that requested a command be run will want or need feedback on the results of the command and in many cases data that results from running the command. The use case depicted in **FIG. 7** describes how feedback data may be returned to service clients **34**.

[**0065**] The following steps occur when data and results are to be returned to the service client **34**.

[**0066**] In step **1**, the service client **34** places the command into the shared memory area **50**. Included with the command information is the name of the global event for which the service client **34** is waiting and which should be set by the command processor **22** upon completion of the command.

[**0067**] As shown in step **2**, upon receiving the command, the DataMgr object **72** extracts the command information from the shared memory area **50**, including the name of the global event. At step **3**, all command information is passed to the. QueueMgr object **74**.

[**0068**] As shown at step **4**, the QueueMgr object **74** packages the command information into a command element that is then placed within the appropriate command priority queue **76***a* and/or **76***b*.

[**0069**] In step **5**, the CommandMgr objects **84** within the command threads **62** detect the command by querying the QueueMgr object **82***b*. In step **6**, the QueueMgr objects **82** return the command element or elements to the CommandMgr objects **84**.

[**0070**] In step **7**, the CommandMgr objects **84** run the command by delegating it to the appropriate command target **32**. Upon completion of the command, the CommandMgr objects **84** update the shared memory **52** referenced by the command element with the return result and any data returned by the command targets **32**. Once all data is updated, the CommandMgr objects **84** set the global event referenced by the command element, notifying other components of the command processor **22** that execution of the command is complete.

[**0071**] In step **8**, the event that the service client **34** is waiting on is released, thus freeing the service client **34** to continue with the data placed in the shared memory area **52** back in step **7**. At this point the command processing for the command is complete.

[**0072**] In some cases, it is desirable for the service client **34** to receive 'unsolicited' updates when certain events occur. **FIG. 8** depicts the situation in which the service client **34** receives updates upon the occurrence of certain events. To receive events, the event component **44** is accessible by the command client **34** and the command target **32**. In addition, the service client **34** calls a command source **30** to 'subscribe' to the event. Once subscribed, the event is fired to the service client **34** when the event condition is met. The following steps occur when events are sent back to the service client **34**.

[**0073**] In a first step, when the event condition is met, the component that is the source of the event fires the event using the event component **44**. In step **2**, the event component **44** sends the 'global' event to all instances of the event component **44**. In step **3**, the instance of the event component **44** used by the service client **34** picks up the event and calls an event handler on the service client **34**. At this point the event routing has completed.

[**0074**] Referring now to **FIGS. 9-14**, a modular design of a command processing system **120** of the present invention will now be described. The command processing system **120** comprises command processor **122**. The command processing system **120** is more scaleable than the command processing system **20** described above in that it can support any type of command without requiring any changes within the command processor **122**.

[**0075**] In general, two component types interact with one another to process commands received: the command processor **122** and a number of command execution components that will be described in further detail below. As with the system **20** described above, the system **120** transfers commands between one or more command sources **130** and one or more command targets **132**. Each command source **130** is associated with a service client **134**. The system **120** further comprises a command services module **140** and a configuration and status module **142**. The system **120** further defines shared memory areas **150** and **152***a,* **152***b,* and **152***c*.

[**0076**] To process commands, the command processor **122** routes each command received to an appropriate command execution component **160** designated to handle the type of command received.

[**0077**] Optionally, each of the command execution components **160** may be given a global priority that dictates how and when the command processor **122** sends commands thereto. For example, **FIG. 1** shows how three different types of commands associated with three types of command targets **132***a,* **132***b,* and **132***c* may be supported. The design is specifically intended to support many different kinds of commands, including commands not yet defined by the command implementer of the command processor **122** and/or commands defined by a third party. The design of the command processing system **120** thus allows for supporting many different types of commands without requiring changes in the overall command processor **22** architecture. Another advantage of the design of the command processing system **120** is that this design allows for the deployment of new command types to the field where the command processor **22** is already in use.

[**0078**] **FIG. 10** is a slightly more detailed block diagram illustrating the command processor **122** and each command execution components **160**.

[**0079**] The service client **134** functions as an interface between a shared memory area **150** and is used to communicate command requests to the command processor **22**. The service clients **134** may also be used to relay input to the command processor **22** by receiving command via some other protocol such as TCP/IP, SOAP Messaging, etc., that is transferred either locally or across a network. Once received, the command is then converted into the appropriate shared memory format to direct the command processor **22** that a new command is ready for processing. Optionally, the service client **134** may communicate either locally or across a network using the OLE/COM interface methods of the components forming the command processor **122**. This method is not as fast, but can allow for architectural flexibility.

[**0080**] The command processor component **122** receives and delegates each command to the appropriate command execution component **160**. The command processor component **122** may also run optionally as a COM+ component that services SOAP or other Web Service requests, either directly or via COM+. Optionally, the command processor **122** may communicate with the command execution components **160** across a network.

[**0081**] Command execution components **160** are responsible for running the set of commands associated with the component. For example, individual command execution components **160***a,* **160***b,* and **160***c* run commands that are destined for the target component **132***a,* **132***b,* and **132***c,* respectively. Optionally each individual command execution component **160** may run as a COM+ component. Again, this may not optimize system speed, but can provide desirable architectural flexibility.

[**0082**] The command execution components **160** may support using Artificial Intelligence to break down generic commands into a set of more complex commands used to carry out a task. As used herein, the term "artificial intelligence" refers to algorithms such as Neural Networks, Genetic Algorithms, Fuzzy Logic, Expert Systems, combinations of all listed and other computer based decision making and pattern matching based systems. For example, a generic command may state to lift up a box. This command would then be broken down into the sequence of moves given the current position of a loader arm, necessary to pick up the box. The command execution component **160** may use Artificial Intelligence to do such a breakdown.

[**0083**] When communicating to the target component **132**, the command execution component **160** may do so either locally or across a network depending on the overall system architecture. In the event that the commands sent contain a critical operation that must run as a set of commands or not at all, the command processor may employ a form of command 'framing' as generally described above.

[**0084**] The example command service component **140** is a very thin Windows NT Service that optionally hosts the command processor **122** thus allowing the command processor to run even while the current user is not logged into the system. It should be noted that future versions may not need this service as COM+ supports running components as a services. Since the command processor component **122** optionally supports COM+ it may also be run as a service in COM+.

[**0085**] The configuration and status module application **142** allows the user to configure the command processor **122** and various command execution components **160** and obtain status on how each component is running.

[**0086**] The command targets **132** are or may be similar to the command targets **32** described above, and the command targets **132** will not be described again herein beyond what is necessary for a complete understanding of the present invention.

[**0087**] Like the event component **44** described above, the event component **44**; sends event data received from one of the various command targets **132** to one or more 'listening' service clients **134**.

[**0088**] The details of the example command processor **122** will now be described in detail. The example command processor **122** comprises several C++ objects and a Windows NT thread that interact with one another to route the commands received to the appropriate command execution component **160**.

[**0089**] The command process comprises a reception thread **170** that receives commands placed in the shared memory area **150**. The thread **170** continually scans for new commands in the shared memory area **150**. The new commands may be triggered by the use of global events.

[**0090**] The following example objects are C++ objects used to implement portions of the command processor **122**. A ConfigMgr object **172** pulls configuration information set in the shared memory area **150** by the configuration and status module **142**. A DataMgr object **174** pulls commands, :stored by the service client **134** in the shared memory area **150**.

[**0091**] The command execution components will now be described in further detail. Within the command execution component **160** several C++ objects and a Windows NT thread interact with one another to run the commands received.

[**0092**] Each command execution component **160** comprises a command thread **180**. The command threads **180** process commands destined for the command target **132** that supports the command set associated with the command execution component **160**.

[**0093**] The following C++ objects are used to implement portions of the command execution component **160**. A QueueMgr object **182** is responsible for managing the various priority queues **184** servicing the command threads **162**.

[**0094**] A StatusMgr object **190** manages and updates the status area of the shared memory used by the configuration and status module **142**. The status information updated is used to allow visual feedback on the state of the command threads **62** as well as the number of elements in the command queues **184**.

[**0095**] A CommandMgr object **192** carries out each command by calling the appropriate command targets **132**.

[**0096**] The interaction of the objects, threads and components of the command processing system **120** will now be described in reference to several common use cases that take place on the command processor **122** during normal use. The following use cases will be described in detail below: Initialization, Command Processing, Receiving Events, and Updating Status.

[**0097**] As shown in **FIG. 11**, when initializing the system, the following steps take place. In step **1**, before actually starting the initialization of the component, the user may optionally change the configuration of the component using the configuration and status application **142**, which allows the user to configure the command processor **122** and/or all command execution components **160**.

[**0098**] At step **2**, when actually initializing the component, the command target **132** (optionally a DLLHOST used when run as a COM+ server) creates the command processor component **122** and directs it to initialize itself.

[**0099**] At step **3**, when created, the command processor **122** creates the reception thread **60** and runs it. Within the reception thread **60** the ConfigMgr is initialized at step **4**. At step **5**, the reception thread **60** initializes the DataMgr object **174**.

[**0100**] During its initialization, the DataMgr object **174** queries the ConfigMgr object **172** for settings previously made by the user. For example, the list of command execution components **160** installed is queried.

[**0101**] At step **7**, the DataMgr object **174** then creates each command execution component **160**. When created, each command execution component **160** creates its command thread **180** and starts running it at step **8**. Within the command thread **180**, the StatusMgr, QueueMgr and CommandMgr objects are next initialized at step **9**.

[**0102**] Upon completion of the command execution component **160** creation, at step **10** the DataMgr object **174** within the reception thread **170** of the command processor **122** sends a command to the command execution component **160** directing the execution component **160** to initialize itself.

[**0103**] At step **11**, the initialization command is received by the QueueMgr object **192** in the command execution component **160**. At step **12**, the QueueMgr object **192** immediately places the command received into the command queue **184**.

[**0104**] Within the command thread **180** of the command execution component **160**, at step **13** the CommandMgr object **194** queries the QueueMgr object **192** for any new commands and pulls the initialize command from the queue (previously placed in the queue in step **12** above).

[**0105**] The CommandMgr object **194** creates the appropriate command target **132** at step **14**, which runs the commands in the set associated with the specific command execution component **160**. The command target **132** is also directed to initialize itself making it ready to process commands. Upon completing the initialization, the CommandMgr **194** unlocks the Windows Event associated with the command signifying that the command has been completed.

[**0106**] Referring back to the DataMgr object **174** within the reception thread **170** in the command processor component **122**, the DataMgr object **174** detects that the command has been completed and prepares to run more commands as shown at step **15**.

[**0107**] The creation process, in which the command processor **122** and command execution components **160** are created, and the initialization process may optionally be separated. In this case, a specific command is first created and then a specific 'initialize' command is then sent to the command processor directing it to prepare for receiving commands. In such a situation, the command processor **122** could block (wait until the initialization command completed) and then return the results of the initialization back to the configuration and status application **142** (or other host, such as DLLHOST, or a service client **134** using DLLHOST).

[**0108**] At this point the command processor **122** is running and ready to process commands from the service client or clients **34**.

[**0109**] Referring now to **FIG. 12**, the following steps take place when processing a given command. In step **1**, the service client **134** software calls the service client **134** directing it to run a given command.

[**0110**] In the step **2**, the service client **134** then places the command information into the shared memory area **150** designated by the command processor **122** for the specific instance of the service client **134** (this designation occurs when first creating the service client **134**). Optionally, the service client **134** then waits for the command processor **122** to signal that the event has completed. This signaling occurs either through information passed through the shared memory or with a global synchronization object, like a Windows NT Event object.

[**0111**] In step **3**, the DataMgr object **174** of the reception thread **170** in the command processor **122** detects that a command is ready in the shared memory **150**. The command information is extracted from the shared memory **150**.

[**0112**] In step **4**, the DataMgr object **174** sends the command information to the command execution component **160**.

[**0113**] Upon receiving the command information, the information is routed to the QueueMgr **192** which then places the command information into the command queue at step **5**. Optionally, the command information is placed into the queue **184** at a location specified by the command priority. For example, a high priority command may be placed at the beginning of the queue (i.e. pulled off the queue first) whereas a low priority command may be placed at the end of the queue (i.e. pulled off the queue last).

[**0114**] In step **6**, the CommandMgr **194** within the command thread **180** queries the QueueMgr **192** for any commands that may exist and, if one does exist, pulls the command from the front of the command queue **184**.

[**0115**] The command is then run at step **7** by passing the command to the command target **132** used to run the command. For example, second type command might be passed to the second command target **160***b*.

[**0116**] At step **8**, upon completion of the command, the CommandMgr **194** copies all return data into the shared memory **150** and then either toggles information in the shared memory **150** associated with the command or signals a synchronization object, such as a Windows NT Event, to signify that the command has completed.

[**0117**] In step **9**, the service client **134** detects that the command has completed and picks up any return data placed in the shared memory **150** and returns it to the command source **30**.

[**0118**] At this point the command processing has completed.

[**0119**] Referring now to **FIG. 13**, the following steps occur when the service client **134** receives unsolicited events from the command target **132**.

[**0120**] When the event condition is met (the event condition being previously configured), the command target **132** fires the event using the event component **144** as shown in step **1**. In step **2**, the event component **144** fires the event to all listening components including other instances of the event component **144**. In step **3**, the instance of the event component **144** used by the service client **134** picks up the event and routes it to the service client **134**. The service client **134** then routes the event information to the command source **130**.

[**0121**] At this point the event processing is complete.

[**0122**] Referring now to **FIG. 14**, the following steps take place when updating status information while the command processor component **122** and command execution component **160** process commands.

[**0123**] In step **1**, during each loop within each command execution component **160** status information is continuously updated using the StatusMgr object **190**. For example, the number of commands in the command queue **174** may be set in the status shared memory **152**.

[**0124**] The configuration and status module **142** is then able to pick up the information from the shared memory and display it to the user, thus notifying the user of the status of each command execution module **160** (and optionally command processor **122**) components. Optionally, a separate thread may be used to monitor status information so as to not slow down or otherwise interfere with the command thread.

[**0125**] As generally described above, the example command processor **122** is a modular system made up of a set of components (i.e. each component is based on a component technology such as OLE/COM from Microsoft Corporation). Optionally, each component uses a separate 'parallel' ActiveX component to implement all user interface aspects of the main component. Each ActiveX component may be implemented either within the main component module or separately in its own module. Bundling each object within one module is not required as the objects may be located at any location (i.e. across a network, and so forth), but doing so may optimize communication between modules. The exact location of the components in any given implementation of the present invention is merely a logistical decision. Once components are built and deployed, it is difficult to update a single component if all components are implemented within a single DLL or EXE module.

[**0126**] As shown in **FIG. 15**, the example components forming the command processor **122** implement, at a minimum, a single interface: the IXMCDirect interface. Optionally, components that receive events from other components can implement the IXMCDirectSink interface as well.

[**0127**] OLE Categories are used to determine how many components fall into a certain group of components. Currently the following categories are used:

[**0128**] command processor components—Typically there is only one command processor component **122**. However, in the event that the command processor improves over time and has future more improved versions, each new and improved version would fall into this category of components.

[**0129**] command execution components—command execution components **160** are used to process a set of commands of a given type. For example, the first command target **132***a,* the second command target **132***b,* and the third command target **132***c* represent command types that may each have an associated command execution component **160**.

[**0130**] The IXMCDirect interface is used for most communications between all components making up the command processor **122** Technology. The following methods make up this interface (as specified in the standard OLE/COM IDL format):

[**0131**] GetProperty—This method is used to query a specific property from the component implementing the interface.

[**0132**] SetProperty—This method is used to set a specific property from the component implementing the interface.

[**0133**] InvokeMethod—This method is used to invoke a specific action on the component implementing the interface. It should be noted that an action can cause an event to occur, carry out a certain operation, query a value and/or set a value within the component implementing the method.

[**0134**] A more detailed description of each method implemented by the object is described below.

IXMCDirect::GetProperty

Syntax	HRESULT GetProperty(LPCTSTR pszPropName, LPXMC_PARAM_DATA rgData, DWORD dwCount);
Parameters	LPCTSTR pszPropName - string name of the property to query. LPXMC_PARAM_DATA rgData - array of XMC_PARAM_DATA types that specify each parameter corresponding to the property. For example, a certain property may be made up of a number of elements - in this case an array of XMC_PARAM_DATA items is returned, one for each element making up the property. In most cases a property is made up of a single element, thus a single element array is passed to this method. For more information on the XMC_PARAM_DATA type, see below. DWORD dwCount - number of XMC_PARAM_DATA elements in the rgData array.
Return Value	HRESULT - NOERROR on success, or error code on failure.

[**0135**] This method is used to query the property corresponding to the property name 'pszPropName'. Each component defines the properties that it supports.

IXMCDirect::SetProperty

Syntax	HRESULT SetProperty(LPCTSTR pszPropName, LPXMC_PARAM_DATA rgData, DWORD dwCount);
Parameters	LPCTSTR pszPropName - string name of the property to set. LPXMC_PARAM_DATA rgData - array of XMC_PARAM_DATA types that specify each parameter corresponding to the property. For example, a certain property may be made up of a number of elements - in this case an array of XMC_PARAM_DATA items is returned, one for each element making up the property. In most cases a property is made up of a single element, thus a single element array is passed to this method. For more information on the XMC_PARAM_DATA type, see below. DWORD dwCount - number of XMC_PARAM_DATA elements in the rgData array.
Return Value	HRESULT - NOERROR on success, or error code on failure.

[**0136**] This method is used to set a property in the component corresponding to the ‘pszPropName’ property. For the set of properties supported by the component, see the specific component description.

IXMCDirect::InvokeMethod	
Syntax	HRESULT InvokeMethod(DWORD dwMethodIdx, LPXMC__PARAM__DATA rgData, DWORD dwCount);
Parameters	DWORD dwMethodIdx - number corresponding to the specific method to invoke. For more information on the method indexes available, see the set of namespaces defined for the component. LPXMC__PARAM__DATA rgData [optional] - array of XMC__PARAM__DATA types that specify each parameter for the method called. For more information on the XMC__PARAM__DATA type, see below. NOTE: if no parameters exist for the method called, a value of NULL must be passed in. DWORD dwCount [optional] - number of XMC__PARAM__DATA elements in the rgData array. NOTE: if no parameters exist for the method called, a value of 0 (zero) must be passed in for this parameter. LPXMC__PARAM__DATA rgData [optional] - namespace associated with the instance of the custom extension module added.
Return Value	HRESULT - NOERROR on success, or error code on failure.

[**0137**] This method is used to call a specific method implemented by the component. For more information on the methods supported, see the description of the specific component.

[**0138**] The IXMCDirectSink interface is an event reception point on which one component can send event data to another. The component implementing this interface is the event receiver. The event source calls the interface passing to it event data.

[**0139**] The IXMCDirectSink interface is made up of the following functions.

[**0140**] OnEvent—This method is called by the event source when an event occurs (i.e. the conditions defining the event are met).

[**0141**] OnError—This method is called by the event source when an error occurs.

[**0142**] A more detailed description of each method implemented by the object is described below.

IXMCDirectSink::OnEvent	
Syntax	HRESULT OnEvent(long lApiIdx, SAFEARRAY** ppSA);
Parameters	long lApildx - index associated with the event type.. SAFEARRAY** ppSA - pointer to a pointer to a SAFEARRAY containing an array of XMC__PARAM__DATA structures. For more information on the XMC__PARAM__DATA type, see below.
Return Value	HRESULT - NOERROR on success, or error code on failure.
Notes	The SAFEARRAY passed to this method contains an array of XMC__PARAM__DATA structures. This array has the following entries:
rgData[0]	LONG lConnectionCookie - unique cookie associated with this connection to the XMC Motion Server (returned when calling the InitializeHardware method on the XMC Motion Server).
rgData[1]	DWORD dwSubscriptionCookie - unique cookie associated with the subscription for which this event has fired. This cookie is returned when making the subscription.
rgData[2]	DWORD dwDataCookie - unique cookie associated with the specific data change that triggered the event. This cookie is generated within the XMC Motion Server.
rgData[3]	LPCTSTR pszItemName - name of the item or variable for which the subscription is associated.
rgData[4]	double dfTimeStamp - number of milliseconds passed from the time that the event pump, implemented by the XMC Motion Server, was first started.

-continued

IXMCDirectSink::OnEvent	
rgData[5]	DWORD dwDataCount - number of data values associated with the event (i.e. the number of structure elements that follow).
rgData[6 + n]	Number or String - actual data values associated with the event.

[0143] This method is called by the event source and passed the event data in a SAFEARRAY form for easy marshalling across process boundaries.

IXMCDirectSink::OnError	
Syntax	HRESULT OnError(long IApiIdx, SAFEARRAY** ppSA);
Parameters	long lApildx - index associated with the event type.. SAFEARRAY** ppSA - pointer to a pointer to a SAFEARRAY containing an array of XMC_PARAM_DATA structures. For more information on the XMC_PARAM_DATA type, see below.
Return Value	HRESULT - NOERROR on success, or error code on failure.
Notes	The SAFEARRAY passed to this method contains an array of XMC_PARAM_DATA structures. This array has the following entries:
rgData[0]	LONG lConnectionCookie - unique cookie associated with this connection to the XMC Motion Server (returned when calling the InitializeHardware method on the XMC Motion Server).
rgData[1]	DWORD dwSubscriptionCookie - unique cookie associated with the subscription for which this event has fired. This cookie is returned when making the subscription.
rgData[2]	DWORD dwDataCookie - unique cookie associated with the specific data change that triggered the event. This cookie is generated within the XMC Motion Server.
rgData[3]	LPCTSTR pszItemName - name of the item or variable for which the subscription is associated.
rgData[4]	double dfTimeStamp - number of milliseconds passed from the time that the event pump, implemented by the XMC Motion Server, was first started.
rgData[5]	HRESULT hrResult - result code of the error for which the event is associated.
rgData[6]	LPCTSTR pszError - string description of the error.
rgData[7]	LONG ISrcError - error code describing the source of the error. For example, this may be an error code returned by a computer controlled piece of hardware.
rgData[8]	LPCTSTR pszSrcError - string describing the source error.

[0144] This method is called by the event source when an error occurs and passed the event error data in a SAFEARRAY form for easy marshalling across process boundaries.

[0145] The methods supported by each component making up the system **120** will now be described. In particular, the methods supported by the majority of the components will be described below. For the specific list of methods supported by each component, see the section describing each component.

XMC_CP_SYSTEM_CONNECT_CMPNT	
Index	8000
Data In	rgData[0] - (number) DWORD, type of component. The type of component is a value that is server specific. For component type information, see the description for this method under each server's description. rgData[1] - (string) LPTSTR, component class id as an ASCII string.
Data Out	None.

[0146] This method is used to connect one server to another so that they may interact with one another.

XMC_CP_SYSTEM_DISCONNECT_CMPNT	
Index	8001
Data In	rgData[0] - (number) DWORD, type of component. The type of component is a value that is server specific. For

-continued

XMC_CP_SYSTEM_DISCONNECT_CMPNT	
	component type information, see the description for this method under each server's description. rgData[1] - (string) LPTSTR, component class id as an ASCII string.
Data Out	None.

[0147] This method is used to disconnect one server to another so that they stop interacting with one another.

XMC_CP_PROCESS_START	
Index	8500
Data In	None.
Data Out	None.

[0148] This method is called to start the command processor technology making it ready to process commands.

XMC_CP_PROCESS_ENABLE	
Index	8501
Data In	rgData[0] - (number) BOOL - TRUE enables the command processor, FALSE disables it. The command processor only processes commands when it is enabled.
Data Out	None.

[0149] This method is used to configure what type of data is returned when processing a given data item. For example in the server may be configured to return the minimal amount of data on each read (i.e. just the data item value), or the server may be requested to return more substantial data.

XMC_CP_PROCESS_STOP	
Index	8061
Data In	None.
Data Out	None.

[0150] This method is called to shut-down the command processor.

XMC_DE_EVENT_ENABLE	
Index	2892
Data In	rgData[0] - (number) DWORD, cookie (unique identifier) associated with the subscription. This value is returned to the service client 34 when calling the subscription COMMAND SOURCE #1 above. NOTE: using a cookie value of zero (0) will enable/disable ALL items subscribed to the server. rgData[1] - (number) BOOL, TRUE to enable the subscription(s), FALSE to disable the subscription(s). Only enabled subscriptions actually fire events.
Data Out	None.

[0151] This method enables/disables a previously subscribed data item in the subscription list maintained by the server. Only enabled subscriptions actually fire.

XMC_DE_EVENT_RECEIVE_DATA	
Index	8045
Data In	rgData[0] - (number) DWORD, subscription cookie corresponding to the subscribed data item. rgData[1] - (number or string), data item value. rgData[2] - (OPTIONAL number) DWORD, data item time-stamp as a system time value. rgData[3] - (OPTIONAL string) LPSTR, data item ASCII text name. rgData[4] - (OPTIONAL number) DWORD, data item unique cookie. NOTE: Since the last three items are optional, only those items specified when configuring the data to receive are actually sent. If, for example, one or more data items are NOT requested, then the items are returned in slots shifted up toward rgData[1]. For example if only the data item name is requested in addition to the default data items, the data returned would look like the following: rgData[0] - (number) DWORD, subscription cookie. rgData[1] - (number or string), data item value. rgData[2] - (string) LPSTR, data item name.
Data Out	None.

[0152] This method is called by the server (and implemented by the service client **34**) when each subscribed event fires.

XMC_DE_EVENT_RECEIVE_DATA_CONFIGURE	
Index	8044
Data In	rgData[0] - (number) DWORD, flag describing the type of data to be returned on each event. The following flags are supported: XMC_DE_EVENT_DATA_FLAG_TIMESTAMP - requests that the time stamp recorded when reading the data is returned. XMC_DE_EVENT_DATA_FLAG_NAME - requests that the data items ASCII text name be returned. XMC_DE_EVENT_DATA_FLAG_DATA_COOKIE - requests that the unique data item cookie corresponding to the read made for the data item be returned. NOTE: by default, the subscription cookie and data item value are always returned.
Data Out	None.

[0153] This method is used to configure what type of data is returned on each event that is fired. For example in the server may be configured to send the minimal amount of data on each event (i.e. subscription cookie and data item value), or the server may be requested to return more substantial data.

XMC_DE_EVENT_SUBSCRIBE

Index	2890
Data In	rgData[0] - (number) DWORD, flags describing the initial state of the subscription. The following flags are supported: XMC_DE_EVENT_FLAG_ENABLED - subscription is immediately enabled upon subscription. XMC_DE_EVENT_FLAG_DISABLED - subscription is disabled upon making the subscription. The Enable function must be called to enable the subscription. rgData[1] - (number) DWORD, number of subscription criteria rules. rgData[2 + (2*n)] - (number) DWORD, event condition type where the following types are supported: XMC_CNC_EVENTCONDITION_DATA_CHANGE - any data changes in the data type above will trigger the event. XMC_CNC_EVENTCONDITION_DATA_EQUAL XMC_CNC_EVENTCONDITION_DATA_LESSTHAN XMC_CNC_EVENTCONDITION_DATA_GREATERTHAN XMC_CNC_EVENTCONDITION_DATA_AND XMC_CNC_EVENTCONDITION_DATA_OR Each of the conditions above are used in a combined manner. Where the logical condition (=, <, >) are applied for each type respectively. For example, in an array that contains the following items: rgData[2] = 4 (4 condition values) rgData[3] = XMC_CNC_EVENTCONDITION_EQUAL rgData[4] = 3.0 rgData[5] = XMC_CNC_EVENTCONDITION_LESSTHAN rgData[6] = 3.0 rgData[7] = XMC_CNC_EVENTCONDITION_OR rgData[8] = 1.0 rgData[9] = XMC_CNC_EVENTCONDITION_GREATHERTHAN rgData[10] = 5.0 the array would be evaluated using the following logic: If (DATA <= 3.0 OR DATA > 5.0) then Trigger Event rgData[3 + (2*n)] - (number) double, the value for the condition. See above.
Data Out	rgData[0] - (number) DWORD, cookie (unique identifier) representing the subscription.

[**0154**] This method subscribes to a given data item activating the event interface when the subscription criteria are met for the data item. In the example system **120**, all ubscribing components must use the IXMCDirect interface to receive events received from the server for which they are subscribed.

XMC_DE_EVENT_UNSUBSCRIBE

Index	2891
Data In	rgData[0] - (number) DWORD, cookie (unique identifier) associated with the subscription. This value is returned to the service client 34 when calling the subscription COMMAND SOURCE #1 above. NOTE: using a cookie value of zero (0) will unsubscribe ALL items subscribed to the server.
Data Out	None.

[**0155**] This method removes a previously subscribed data item from the subscription list maintained by the server.

XMC_DE_SYSTEM_INITIALIZEHW

Index	500
Data In	None.
Data Out	None.

[**0156**] This method is used to initialize any hardware systems associated with the component.

XMC_DE_SYSTEM_SHUTDOWNHW

Index	501
Data In	None.
Data Out	None.

[**0157**] This method is used to shut down any hardware systems associated with the component.

[**0158**] The command processor component **122** implements the following general methods listed above.

Method	Implemented	Not Implemented
XMC_CP_PROCESS_START	X	x
XMC_CP_PROCESS_ENABLE	X	x
XMC_CP_PROCESS_STOP	X	
XMC_DE_EVENT_ENABLE	X	
XMC_DE_EVENT_RECEIVE_DATA	X	
XMC_DE_EVENT_RECEIVE_DATA_CONFIGURE	X	
XMC_DE_EVENT_SUBSCRIBE	X	
XMC_DE_EVENT_UNSUBSCRIBE	X	
XMC_DE_SYSTEM_CONNECT_CMPNT	X	
XMC_DE_SYSTEM_DISCONNECT_CMPNT	X	
XMC_DE_SYSTEM_INITIALIZEHW	X	
XMC_DE_SYSTEM_SHUTDOWNHW	X	

[0159] There are no special notes for the methods that this component implements.

[0160] The command execution components **160** implement the following general methods listed in the general component methods section above.

Method	Implemented	Not Implemented
XMC_CP_PROCESS_START		X
XMC_CP_PROCESS_ENABLE		X
XMC_CP_PROCESS_STOP		X
XMC_DE_EVENT_ENABLE	X	
XMC_DE_EVENT_RECEIVE_DATA	X	
XMC_DE_EVENT_RECEIVE_DATA_CONFIGURE	X	
XMC_DE_EVENT_SUBSCRIBE	X	
XMC_DE_EVENT_UNSUBSCRIBE	X	
XMC_DE_SYSTEM_CONNECT_CMPNT		X
XMC_DE_SYSTEM_DISCONNECT_CMPNT		X
XMC_DE_SYSTEM_INITIALIZEHW	X	
XMC_DE_SYSTEM_SHUTDOWNHW	X	

[0161] There are no special notes for the methods that this component implements.

[0162] The definitions of all special types used by the methods and properties of each component making up the command processor system **122** will now be described.

[0163] XMC_PARAM_DATA Structure

[0164] All methods exposed by each component in the example system **122** use a standard parameters set to describe data used to set and query properties as well as invoke methods. The standard parameters are in the following format:

[0165] pObj->InvokeMethod(LPXMC_PARAM_DATA rgData, DWORD dwCount);

[0166] Each element in the rgData array corresponds to a parameter, with the first element in the array corresponding to the first parameter.

[0167] The XMC_PARAM_DATA structure can contain either a numerical or a string value and is defined as follows:

```
typedef struct tagXMC_PARAM_DATA
{
  LNG_PARAM_DATATYPE adt;
  union
  {
    double df;
    LPTSTR psz;
  };
}XMC_PARAM_DATA;
```

[0168] The 'adt' member of the XMC_PARAM_DATA structure describes the data contained within the XMC_PARAM_DATA structure. The values are described below:

LNG_PARAM_DATATYPE	Description
LNG_ADT_NUMBER	Use this value when passing a numerical value via the 'adt' member of the XMC_PARAM_DATA structure.
LNG_ADT_STAT_STRING	Use this value when passing a static string value via the 'psz' member of the XMC_PARAM_DATA structure. Static strings do not need to be freed from memory.
LNG_ADT_MEM_STRING	Use this value when passing a string value via the 'psz' member of the XMC_PARAM_DATA structure. LNG_ADT_MEM_STRING denotes that the string must be freed from memory during cleanup.
LNG_ADT_NOP	This value is used to ignore items within the XMC_PARAM_DATA array. When specifies, this parameter is not used.

[0169] When querying and setting boolean TRUE/FALSE values, any non-zero value is considered TRUE, whereas a zero value is considered FALSE.

[0170] The command processor **122** of the present invention may be used on more than just motion based devices and machines, although the present invention is of particular significance in that environment. The principles of the present invention may also be used to send commands to medical devices where each command directs the medical device to carry out a set of operations. It may also be used to send commands to farming equipment, heavy machinery such as tractors, excavators, bulldozers, cranes, semi-trucks, automobiles, drilling equipment, water craft such as submersibles, boats and ships, airplanes (including jets), spacecraft, satellites, and any other kind of mobile device or machine that moves on land, water or within the air or space.

[0171] The technology implemented by the present invention may be used to send commands in the following environments:

[0172] office equipment such as printers, fax machines, telephone systems, internet routers, internet firewalls and security cameras and general security systems.

[0173] general consumer devices such as home entertainment systems, televisions, microwaves, ovens, refrigerators, washers and driers, vacuums, hand held music systems, personal digital assistants, toys, musical instruments, etc.

[0174] yard items such as lawn mowers, yard care devices, snow blowers, air blowers, edger's, etc.

[0175] military equipment such as drone airplanes, drone tanks, drone land mobiles, drone boats, tanks, ships, jets and any other mobile or stationary devices used on land, sea or in the air or space.

[0176] various types of factory equipment that may or may not use motion to carry out its task, such as i/o devices, analog devices, CNC machines, General Motion machines, FMS machines, measuring systems, etc.

[0177] animatronics devices such as robot dogs, robotic mannequins, robotic helpers, or other robotic human-like or robotic animal like devices.

[0178] The term "command data" as used herein refer to any numeric or string data values used to describe the command and parameters describing how to perform the command. For example, BIT, BYTE, WORD, DWORD, LONG, REAL, DOUBLE, FLOAT, STRING, ASCII STRING are a few command data types that represent commands and/or command parameters. Command data may eventually be sent to the command target by writing register values on the command target, writing to shared memory provided by the command target, sending commands to the command target for which a data response is given containing the data requested, writing to variables provided by the command target, reading and writing to variables in a sequence necessary to carry out the commanded operation, using a proprietary or standard data protocol, calling a function provided by the command target, etc.

[0179] From the foregoing, it should be apparent that the invention may be embodied in forms other than those described above. The scope of the present invention should thus be determined by the following claims and not the foregoing detailed description of the invention.

What is claimed is:

1. A command processing system for transferring commands from at least one command source to at least one command target of at least one command target type, comprising:

a command processor in communication with the at least one command source; and

a command thread associated with each command target type; wherein

the command thread is in communication with the command processor,

the command thread is in communication with at least one command target;

the command source transfers commands to the command processor; and

the command thread transfers commands from the command processor to the command target.

* * * * *