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(54) # SYSTEM AND METHOD FOR THE MANAGEMENT OF WIRELESS COMMUNICATIONS DEVICE SYSTEM SOFTWARE DOWNLOADS IN THE FIELD

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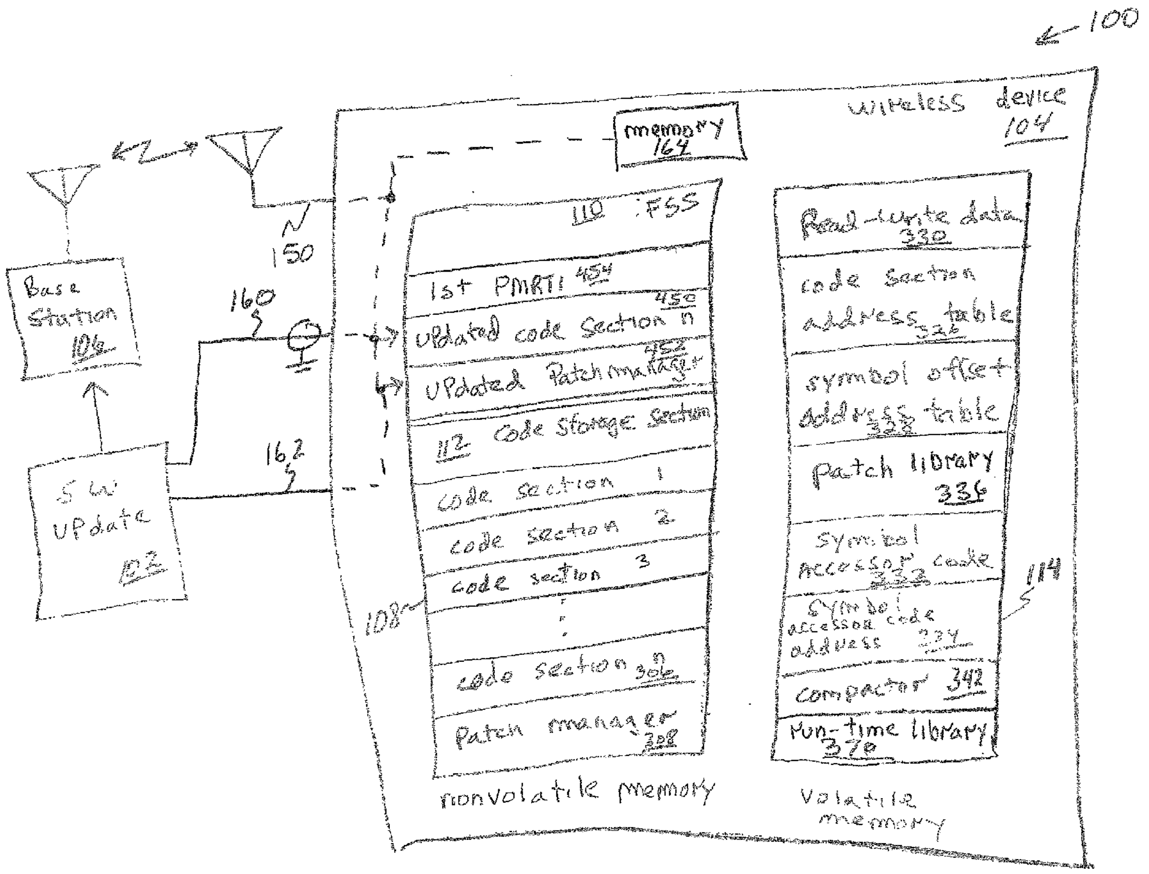
(52) **U.S. Cl.** **455/419**; 455/41.1

(57) **ABSTRACT**

A system and method are provided for managing system software download operations in a wireless communications device. The method comprises: executing system software; launching a run-time engine; processing dynamic instruction sets; and, in response to processing the dynamic instruction sets, managing the downloading of system software updates received via an airlink interface using management functions selected from the group including recovery status monitoring, back up, compacting, and update ordering.



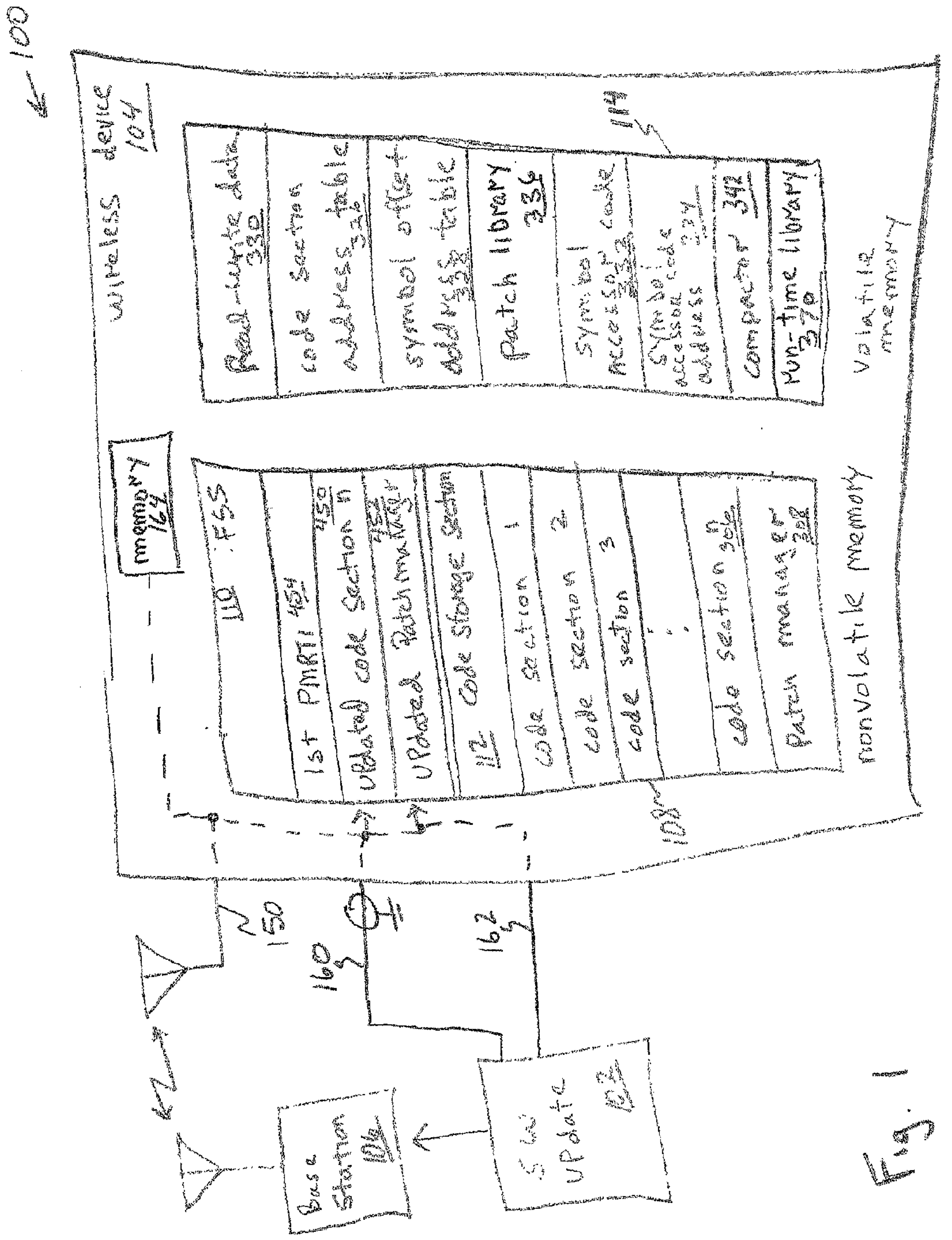

100
wireless device 104
memory 164
110 FSS
1st PMRTI 454
updated code section n 450
updated patch manager 452
112 code storage section
code section 1
code section 2
code section 3
code section n
code section 326
patch manager 328
nonvolatile memory
108
114
Read-write data 330
code section address table 326
symbol offset address table 328
Patch library 336
symbol accessor code 332
symbol accessor code address 334
compactor 342
run-time library 370
volatile memory
150
160
162
Base Station 102
S/W Update 122

Fig. 1

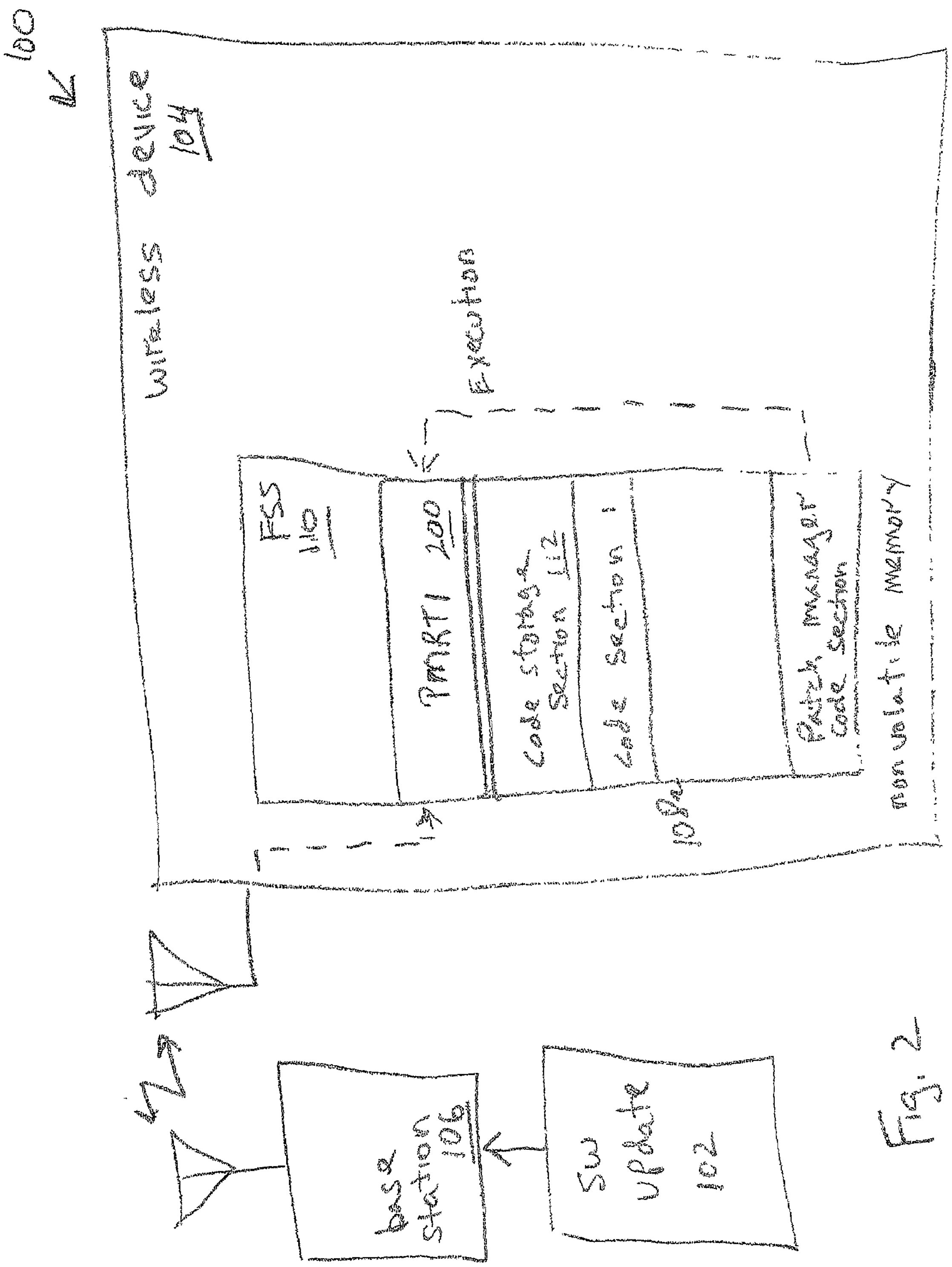

100
wireless device 104
Execution
FSS 110
PMRTI 200
code storage section 112
code section 1
Patch manager code section
non volatile memory
108
base station 106
SW update 102

Fig. 2

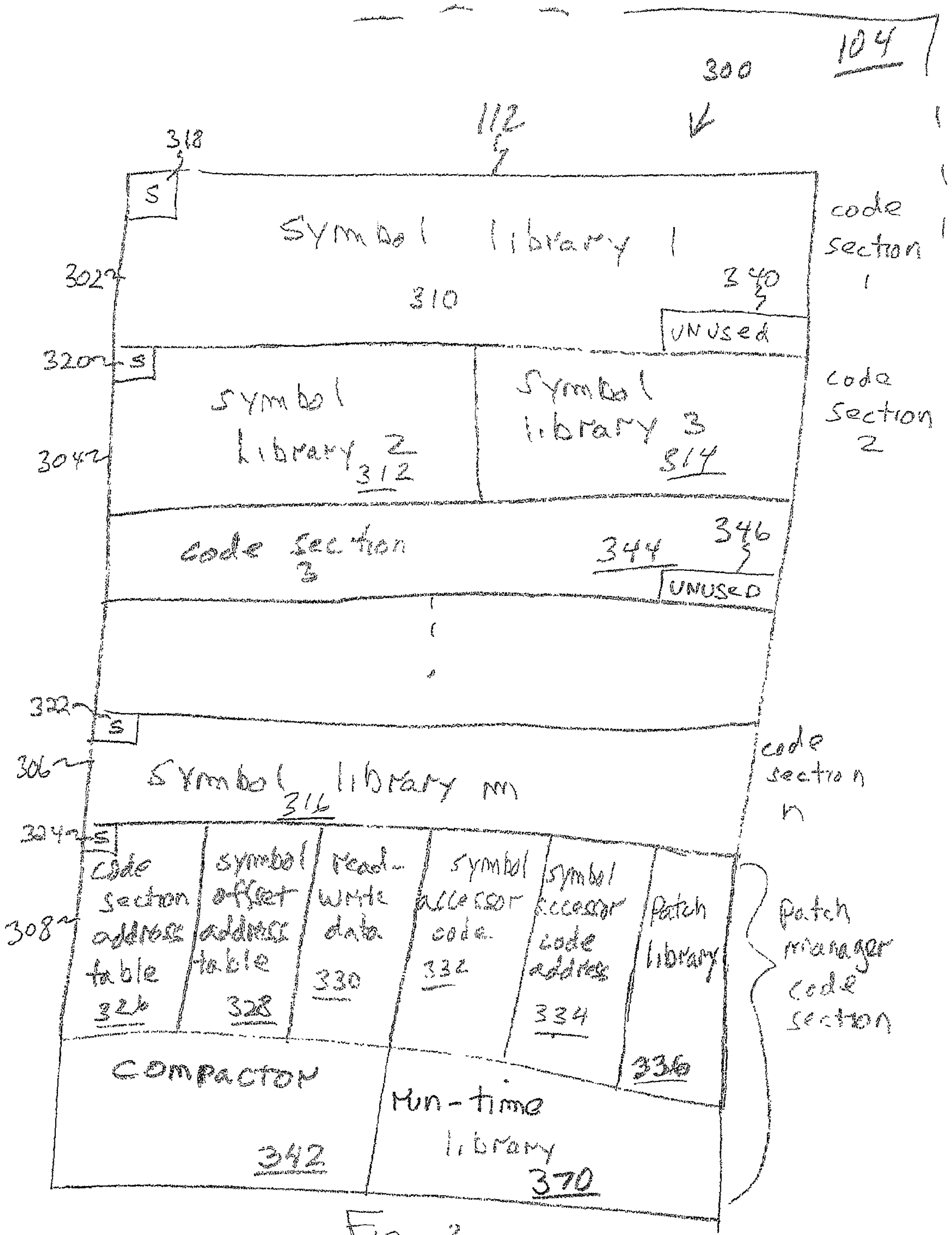

104
300
112
318
S
Symbol library 1
310
340
UNUSED
code section 1
302
320
S
symbol library 2
312
Symbol library 3
314
code section 2
304
code section 3
344
346
UNUSED
322
S
Symbol library m
316
code section n
306
324
S
code section address table
326
symbol offset address table
328
read-write data
330
symbol accessor code
332
symbol accessor code address
334
Patch library
336
Patch manager code section
308
compactor
342
run-time library
370

Fig. 3

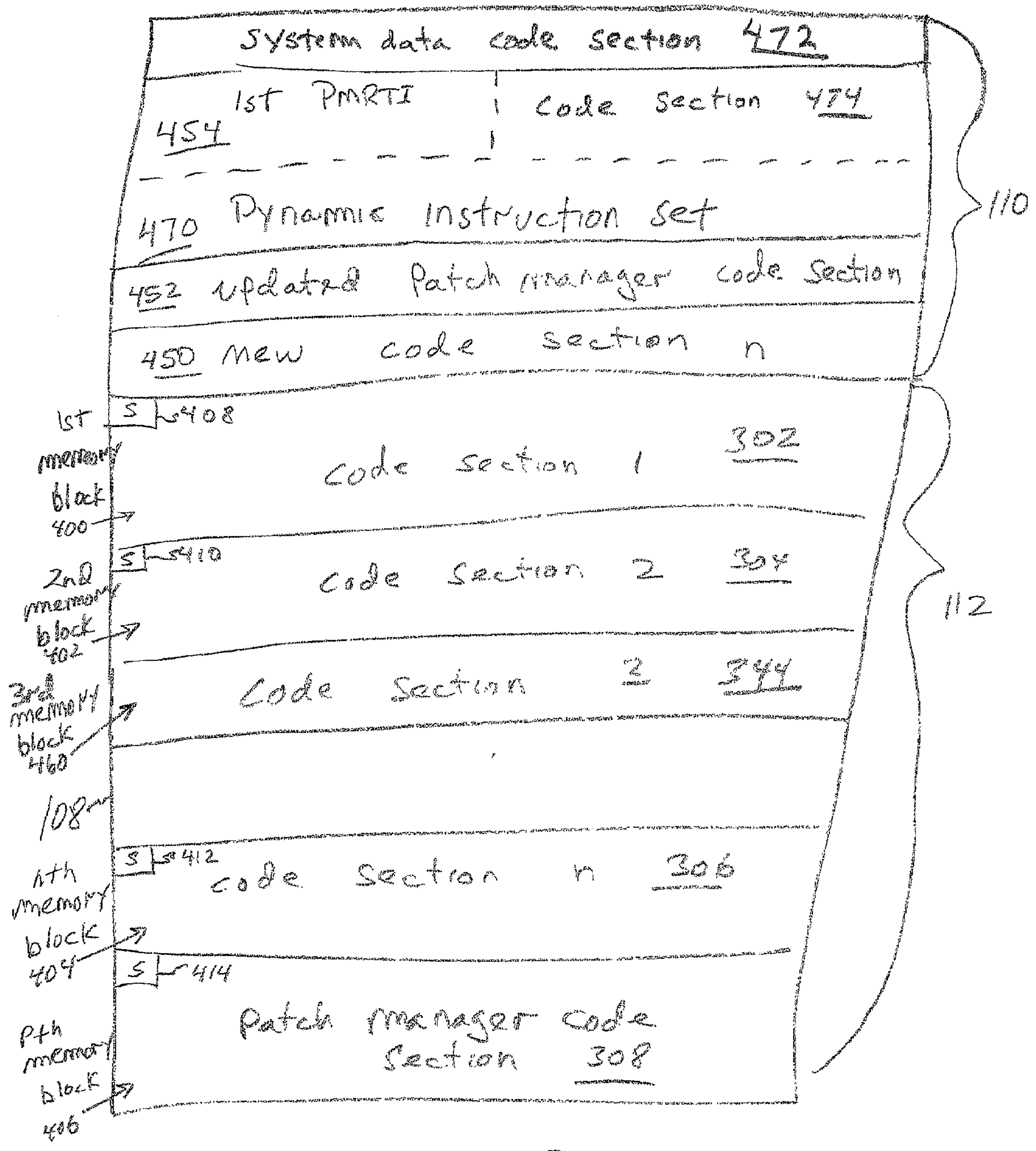
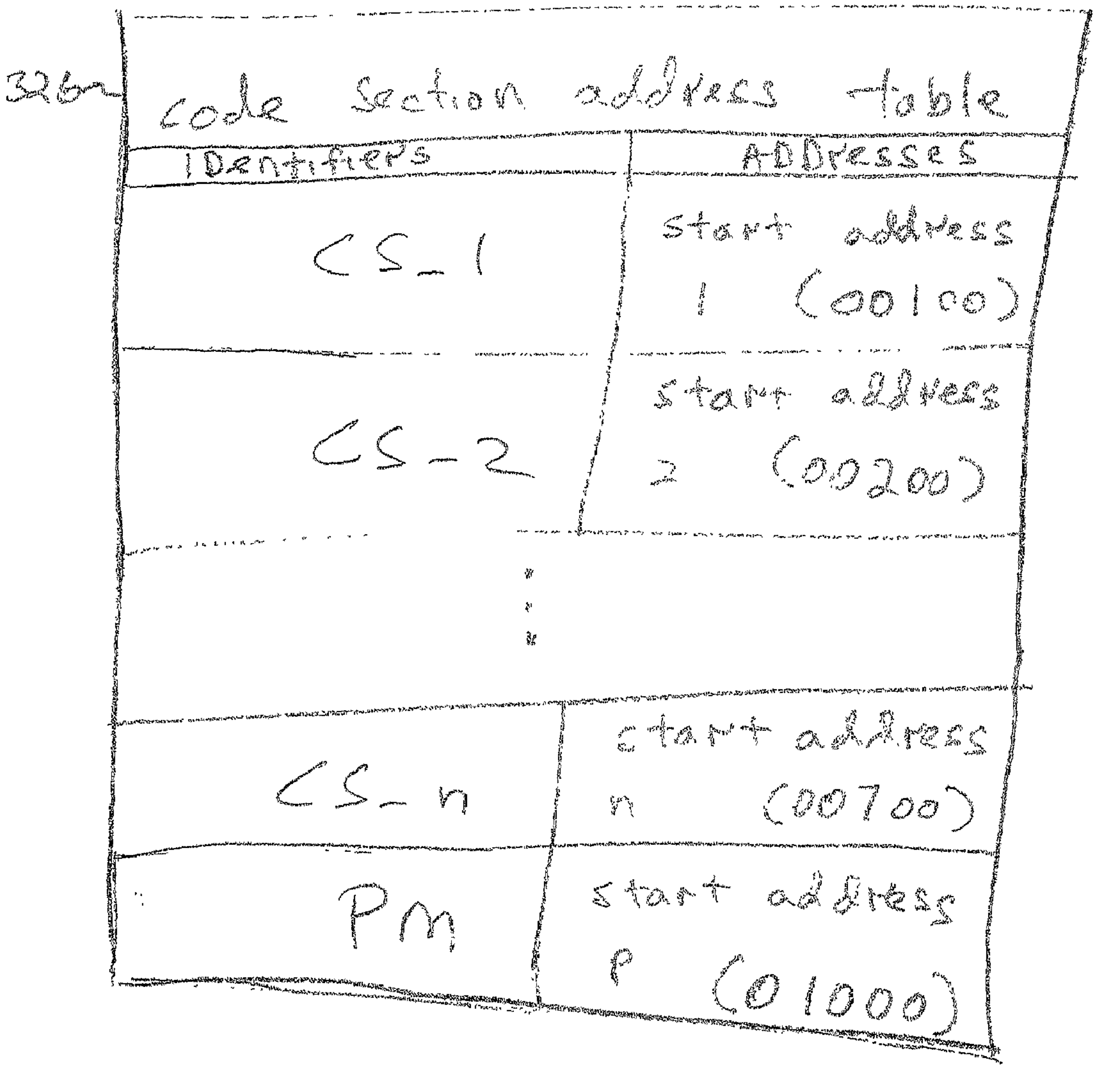

System data code section 472
1st PMRTI 454
Code section 474
470 Dynamic instruction set
452 updated Patch manager code section
450 new code section n
110
S 408
1st memory block 400
code section 1 302
S 410
2nd memory block 402
code section 2 304
3rd memory block 460
Code Section 2 344
108
S 412
nth memory block 404
code section n 306
S 414
pth memory block 406
Patch manager code Section 308
112

Fig. 4



code section address table

IDentifiers	ADDresses
CS_1	start address 1 (00100)
CS_2	start address 2 (00200)
⋮	
CS_n	start address n (00700)
Pm	start address p (01000)

Fig. 5

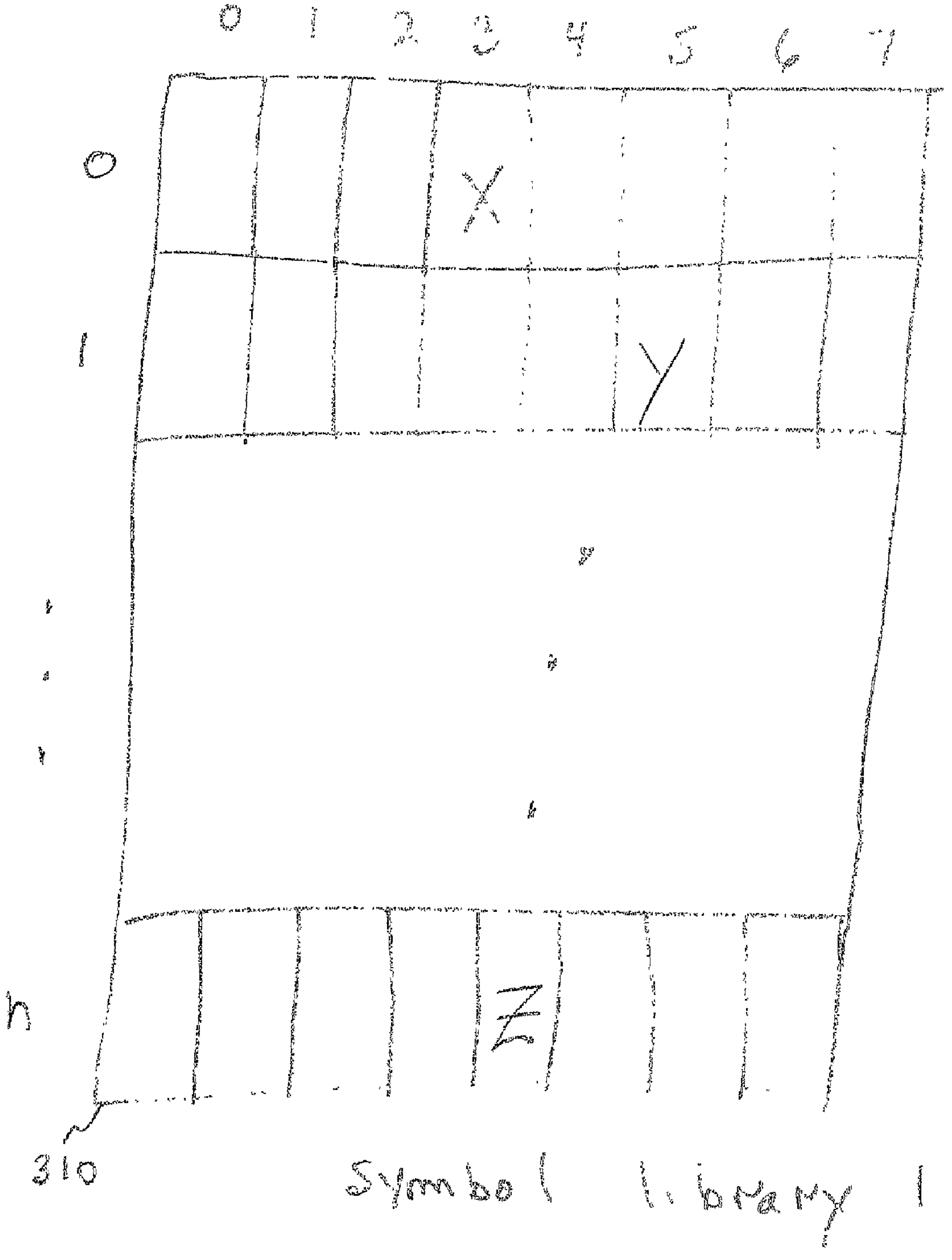
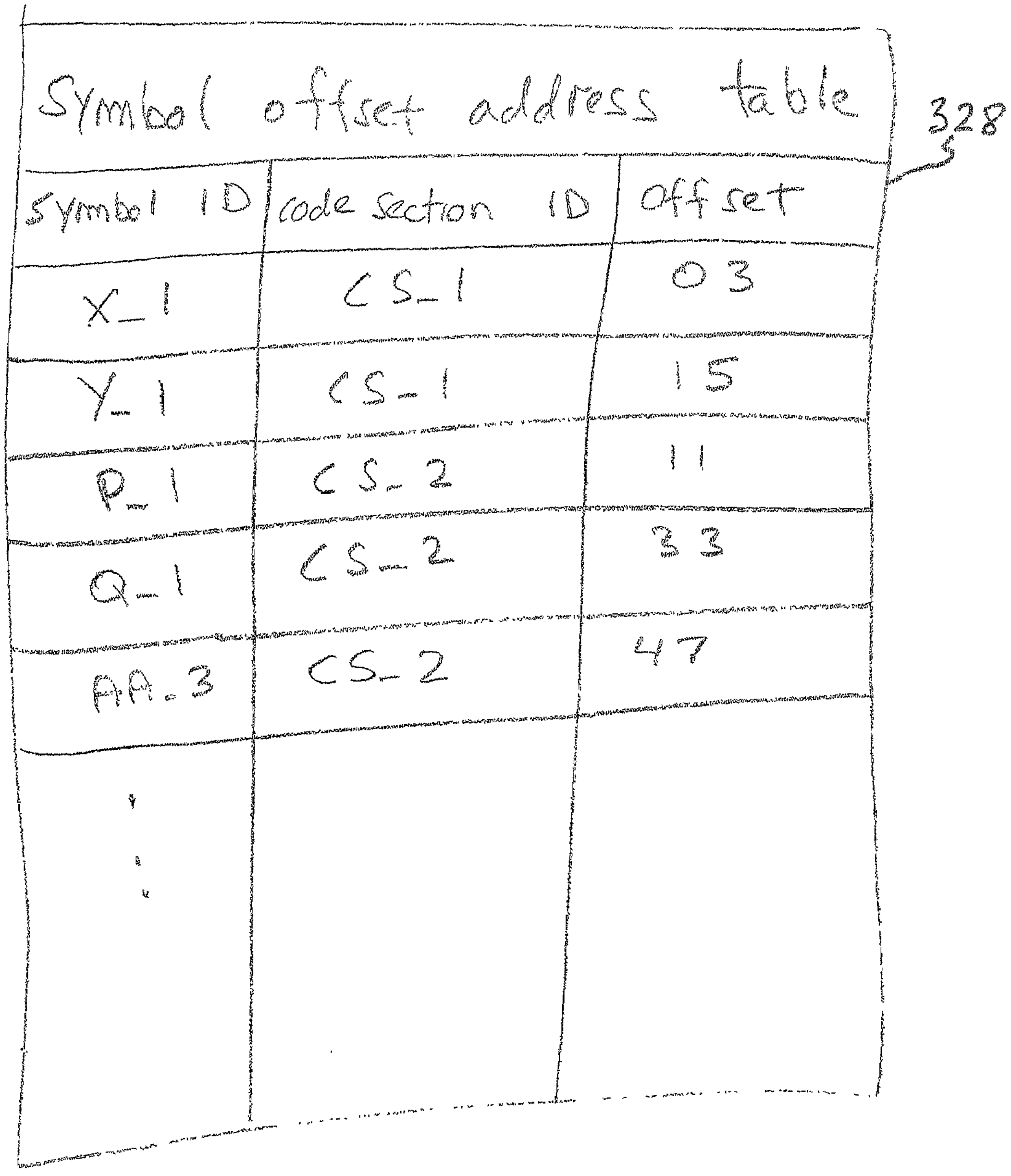


Fig. 6



Symbol offset address table

Symbol ID	code Section ID	Offset
X_1	CS_1	03
Y_1	CS_1	15
P_1	CS_2	11
Q_1	CS_2	33
AA_3	CS_2	47
⋮		

Fig. 7

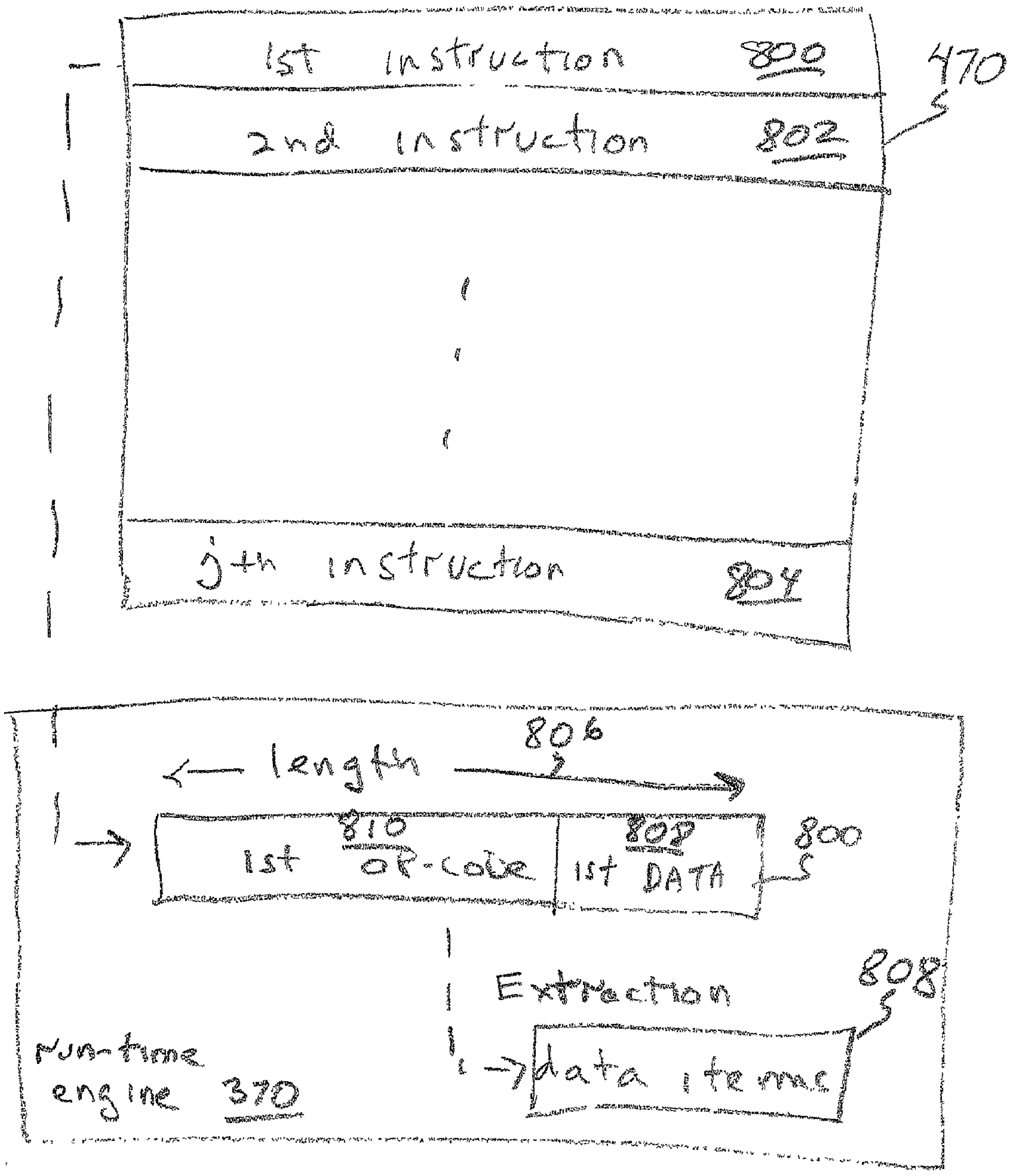

1st instruction 800
2nd instruction 802
jth instruction 804
470
length
806
810
1st op-code
808
1st DATA
800
Extraction
808
data items
run-time engine 370

Fig. 8a

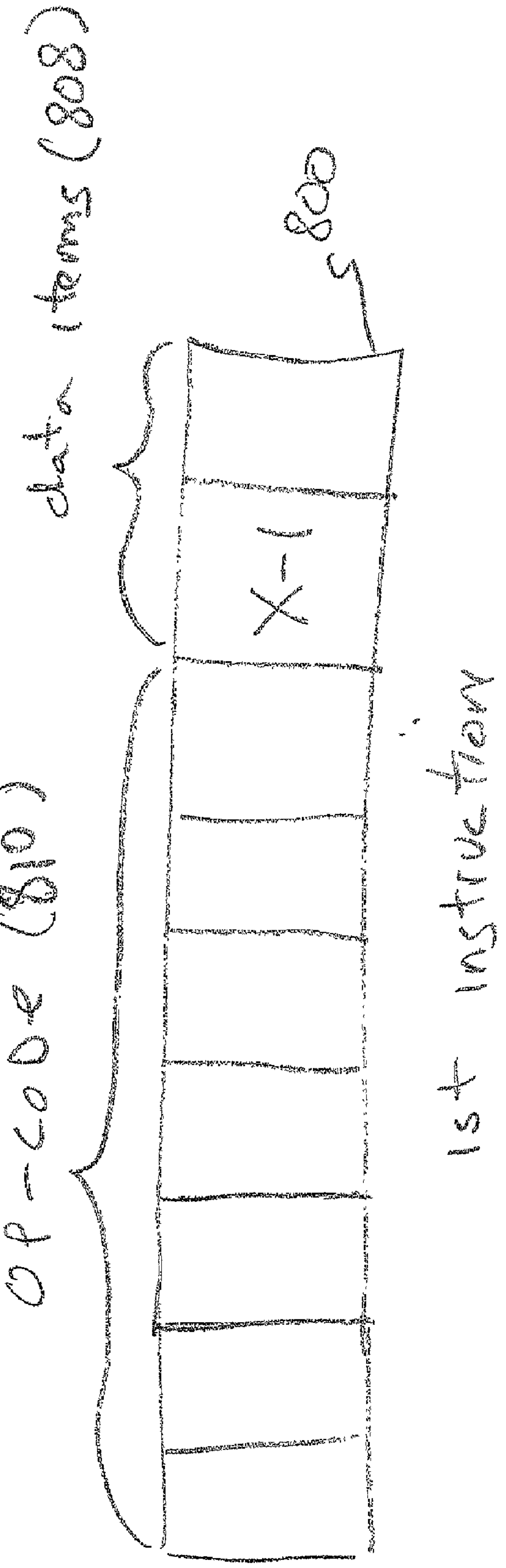


Fig. 8b

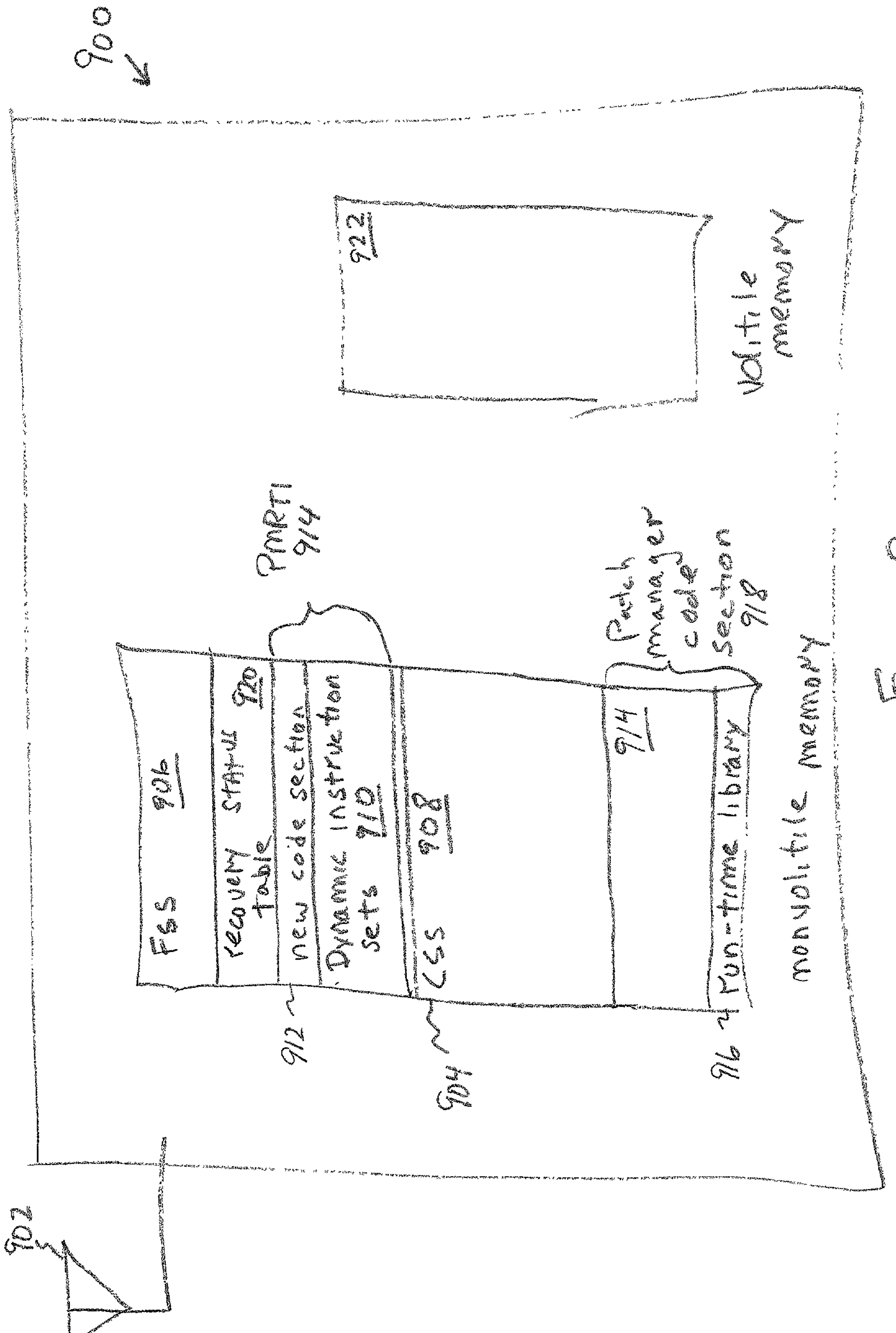

900
902
FSS 906
recovery status table 920
new code section
Dynamic instruction sets 910
CSS 908
912
904
914
PMRTI 914
Patch manager code section 918
Run-time library
916
nonvolatile memory
922
volatile memory

Fig. 9

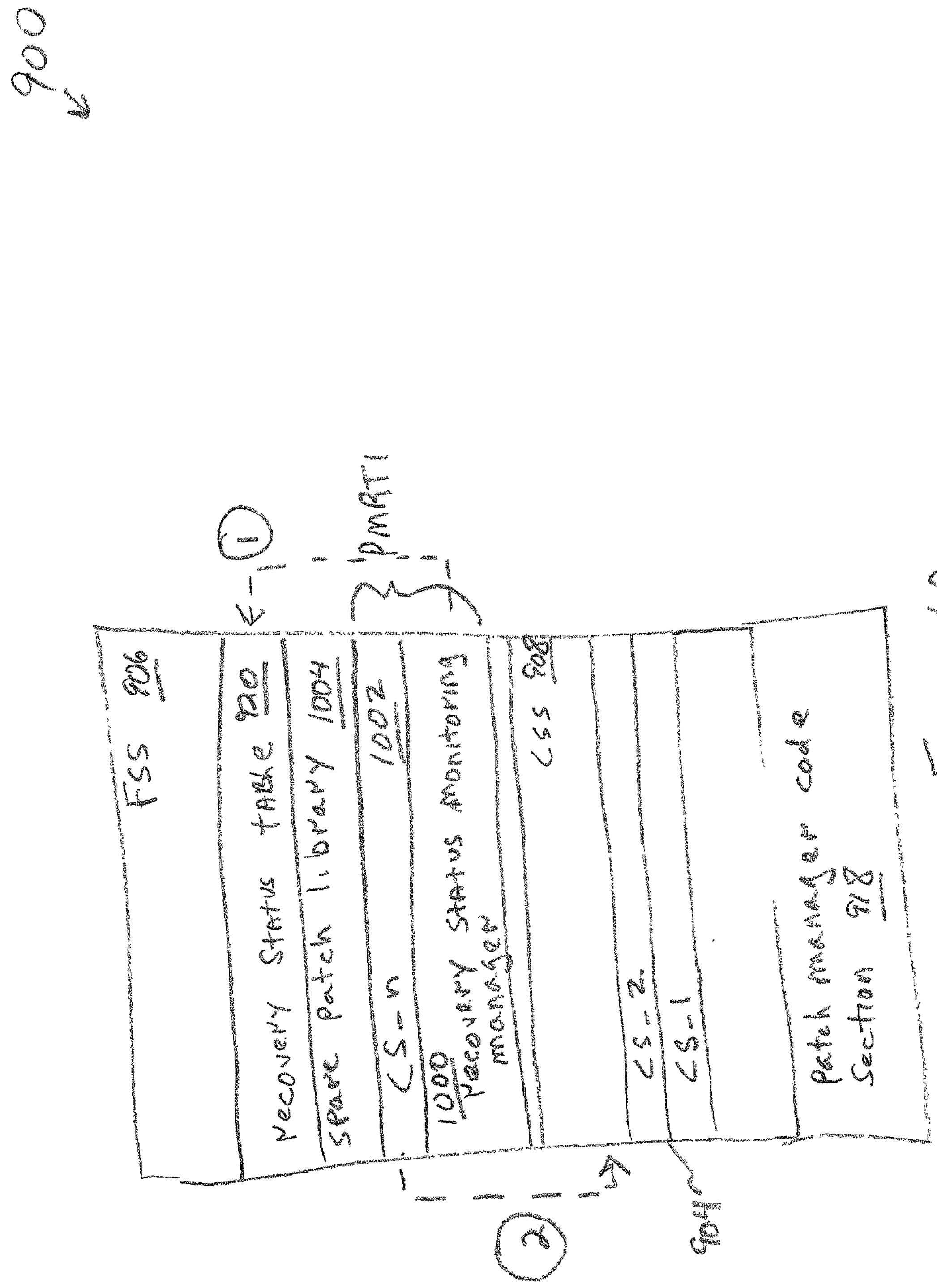
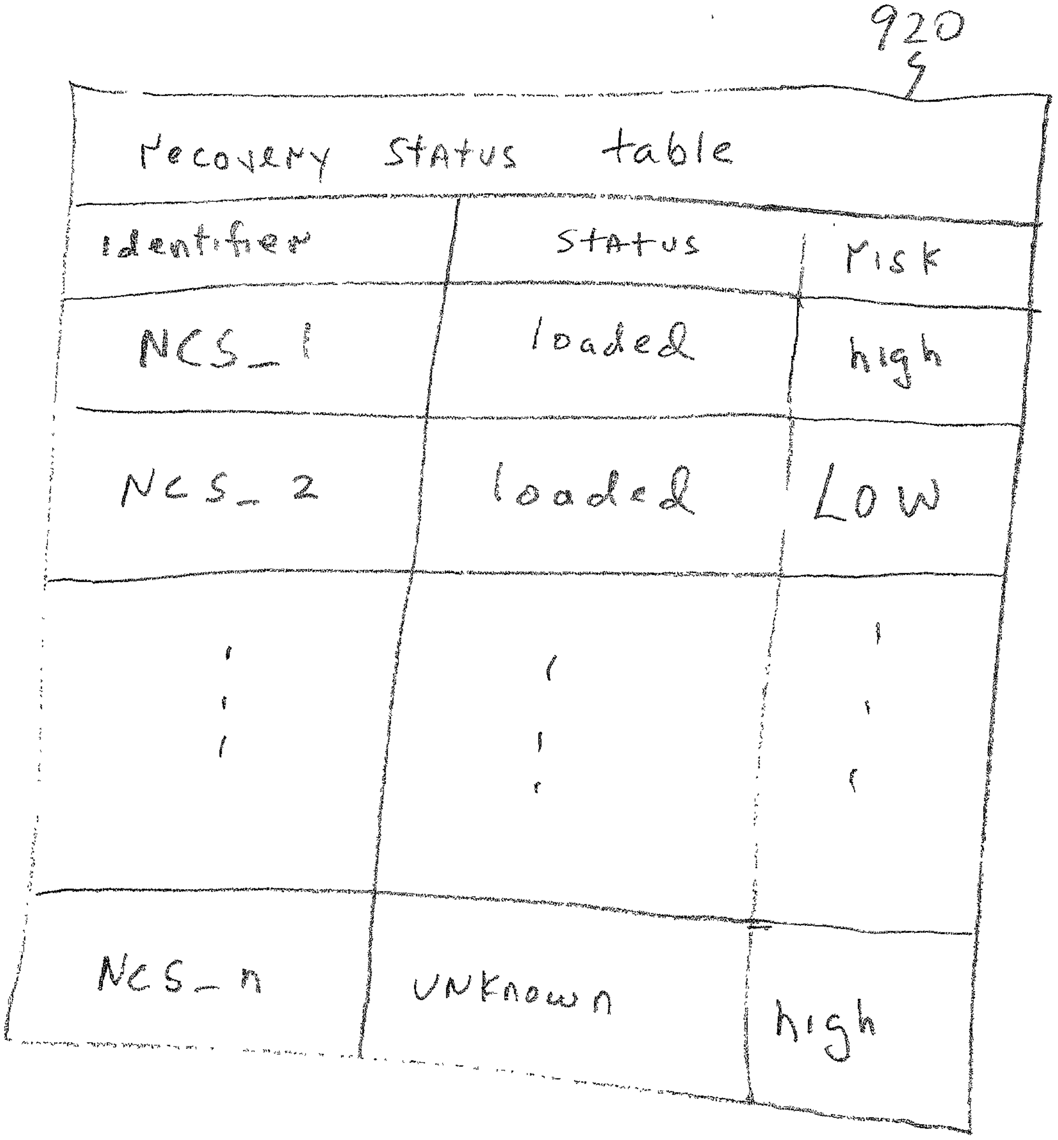

900
FSS 906
Recovery Status table 920
1
PMRT
Spare patch library 1004
CS-n 1002
1000 Recovery Status Monitoring manager
CSS 908
2
CS-2
CS-1
904
Patch manager code Section 918

Fig. 10



recovery status table

identifier	status	risk
NCS_1	loaded	high
NCS_2	loaded	Low
⋮	⋮	⋮
NCS_n	unknown	high

Fig. 11

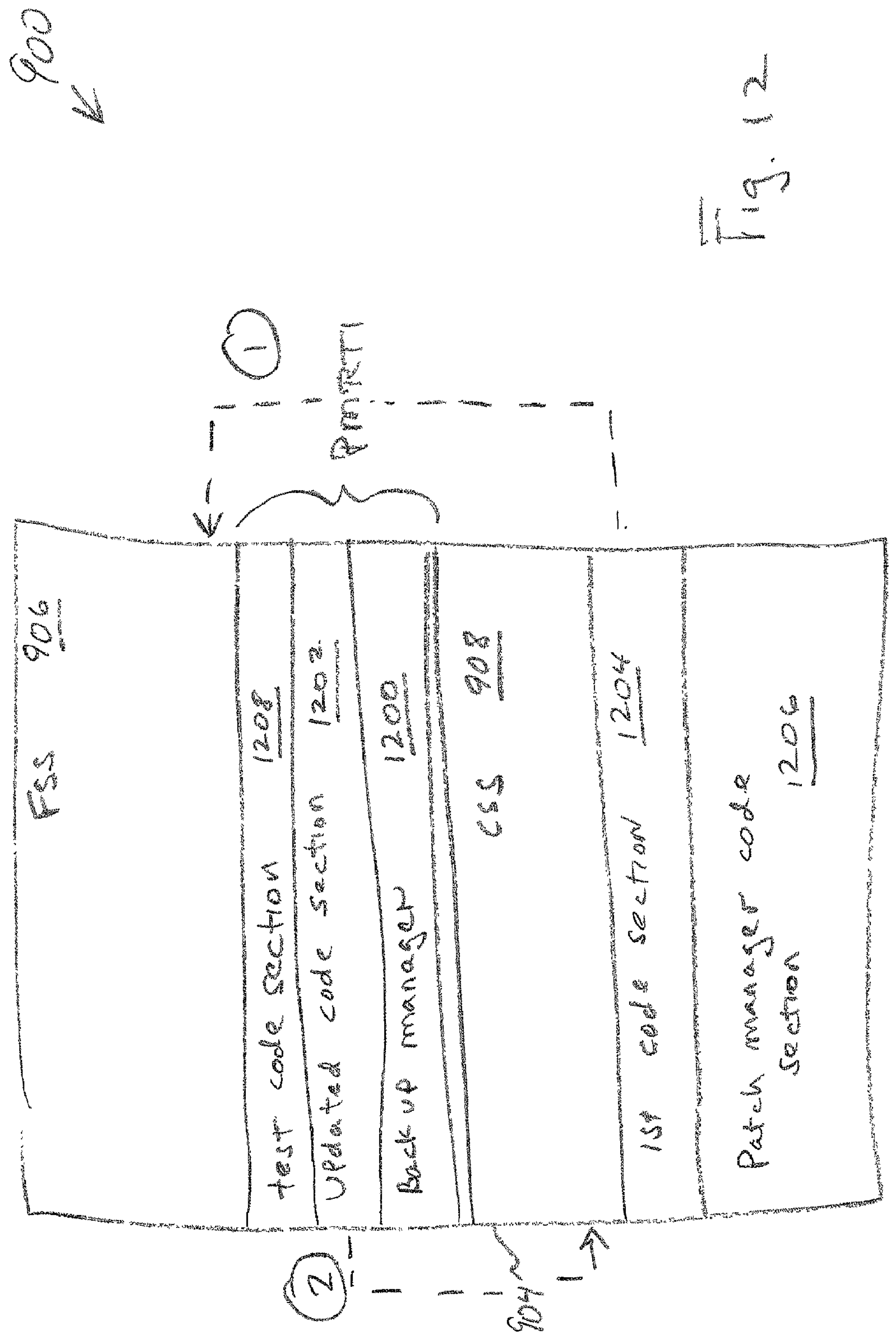

900
FSS 906
test code section 1208
Updated code section 1202
Back up manager 1200
CSS 908
1st code section 1204
Patch manager code section 1206
RMRTI
1
2
904

Fig. 12

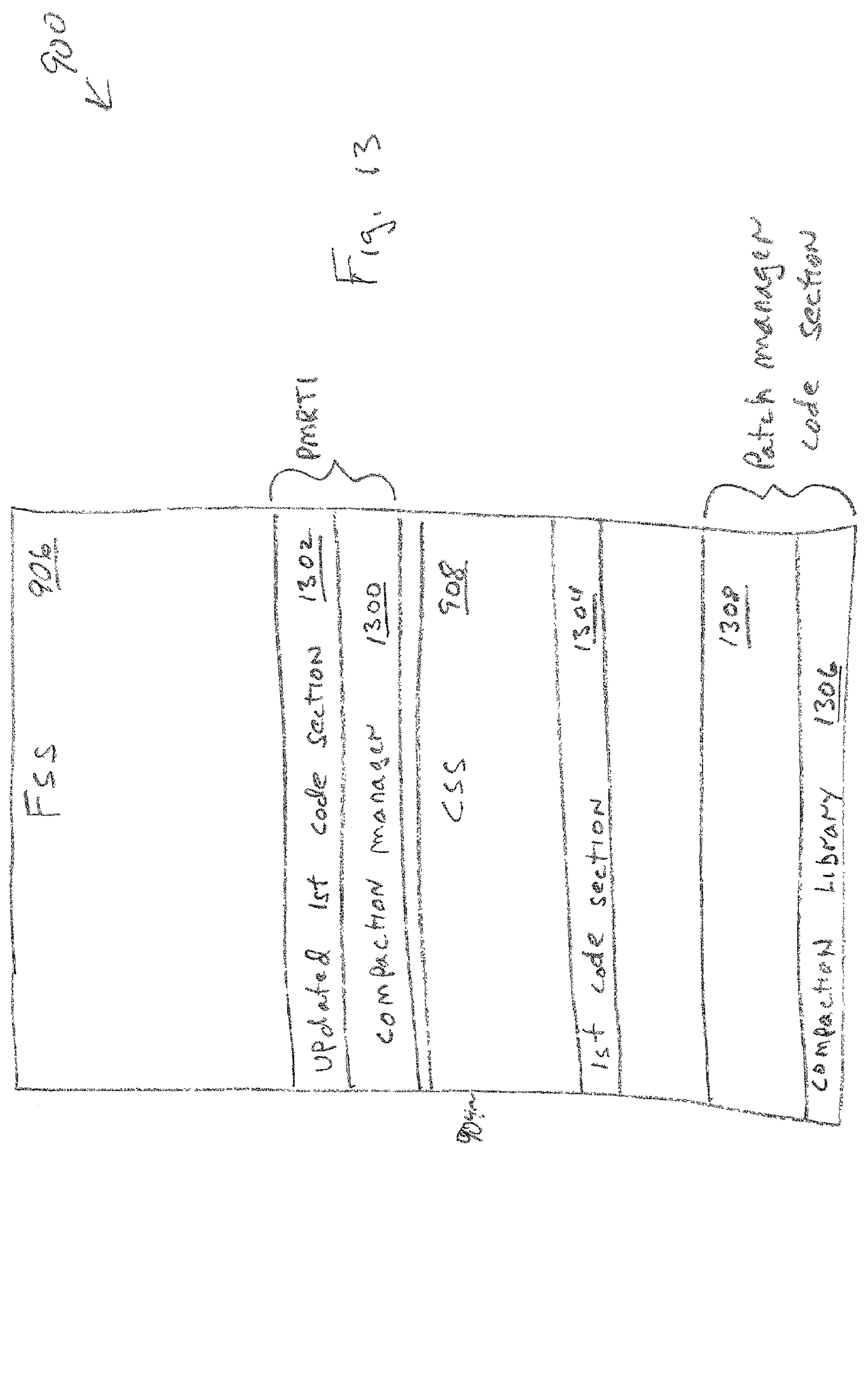
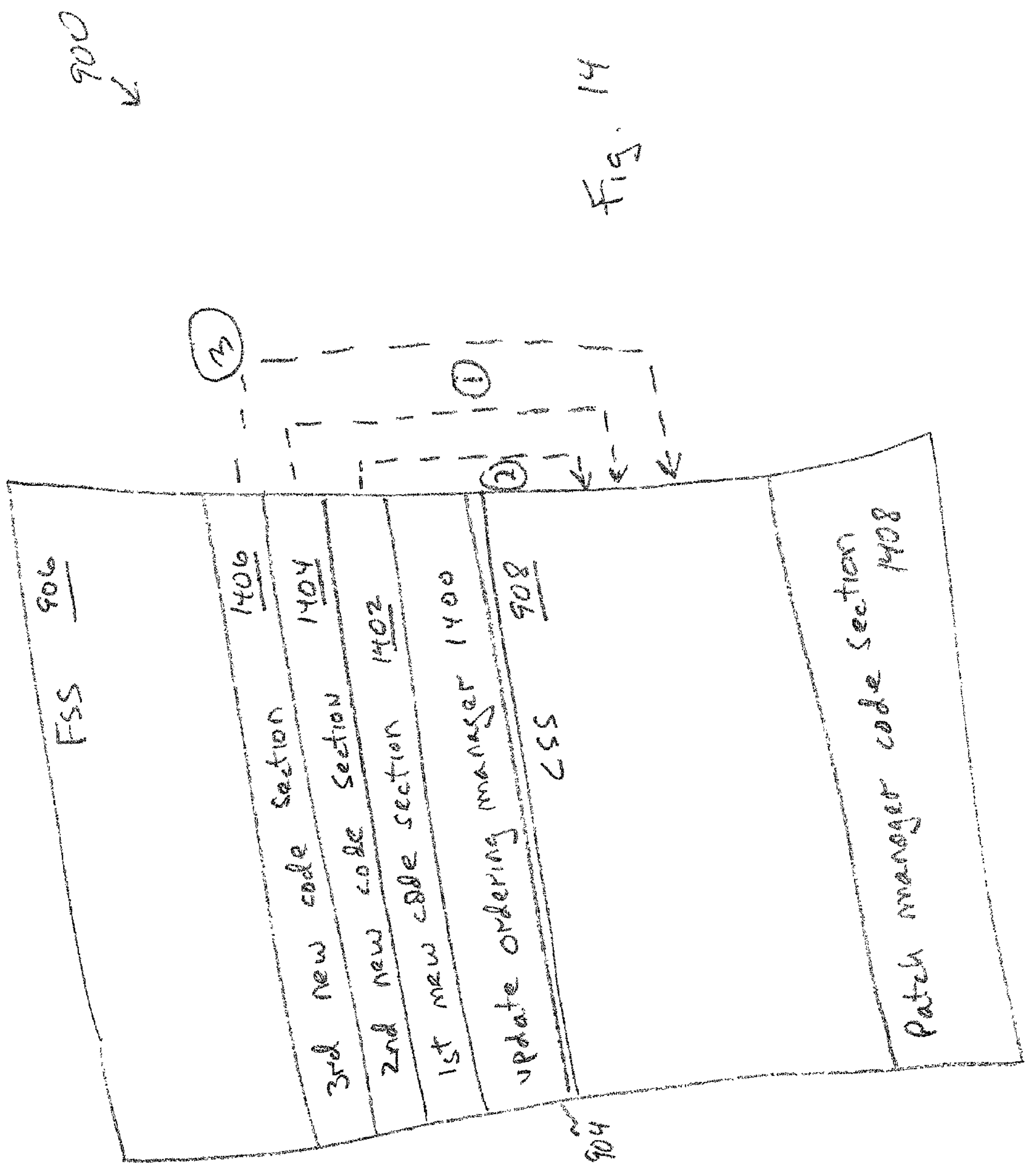

900
FSS 906
Updated 1st code section 1302
compaction manager 1300
OMCTI
CSS 908
1st code section 1304
1308
compaction library 1306
Patch manager code section
904

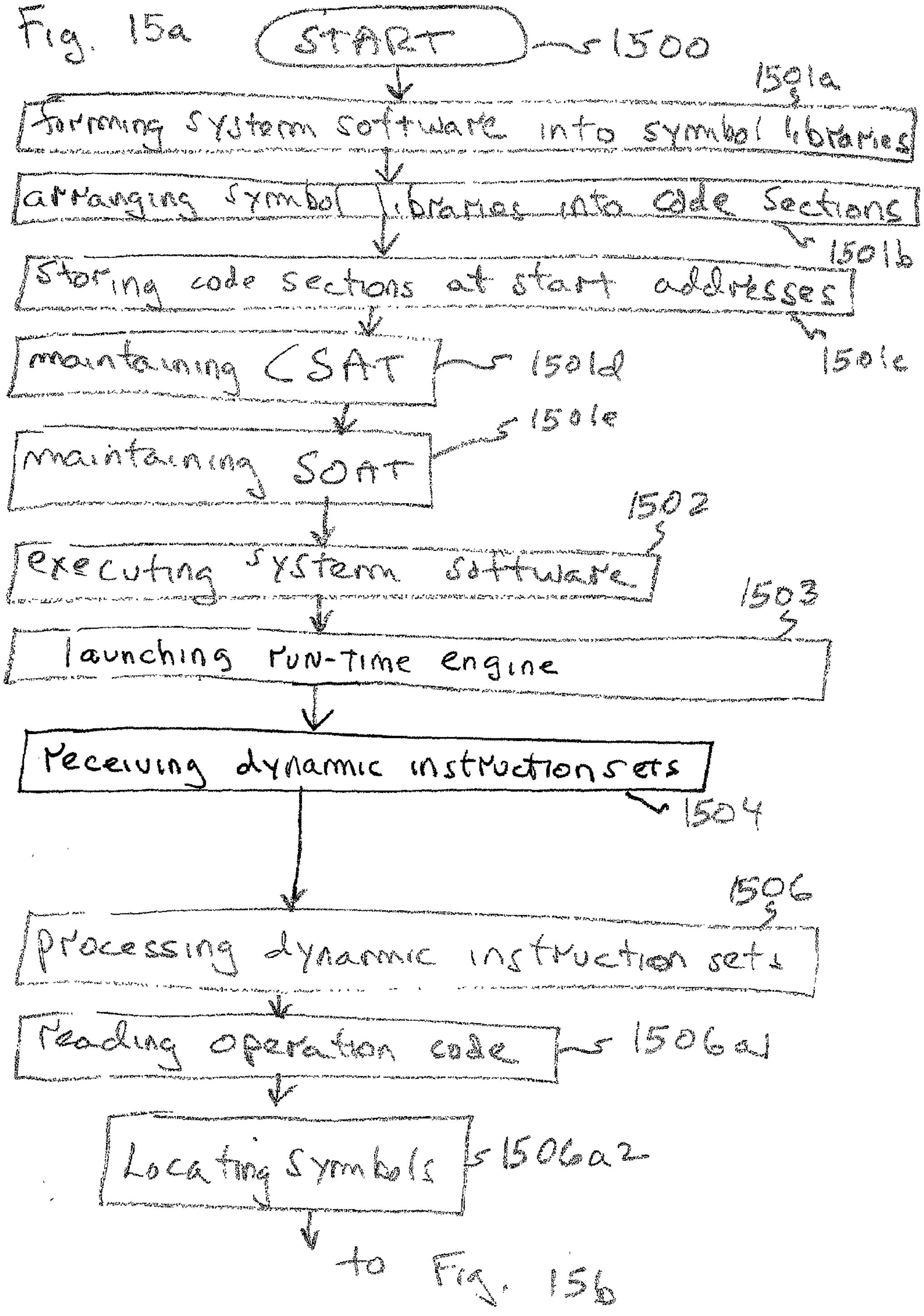
Fig. 13



900
FSS 906
3rd new code section 1406
2nd new code section 1404
1st new code section 1402
update ordering manager 1400
CSS 908
Patch manager code section 1408
904
1
2
3

Fig. 14

Fig. 15a


START
1500
1501a
forming system software into symbol libraries
arranging symbol libraries into code sections
1501b
storing code sections at start addresses
1501c
maintaining CSAT
1501d
1501e
maintaining SOAT
1502
executing system software
1503
launching run-time engine
receiving dynamic instruction sets
1504
1506
processing dynamic instruction sets
reading operation code
1506a1
Locating Symbols
1506a2
to Fig. 15b

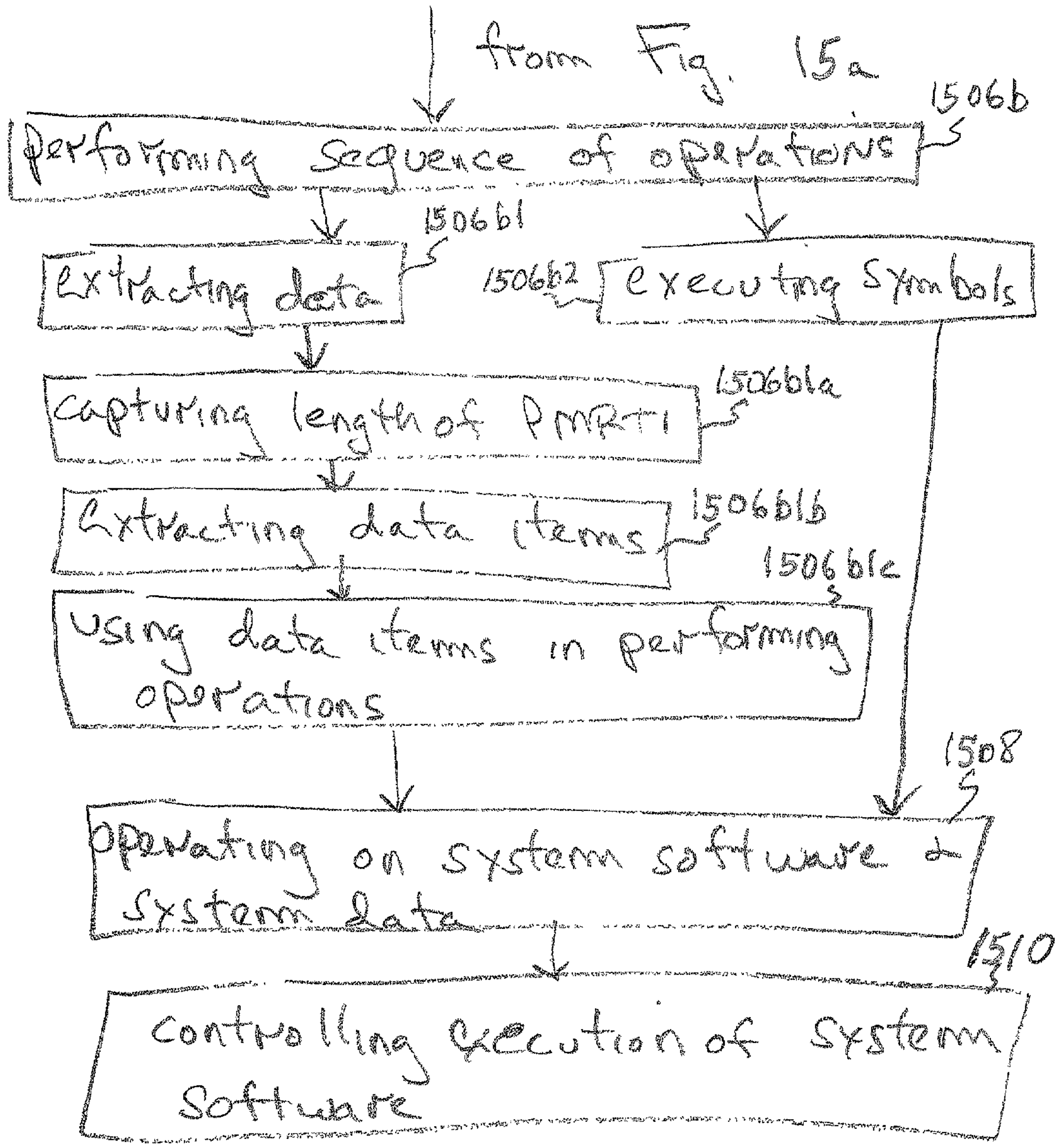

from Fig. 15a
performing sequence of operations
1506b
extracting data
1506b1
1506b2
executing symbols
capturing length of PMRTI
1506b1a
extracting data items
1506b1b
1506b1c
using data items in performing operations
1508
operating on system software & system data
1510
controlling execution of system software

Fig. 15b

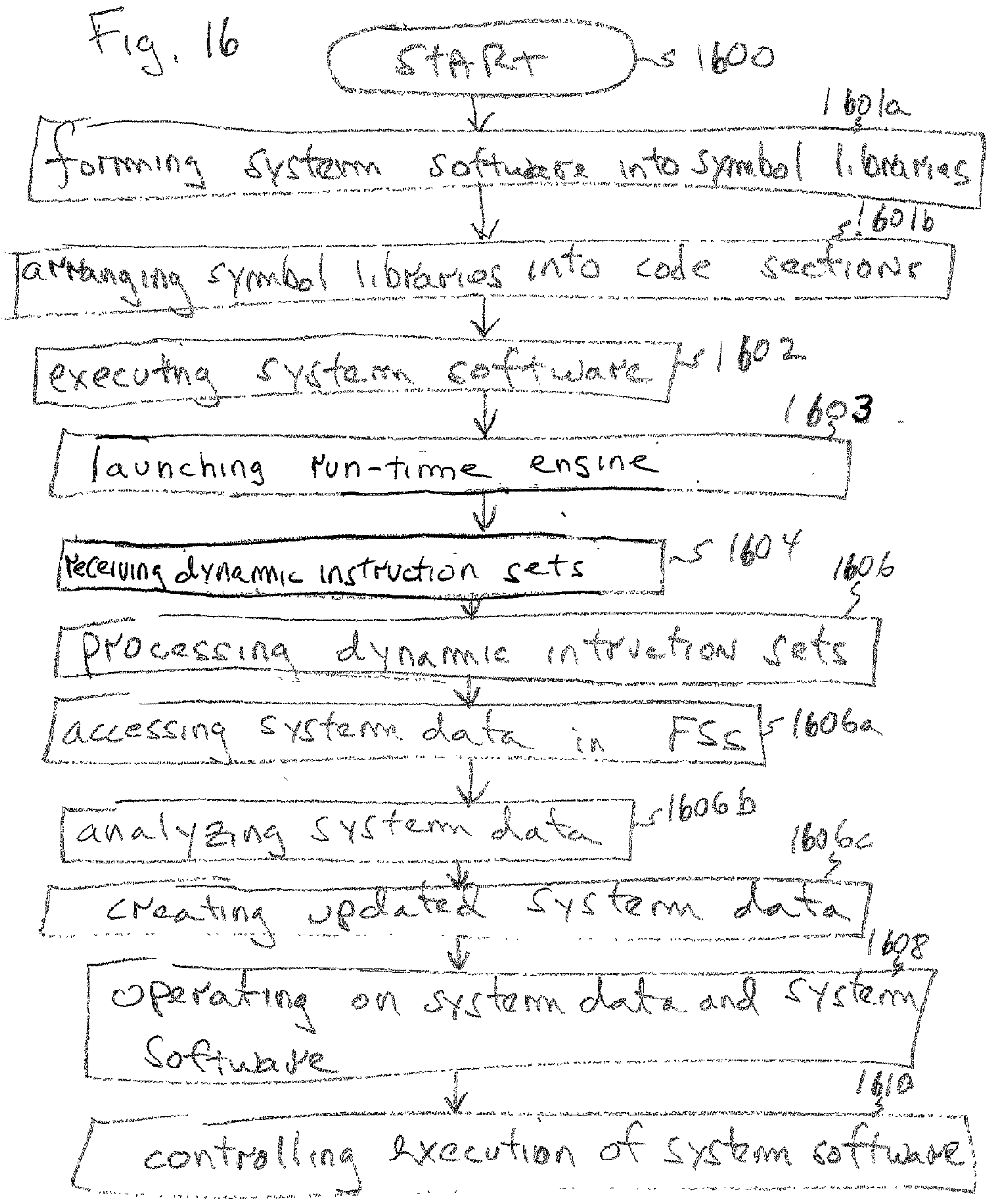

START
1600
1601a
forming system software into symbol libraries
1601b
arranging symbol libraries into code sections
executing system software
1602
1603
launching run-time engine
receiving dynamic instruction sets
1604
1606
processing dynamic intruction sets
accessing system data in FSs
1606a
analyzing system data
1606b
1606c
creating updated system data
1608
operating on system data and system software
1610
controlling execution of system software

Fig. 16

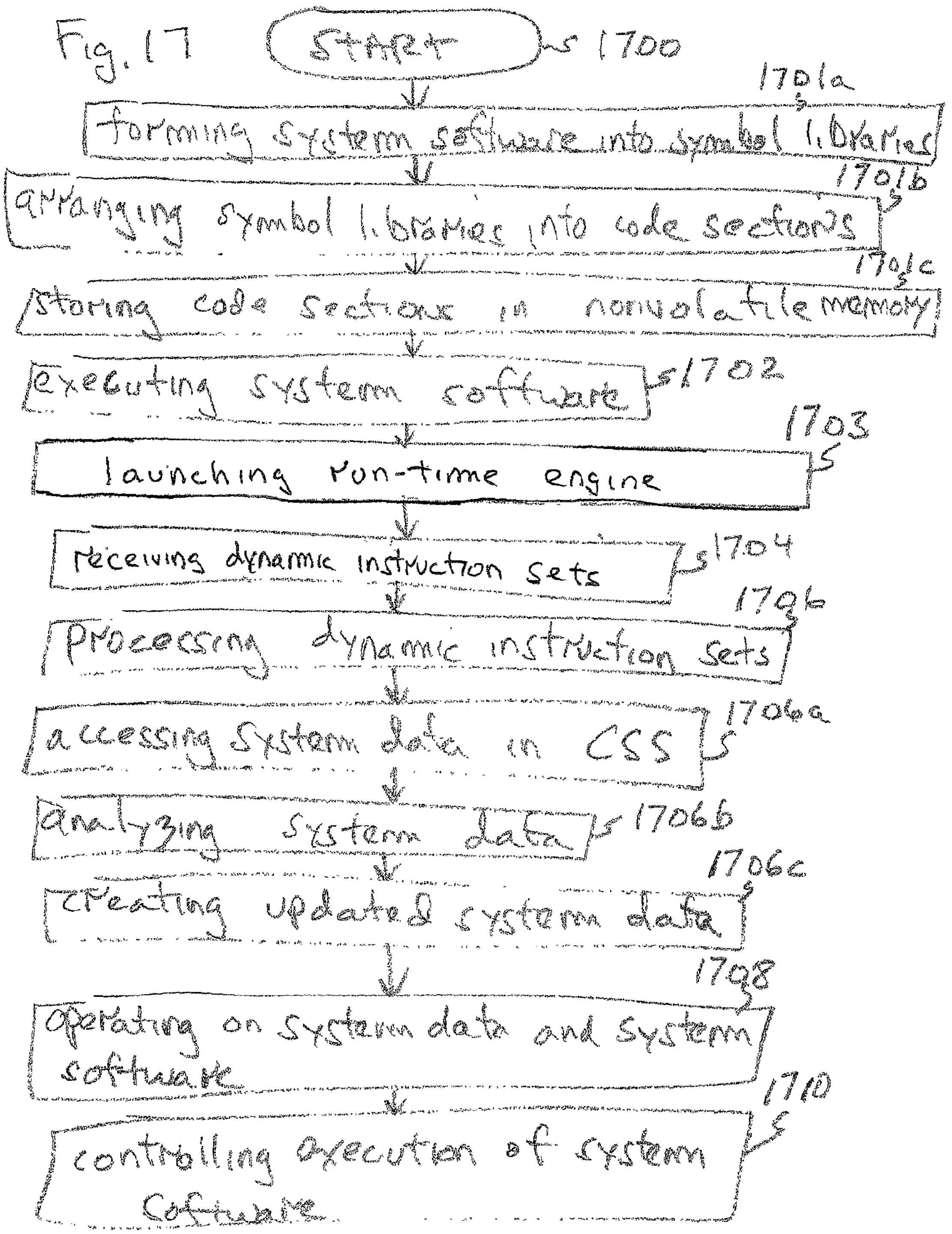
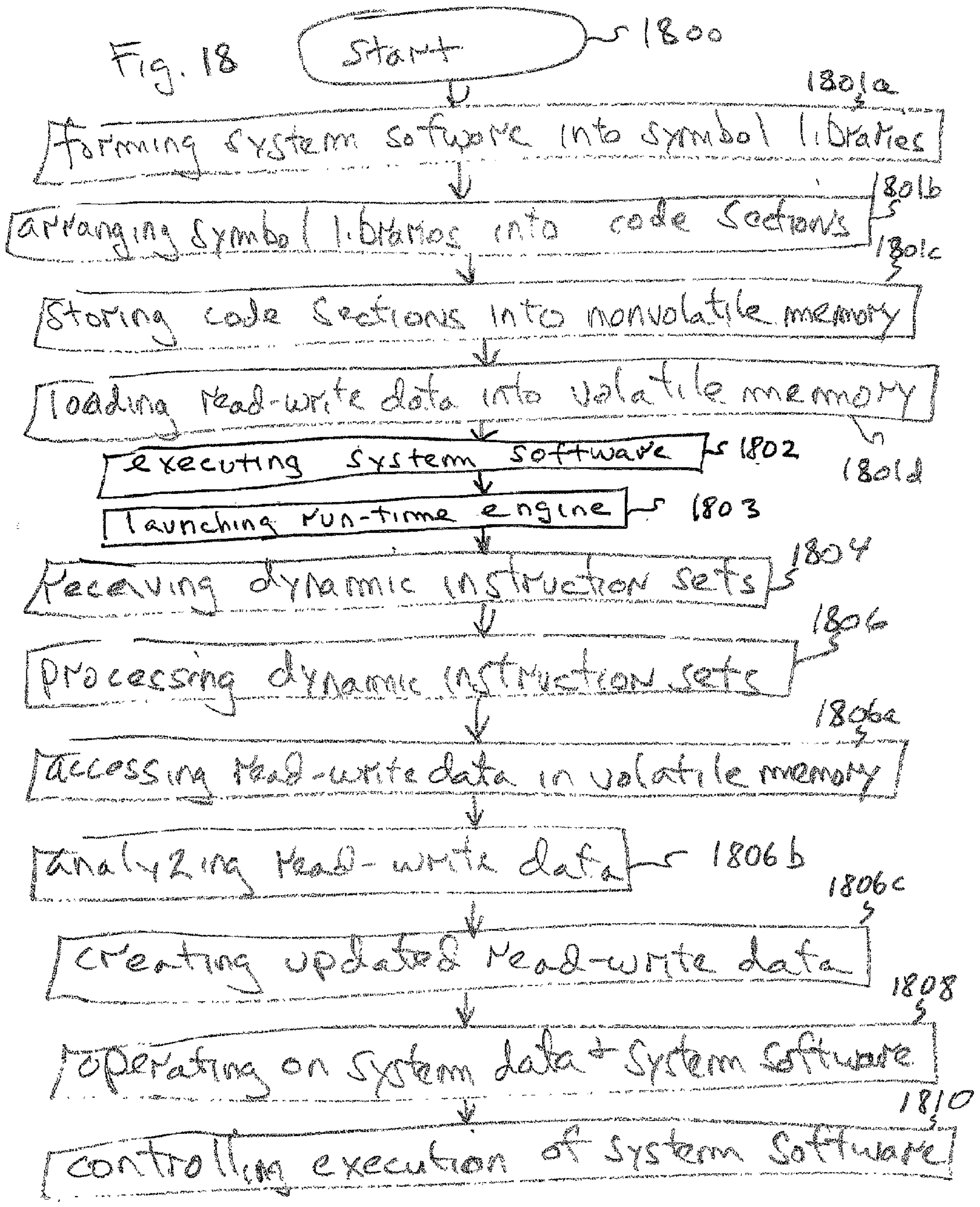


Fig. 17
START
1700
1701a
forming system software into symbol libraries
1701b
arranging symbol libraries into code sections
1701c
storing code sections in nonvolatile memory
executing system software
1702
1703
launching run-time engine
receiving dynamic instruction sets
1704
1706
processing dynamic instruction sets
1706a
accessing system data in CSS
analyzing system data
1706b
1706c
creating updated system data
1708
operating on system data and system software
1710
controlling execution of system software

Fig. 18


Start
1800
1801a
forming system software into symbol libraries
1801b
arranging symbol libraries into code sections
1801c
storing code sections into nonvolatile memory
loading read-write data into volatile memory
1801d
executing system software
1802
launching run-time engine
1803
receiving dynamic instruction sets
1804
processing dynamic instruction sets
1806
1806a
accessing read-write data in volatile memory
analyzing read-write data
1806b
1806c
creating updated read-write data
1808
operating on system data + system software
1810
controlling execution of system software

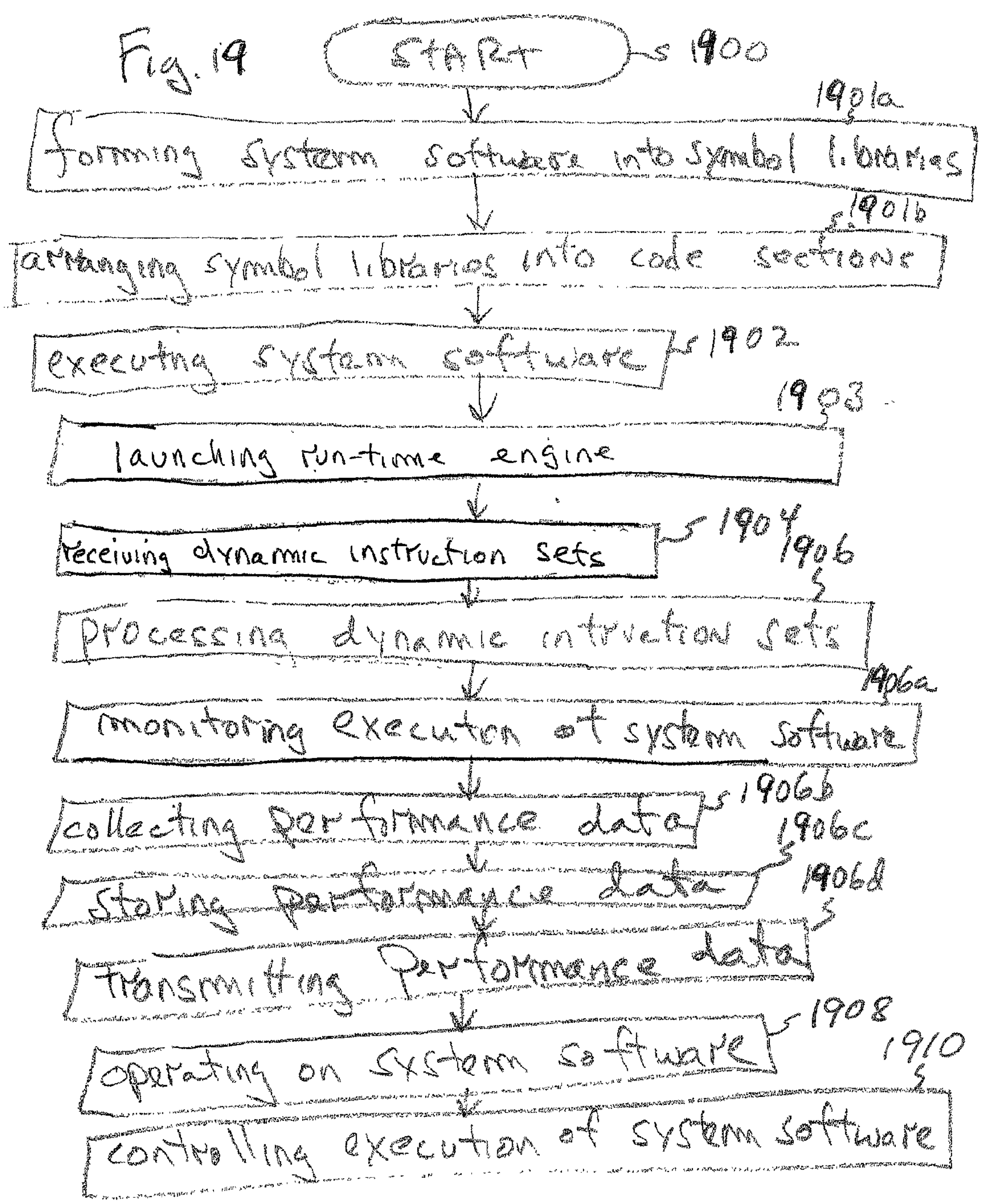
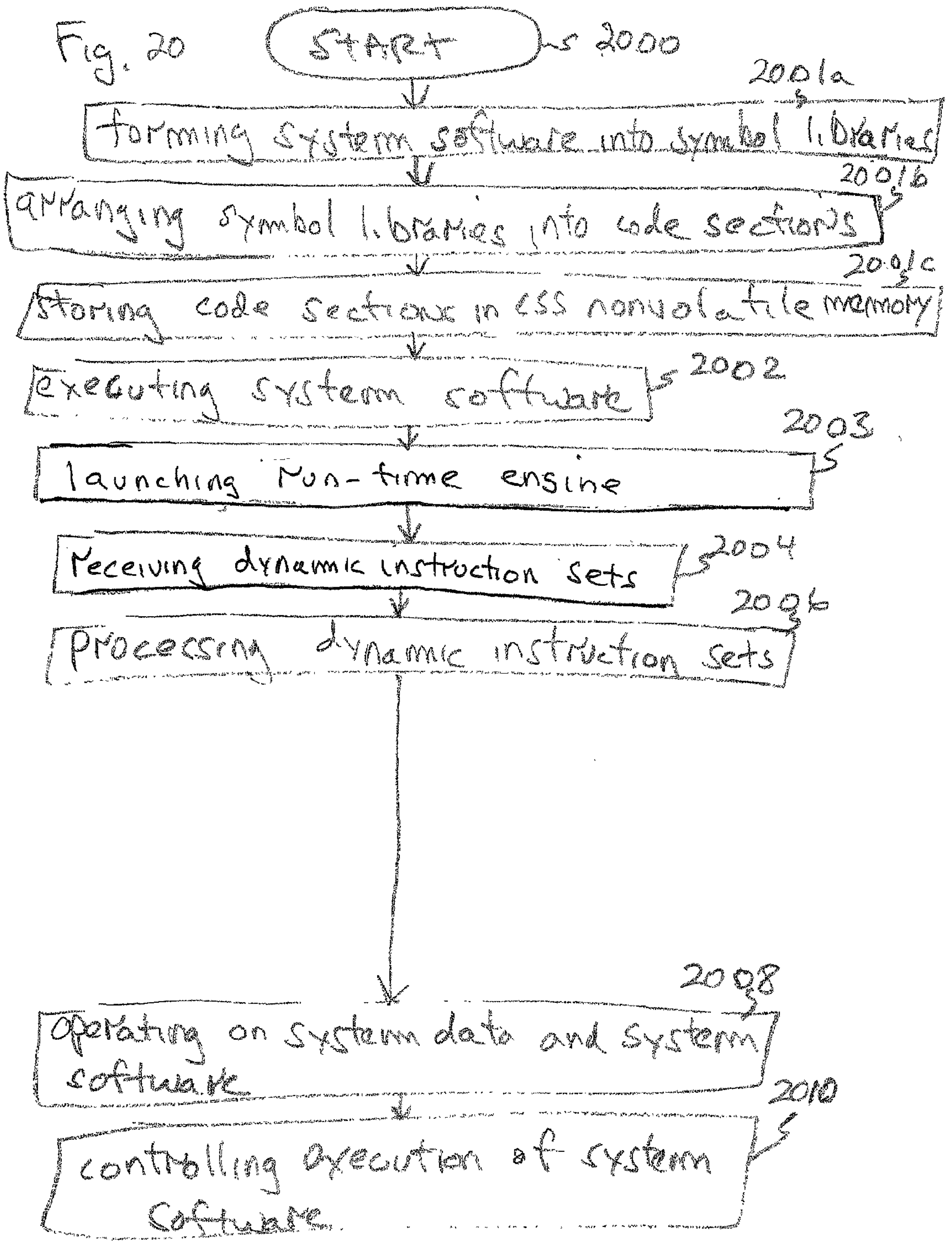


Fig. 19
START
1900
1901a
forming system software into symbol libraries
1901b
arranging symbol libraries into code sections
executing system software
1902
1903
launching run-time engine
1904
receiving dynamic instruction sets
1906
processing dynamic intruction sets
1906a
monitoring execution of system software
collecting performance data
1906b
1906c
storing performance data
1906d
transmitting performance data
1908
operating on system software
1910
controlling execution of system software

Fig. 20


START
2000
2001a
forming system software into symbol libraries
2001b
arranging symbol libraries into code sections
2001c
storing code sections in CSS nonvolatile memory
2002
executing system software
2003
launching run-time engine
2004
receiving dynamic instruction sets
2006
processing dynamic instruction sets
2008
operating on system data and system software
2010
controlling execution of system software

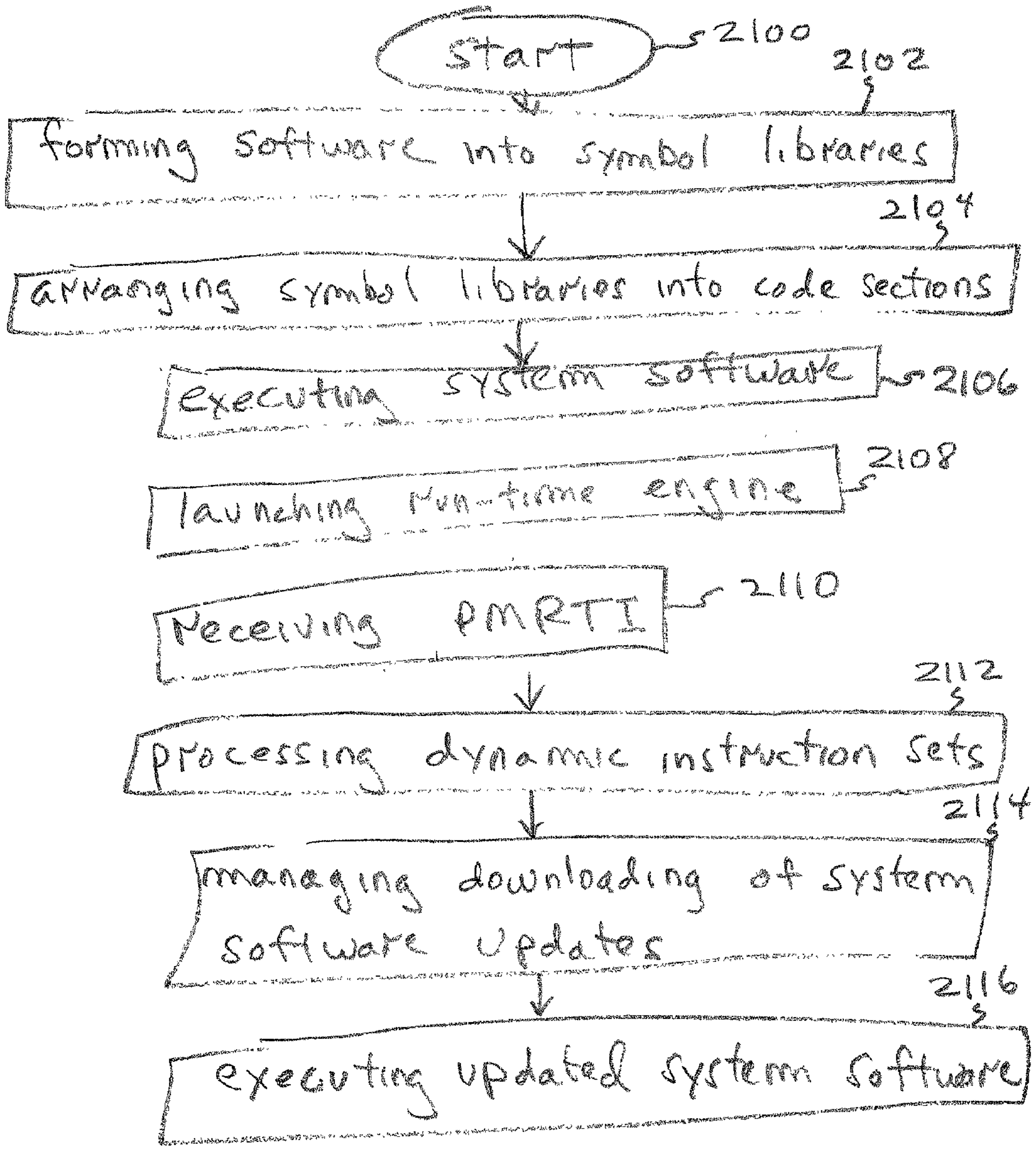

Start
2100
2102
forming software into symbol libraries
2104
arranging symbol libraries into code sections
executing system software
2106
2108
launching run-time engine
2110
receiving PMRTI
2112
processing dynamic instruction sets
2114
managing downloading of system software updates
2116
executing updated system software

Fig. 21

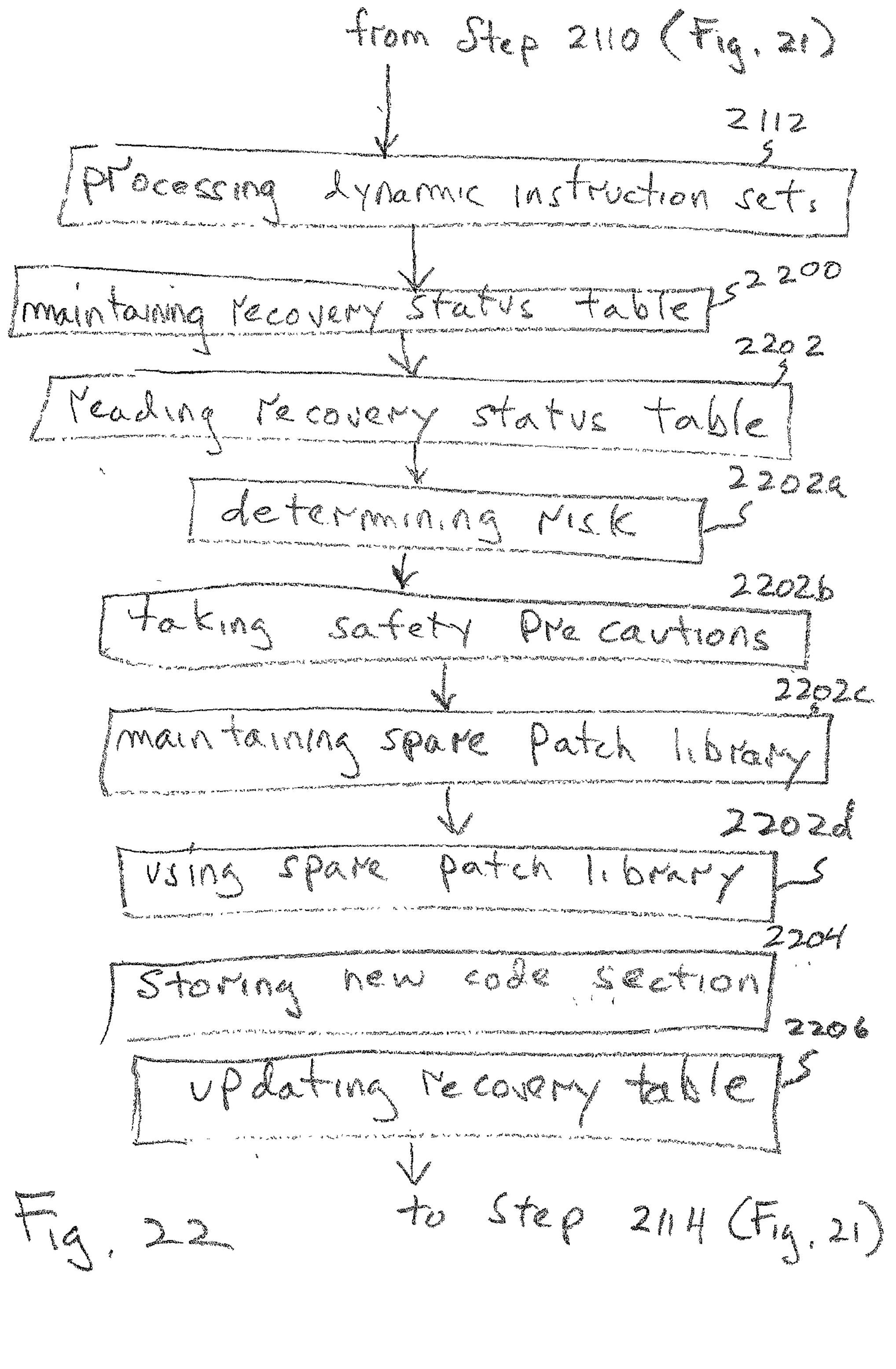

from Step 2110 (Fig. 21)
2112
processing dynamic instruction sets
2200
maintaining recovery status table
2202
reading recovery status table
2202a
determining risk
2202b
taking safety precautions
2202c
maintaining spare patch library
2202d
using spare patch library
2204
Storing new code section
2206
updating recovery table
to Step 2114 (Fig. 21)

Fig. 22

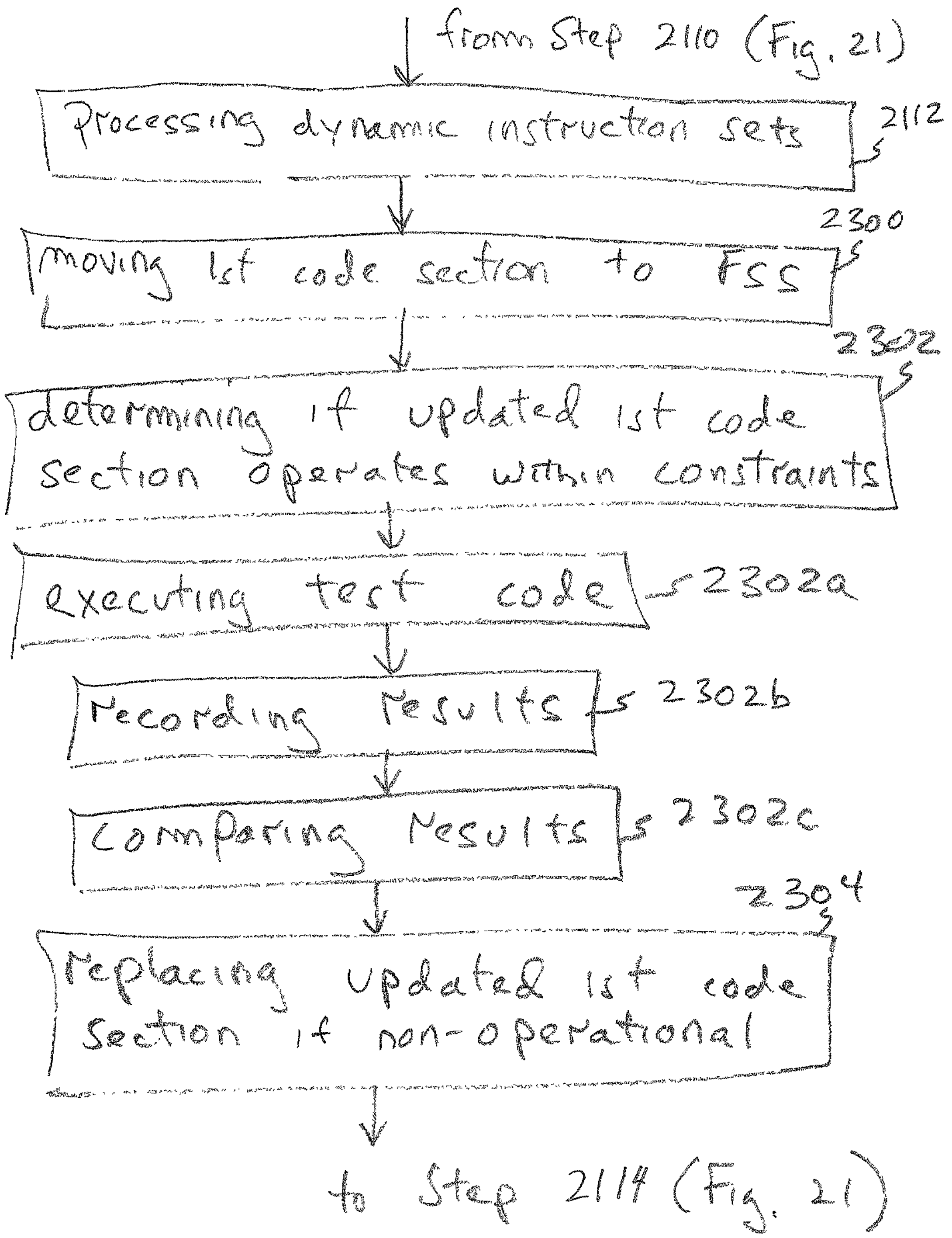

from Step 2110 (Fig. 21)
Processing dynamic instruction sets
2112
moving 1st code section to FSS
2300
determining if updated 1st code section operates within constraints
2302
executing test code
2302a
recording results
2302b
comparing results
2302c
replacing updated 1st code section if non-operational
2304
to Step 2114 (Fig. 21)

Fig. 23

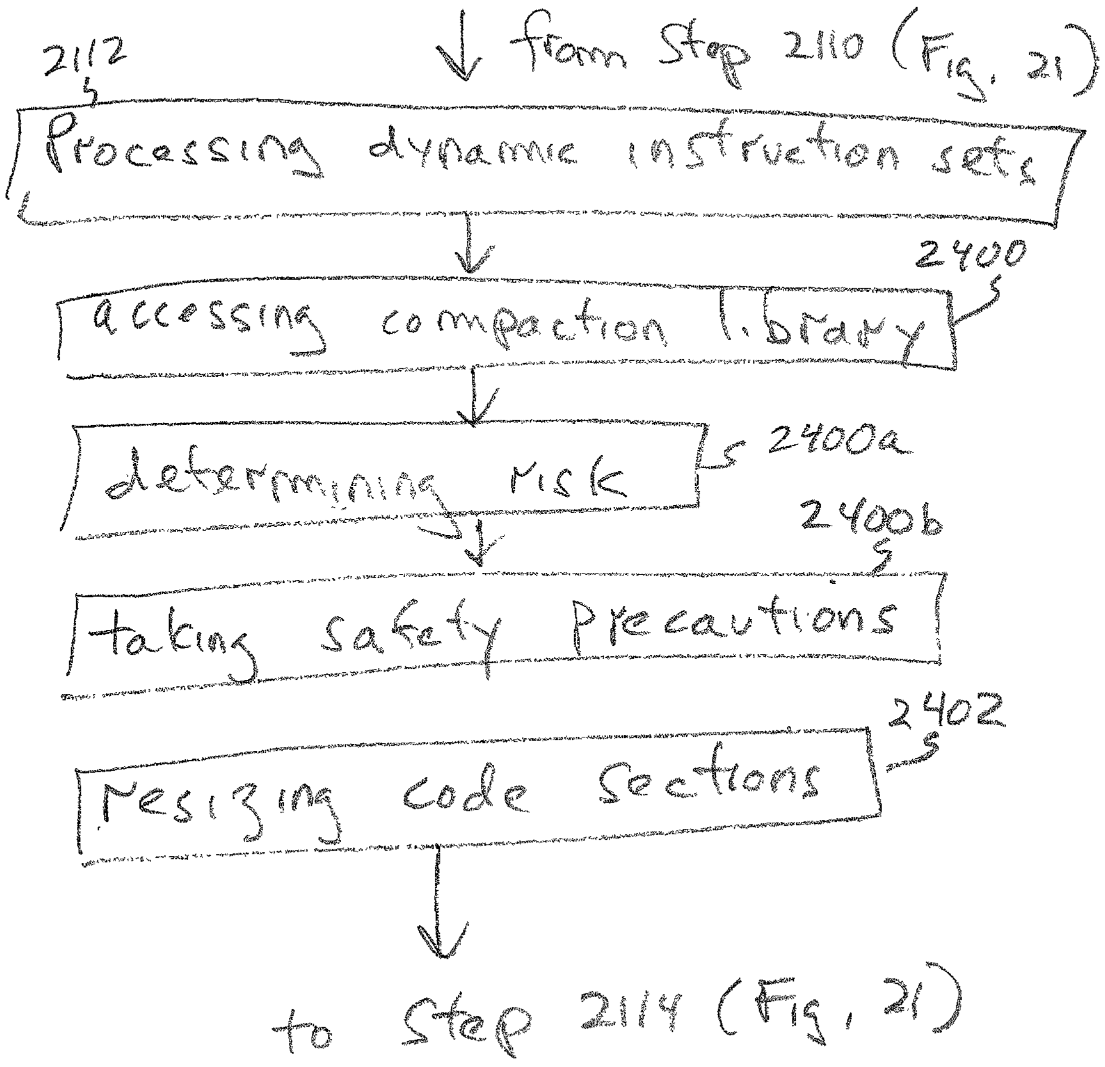

from Step 2110 (Fig. 21)
2112
Processing dynamic instruction sets
2400
accessing compaction library
2400a
determining risk
2400b
taking safety precautions
2402
resizing code sections
to Step 2114 (Fig. 21)

Fig. 24

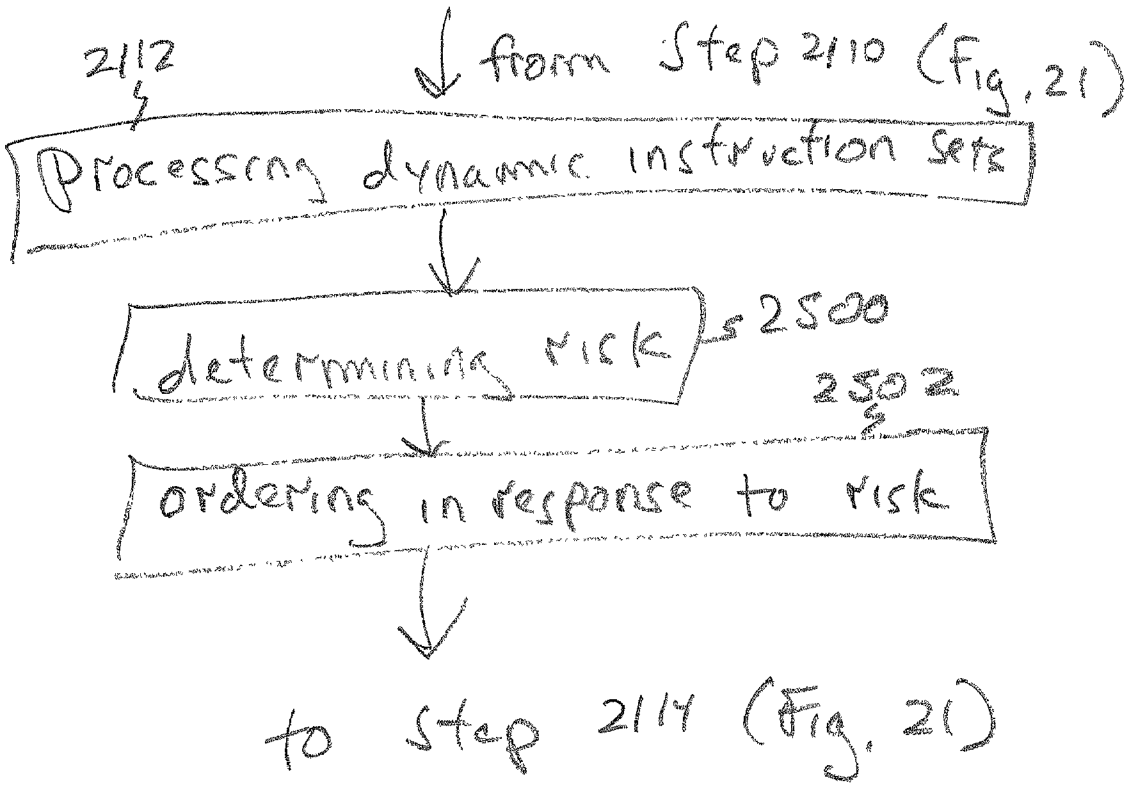

from Step 2110 (Fig. 21)
2112
Processing dynamic instruction sets
determining risk
2500
2502
ordering in response to risk
to Step 2114 (Fig. 21)

Fig. 25

SYSTEM AND METHOD FOR THE MANAGEMENT OF WIRELESS COMMUNICATIONS DEVICE SYSTEM SOFTWARE DOWNLOADS IN THE FIELD

[0001] This application claims priority to U.S. patent application Ser. No. 09/927,131, filed on Aug. 10, 2001, and entitled "System and Method for Executing Wireless Communications Device Dynamic Instruction Sets;" and is related to U.S. patent application Ser. No. 09/916,900, filed on Jul. 26, 2001 and entitled "System and Method for Field Downloading a Wireless Communications Device Software Code Section," and Ser. No. 09/9169,460, filed on Jul. 26, 2001, and entitled "System and Method for Compacting Field Upgradeable Wireless Communication Device Software Code Sections," all of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] This invention generally relates to wireless communications devices and, more particularly, to a system and method for using dynamic instructions sets to manage a variety of system software field download management functions, such as recovery status monitoring, back up, compaction, and update ordering.

[0004] 2. Description of the Related Art

[0005] It is not uncommon to release software updates for phones that are already in the field. These updates may relate to problems found in the software once the phones have been manufactured and distributed to the public. Some updates may involve the use of new features on the phone, or services provided by the service provider. Yet other updates may involve regional problems, or problems associated with certain carriers. For example, in certain regions the network layout of carriers may impose airlink interface conditions on the handset that cause the handset to demonstrate unexpected behavior such as improper channel searching, improper call termination, improper audio, or the like.

[0006] The traditional approach to such updates has been to recall the wireless communications device, also referred to herein as a wireless device, phone, telephone, or handset, to the nearest carrier retail/service outlet, or to the manufacturer to process the changes. The costs involved in such updates are extensive and eat into the bottom line. Further, the customer is inconvenienced and likely to be irritated. Often times, the practical solution is to issue the customer new phones.

[0007] The wireless devices are used in a number of environments, with different subscriber services, for a number of different customer applications. Therefore, even if the software of a wireless device can be upgraded to improve service, it is unlikely that the upgrade will provide a uniform improvement for all users.

[0008] It would be advantageous if wireless communications device software could be upgraded cheaply, and without inconvenience to the customer.

[0009] It would be advantageous if wireless communications device software could be upgraded without the customer losing the use of their phones for a significant period of time.

[0010] It would be advantageous if wireless communications device software could be updated with a minimum of technician service time, or without the need to send the device into a service facility.

[0011] It would be advantageous if the wireless device system software could be differentiated into code sections, so that only specific code sections of system software would need to be replaced, to update the system software. It would be advantageous if these code sections could be communicated to the wireless device via the airlink.

[0012] It would be advantageous if the wireless device could be operated with dynamically loaded instruction sets that would aid in the field updating of system software.

[0013] It would be advantageous if these dynamic instruction sets could protect the wireless device from update errors by monitoring the update status, backing up key code sections, performing memory compaction, and ordering the update storage process.

SUMMARY OF THE INVENTION

[0014] Wireless communications device software updates give customers the best possible product and user experience. An expensive component of the business involves the recall of handsets to update the software. These updates may be necessary to offer the user additional services or to address problems discovered in the use of the phone after it has been manufactured. The present invention makes it possible to practically upgrade handset software in the field, via the airlink interface. More specifically, the present invention permits the wireless communication device to execute dynamic instruction sets. These dynamic instruction sets permit the wireless device to "intelligently", or conditionally upgrade the system software and system data. Further, the dynamic instruction sets permit the wireless device to determine if the updating process has been successfully completed. The dynamic instruction sets permit key code sections to be stored in case the upgrade section are found to be non-operational. The dynamic instruction sets also perform memory compaction and storage ordering.

[0015] Accordingly, a method is provided for managing system software download operations in a wireless communications device. The method comprises: executing system software; launching a run-time engine; processing dynamic instruction sets; and, in response to processing the dynamic instruction sets, managing the downloading of system software updates received via an airlink interface using management functions selected from the group including recovery status monitoring, back up, compacting, and update ordering.

[0016] Details of the above-described recovery status monitoring, back up, compacting, and update ordering management functions, and a system for managing system software download operations in a wireless communications device are provided below.

BRIEF DESCRIPTION OF THE DRAWING

[0017] **FIG. 1** is a schematic block diagram of the overall wireless device software maintenance system.

[0018] **FIG. 2** is a schematic block diagram of the software maintenance system, highlighting the installation of instruction sets via the airlink interface.

[0019] **FIG. 3** is a schematic block diagram illustrating the present invention system for executing dynamic instruction sets in a wireless communications device.

[0020] **FIG. 4** is a schematic block diagram of the wireless device memory.

[0021] **FIG. 5** is a table representing the code section address table of **FIG. 3**.

[0022] **FIG. 6** is a detailed depiction of symbol library one of **FIG. 3**, with symbols.

[0023] **FIG. 7** is a table representing the symbol offset address table of **FIG. 3**.

[0024] **FIGS. 8***a* and **8***b* are depictions of the operation code (op-code) being accessed by the run-time engine.

[0025] **FIG. 9** is a schematic block diagram including features of **FIGS. 1-8***b* presented for the purpose of illustrating the present invention system for managing system software download operations in a wireless communications device.

[0026] **FIG. 10** is the schematic block diagram of the system of **FIG. 9** featuring the dynamic instruction set recovery status monitoring manager aspect of the dynamic instruction sets.

[0027] **FIG. 11** is a representation depicting an exemplary recovery status table of **FIG. 9**.

[0028] **FIG. 12** is the schematic block diagram of the system of **FIG. 9** featuring the dynamic instruction set back up manager aspect of the dynamic instruction sets.

[0029] **FIG. 13** is the schematic block diagram of the system of **FIG. 9** featuring the dynamic instruction compaction manager aspect of the dynamic instruction sets.

[0030] **FIG. 14** is the schematic block diagram of the system of **FIG. 9** featuring the dynamic instruction set update ordering manager aspect of the dynamic instruction sets.

[0031] **FIGS. 15***a* and **15***b* are flowcharts illustrating the present invention method for executing dynamic instruction sets in a wireless communications device.

[0032] **FIG. 16** is a flowchart illustrating an exemplary dynamic instruction set operation.

[0033] **FIG. 17** is a flowchart illustrating another exemplary dynamic instruction set operation.

[0034] **FIG. 18** is a flowchart illustrating a third exemplary dynamic instruction set operation.

[0035] **FIG. 19** is a flowchart illustrating a fourth exemplary dynamic instruction set operation.

[0036] **FIG. 20** is a flowchart illustrating a fifth exemplary dynamic instruction set operation.

[0037] **FIG. 21** is a flowchart illustrating the present invention method for managing system software download operations in a wireless communications device.

[0038] **FIG. 22** is a flowchart illustrating additional details of **FIG. 21** that highlight the recovery status monitoring aspect of the invention.

[0039] **FIG. 23** is a flowchart illustrating additional details of **FIG. 21** that highlight the back up aspect of the invention.

[0040] **FIG. 24** is a flowchart illustrating additional details of **FIG. 21** that highlight the compaction aspect of the invention.

[0041] **FIG. 25** is a flowchart illustrating additional details of **FIG. 21** that highlight the update ordering aspect of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0042] Some portions of the detailed descriptions that follow are presented in terms of procedures, steps, logic blocks, codes, processing, and other symbolic representations of operations on data bits within a wireless device microprocessor or memory. These descriptions and representations are the means used by those skilled in the data processing arts to most effectively convey the substance of their work to others skilled in the art. A procedure, microprocessor executed step, application, logic block, process, etc., is here, and generally, conceived to be a self-consistent sequence of steps or instructions leading to a desired result. The steps are those requiring physical manipulations of physical quantities. Usually, though not necessarily, these quantities take the form of electrical or magnetic signals capable of being stored, transferred, combined, compared, and otherwise manipulated in a microprocessor based wireless device. It has proven convenient at times, principally for reasons of common usage, to refer to these signals as bits, values, elements, symbols, characters, terms, numbers, or the like. Where physical devices, such as a memory are mentioned, they are connected to other physical devices through a bus or other electrical connection. These physical devices can be considered to interact with logical processes or applications and, therefore, are "connected" to logical operations. For example, a memory can store or access code to further a logical operation, or an application can call a code section from memory for execution.

[0043] It should be borne in mind, however, that all of these and similar terms are to be associated with the appropriate physical quantities and are merely convenient labels applied to these quantities. Unless specifically stated otherwise as apparent from the following discussions, it is appreciated that throughout the present invention, discussions utilizing terms such as "processing" or "connecting" or "translating" or "displaying" or "prompting" or "determining" or "displaying" or "recognizing" or the like, refer to the action and processes of in a wireless device microprocessor system that manipulates and transforms data represented as physical (electronic) quantities within the computer system's registers and memories into other data similarly represented as physical quantities within the wireless device memories or registers or other such information storage, transmission or display devices.

[0044] **FIG. 1** is a schematic block diagram of the overall wireless device software maintenance system **100**. The present invention system software organization is presented in detail below, following a general overview of the software maintenance system **100**. The general system **100** describes a process of delivering system software updates and instruction sets (programs), and installing the delivered software in a wireless device. System software updates and patch manager run time instructions (PMRTI), that are more generally known as instruction sets or dynamic instruction sets, are created by the manufacturer of the handsets. The system software is organized into symbol libraries. The symbol libraries are arranged into code sections. When symbol libraries are to be updated, the software update **102** is transported as one or more code sections. The software update is broadcast to wireless devices in the field, of which wireless communications device **104** is representative, or transmitted in separate communications from a base station **106** using well known, conventional air, data or message transport protocols. The invention is not limited to any particular transportation format, as the wireless communications device can be easily modified to process any available over-the-air transport protocol for the purpose of receiving system software and PMRTI updates.

[**0045**] The system software can be viewed as a collection of different subsystems. Code objects can be tightly coupled into one of these abstract subsystems and the resulting collection can be labeled as a symbol library. This provides a logical breakdown of the code base and software patches and fixes can be associated with one of these symbol libraries. In most cases, a single update is associated with one, or at most, two symbol libraries. The rest of the code base, the other symbol libraries, remains unchanged.

[**0046**] The notion of symbol libraries provides a mechanism to deal with code and constants. The read-write (RW) data, on the other hand, fits into a unique individual RW library that contains RAM based data for all libraries.

[**0047**] Once received by the wireless device **104**, the transported code section must be processed. This wireless device over-writes a specific code section of nonvolatile memory **108**. The nonvolatile memory **108** includes a file system section (FSS) **110** and a code storage section **112**. The code section is typically compressed before transport in order to minimize occupancy in the FSS **110**. Often the updated code section will be accompanied by its RW data, which is another kind of symbol library that contains all the RW data for each symbol library. Although loaded in random access volatile read-write memory **114** when the system software is executing, the RW data always needs to be stored in the nonvolatile memory **108**, so it can be loaded into random access volatile read-write memory **114** each time the wireless device is reset. This includes the first time RW data is loaded into random access volatile read-write memory. As explained in more detail below, the RW data is typically arranged with a patch manager code section.

[**0048**] The system **100** includes the concept of virtual tables. Using such tables, symbol libraries in one code section can be patched (replaced), without breaking (replacing) other parts of the system software (other code sections). Virtual tables execute from random access volatile read-write memory **114** for efficiency purposes. A code section address table and symbol offset address table are virtual tables.

[**0049**] The updated code sections are received by the wireless device **104** and stored in the FSS **110**. A wireless device user interface (UI) will typically notify the user that new software is available. In response to UI prompts the user acknowledges the notification and signals the patching or updating operation. Alternately, the updating operation is performed automatically. The wireless device may be unable to perform standard communication tasks as the updating process is performed. The patch manager code section includes a non-volatile read-write driver symbol library that is also loaded into random access volatile read-write memory **114**. The non-volatile read-write driver symbol library causes code sections to be overwritten with updated code sections. The patch manager code section includes the read-write data, code section address table, and symbol offset address table, as well a symbol accessor code and the symbol accessor code address (discussed below). Portions of this data are invalid when updated code sections are introduced, and an updated patch manager code sections includes read-write data, a code section address table, and a symbol offset address table valid for the updated code sections. Once the updated code sections are loaded into the code storage section **112**, the wireless device is reset. Following the reset operation, the wireless device can execute the updated system software. It should also be understood that the patch manager code section may include other symbol libraries that have not been discussed above. These other symbol libraries need not be loaded into read-write volatile memory **114**.

[**0050**] **FIG. 2** is a schematic block diagram of the software maintenance system **100**, highlighting the installation of instruction sets via the airlink interface. In addition to updating system software code sections, the maintenance system **100** can download and install dynamic instructions sets, programs, or patch manager instruction sets (PMIS), referred to herein as patch manager run time instructions (PMRTI). The PMRTI code section **200** is transported to the wireless device **104** in the same manner as the above-described system software code sections. PMRTI code sections are initially stored in the FSS **110**. A PMRTI code section is typically a binary file that may be visualized as compiled instructions to the handset. A PMRTI code section is comprehensive enough to provide for the performance of basic mathematical operations and the performance of conditionally executed operations. For example, an RF calibration PMRTI could perform the following operations:

[**0051**] IF RF CAL ITEM IS LESS THAN X

[**0052**] EXECUTE INSTRUCTION

[**0053**] ELSE

[**0054**] EXECUTE INSTRUCTION

[**0055**] A PMRTI can support basic mathematical operations, such as: addition, subtraction, multiplication, and division. As with the system software code sections, the PMRTI code section may be loaded in response to UI prompts, and the wireless device must be reset after the PMRTI is loaded into code storage section **112**. Then the PMRTI section can be executed. If the PMRTI code section is associated with any virtual tables or read-write data, an updated patch manager code section will be transported with the PMRTI for installation in the code storage section **112**. Alternately, the PMRTI can be kept and processed from the FSS **110**. After the handset **104** has executed all the instructions in the PMRTI section, the PMRTI section can be deleted from the FSS **110**. Alternately, the PMRTI is maintained for future operations. For example, the PMRTI may be executed every time the wireless device is energized.

[**0056**] PMRTI is a very powerful runtime instruction engine. The handset can execute any instruction delivered to it through the PMRTI environment. This mechanism may be used to support RF calibrations. More generally, PMRTI can be used to remote debug wireless device software when software problems are recognized by the manufacturer or service provider, typically as the result of user complaints. PMRTI can also record data needed to diagnose software problems. PMRTI can launch newly downloaded system applications for data analysis, debugging, and fixes. PMRTI can provide RW data based updates for analysis and possible short term fix to a problem in lieu of an updated system software code section. PMRTI can provide memory compaction algorithms for use by the wireless device.

[0057] In some aspects of the invention, the organization of the system software into symbol libraries may impact the size of the volatile memory **114** and nonvolatile memory **108** required for execution. This is due to the fact that the code sections are typically larger than the symbol libraries arranged in the code sections. These larger code sections exist to accommodate updated code sections. Organizing the system software as a collection of libraries impacts the nonvolatile memory size requirement. For the same code size, the amount of nonvolatile memory used will be higher due to the fact that code sections can be sized to be larger than the symbol libraries arranged within.

[0058] Once software updates have been delivered to the wireless device, the software maintenance system **100** supports memory compaction. Memory compaction is similar to disk de-fragmentation applications in desktop computers. The compaction mechanism ensures that memory is optimally used and is well balanced for future code section updates, where the size of the updated code sections are unpredictable. The system **100** analyzes the code storage section as it is being patched (updated). The system **100** attempts to fit updated code sections into the memory space occupied by the code section being replaced. If the updated code section is larger than the code section being replaced, the system **100** compacts the code sections in memory **112**. Alternately, the compaction can be calculated by the manufacturer or service provider, and compaction instructions can be transported to the wireless device **104**.

[0059] Compaction can be a time consuming process owing to the complexity of the algorithm and also the vast volume of data movement. The compaction algorithm predicts feasibility before it begins any processing. UI prompts can be used to apply for permission from the user before the compaction is attempted.

[0060] In some aspects of the invention, all the system software code sections can be updated simultaneously. A complete system software upgrade, however, would require a larger FSS **110**.

[0061] **FIG. 3** is a schematic block diagram illustrating the present invention dynamic instruction set execution in a wireless communications device. The system **300** comprises a code storage section **112** in memory **108** including executable wireless device system software differentiated into a plurality of current code sections. Code section one **(302)**, code section two **(304)**, code section n **(306)**, and a patch manager code section **308** are shown. However, the invention is not limited to any particular number of code sections. Further, the system **300** further comprises a first plurality of symbol libraries arranged into the second plurality of code sections. Shown are symbol library one **(310)** arranged in code section one **(302)**, symbol libraries two **(312)** and three **(314)** arranged in code section two **(304)**, and symbol library m **(316)** arranged in code section n **(306)**. Each library comprises symbols having related functionality. For example, symbol library one **(310)** may be involved in the operation of the wireless device liquid crystal display (LCD). Then, the symbols would be associated with display functions. As explained in detail below, additional symbol libraries are arranged in the patch manger code section **308**.

[0062] **FIG. 4** is a schematic block diagram of the wireless device memory. As shown, the memory is the code storage section **112** of **FIG. 1**. The memory is a writeable, nonvolatile memory, such as Flash memory. It should be understood that the code sections need not necessarily be stored in the same memory as the FSS **110**. It should also be understood that the present invention system software structure could be enabled with code sections stored in a plurality of cooperating memories. The code storage section **112** includes a second plurality of contiguously addressed memory blocks, where each memory block stores a corresponding code section from the second plurality of code sections. Thus, code section one **(302)** is stored in a first memory block **400**, code section two **(304)** in the second memory block **402**, code section n **(306)** in the nth memory block **404**, and the patch manager code section **(308)** in the pth memory block **406**.

[0063] Contrasting **FIGS. 3 and 4**, the start of each code section is stored at corresponding start addresses in memory, and symbol libraries are arranged to start at the start of code sections. That is, each symbol library begins at a first address and runs through a range of addresses in sequence from the first address. For example, code section one **(302)** starts at the first start address **408** (marked with “S”) in code storage section memory **112**. In **FIG. 3**, symbol library one **(310)** starts at the start **318** of the first code section. Likewise code section two **(304)** starts at a second start address **410 (FIG. 4)**, and symbol library two starts at the start **320** of code section two **(FIG. 3)**. Code section n **(306)** starts at a third start address **412** in code storage section memory **112 (FIG. 4)**, and symbol library m **(316)** starts at the start of code section n **322 (FIG. 3)**. The patch manager code section starts at pth start address **414** in code storage section memory **112**, and the first symbol library in the patch manager code section **308** starts at the start **324** of the patch manager code section. Thus, symbol library one **(310)** is ultimately stored in the first memory block **400**. If a code section includes a plurality of symbol libraries, such as code section two **(304)**, the plurality of symbol libraries are stored in the corresponding memory block, in this case the second memory block **402**.

[0064] In **FIG. 3**, the system **300** further comprises a code section address table **326** as a type of symbol included in a symbol library arranged in the patch manager code section **308**. The code section address table cross-references code section identifiers with corresponding code section start addresses in memory.

[0065] **FIG. 5** is a table representing the code section address table **326** of **FIG. 3**. The code section address table **326** is consulted to find the code section start address for a symbol library. For example, the system **300** seeks code section one when a symbol in symbol library one is required for execution. To find the start address of code section one, and therefore locate the symbol in symbol library one, the code section address table **326** is consulted. The arrangement of symbol libraries in code sections, and the tracking of code sections with a table permits the code sections to be moved or expanded. The expansion or movement operations may be needed to install upgraded code sections (with upgraded symbol libraries).

[**0066**] Returning to **FIG. 3**, it should be noted that not every symbol library necessarily starts at the start of a code section. As shown, symbol library three (**314**) is arranged in code section two (**304**), but does not start of the code section start address **320**. Thus, if a symbol in symbol library three (**314**) is required for execution, the system **300** consults the code section address table **326** for the start address of code section two (**304**). As explained below, a symbol offset address table permits the symbols in symbol library three (**314**) to be located. It does not matter that the symbols are spread across multiple libraries, as long as they are retained with the same code section.

[**0067**] As noted above, each symbol library includes functionally related symbols. A symbol is a programmer-defined name for locating and using a routine body, variable, or data structure. Thus, a symbol can be an address or a value. Symbols can be internal or external. Internal symbols are not visible beyond the scope of the current code section. More specifically, they are not sought by other symbol libraries, in other code sections. External symbols are used and invoked across code sections and are sought by libraries in different code sections. The symbol offset address table typically includes a list of all external symbols.

[**0068**] For example, symbol library one (**310**) may generate characters on a wireless device display. Symbols in this library would, in turn, generate telephone numbers, names, the time, or other display features. Each feature is generated with routines, referred to herein as a symbol. For example, one symbol in symbol library one (**310**) generates telephone numbers on the display. This symbol is represented by an "X", and is external. When the wireless device receives a phone call and the caller ID service is activated, the system must execute the "X" symbol to generate the number on the display. Therefore, the system must locate the "X" symbol.

[**0069**] **FIG. 6** is a detailed depiction of symbol library one (**310**) of **FIG. 3**, with symbols. Symbols are arranged to be offset from respective code section start addresses. In many circumstances, the start of the symbol library is the start of a code section, but this is not true if a code section includes more than one symbol library. Symbol library one (**310**) starts at the start of code section one (see **FIG. 3**). As shown in **FIG. 6**, the "X" symbol is located at an offset of (03) from the start of the symbol library and the "Y" symbol is located at an offset of (15). The symbol offset addresses are stored in a symbol offset address table **328** in the patch manager code section (see **FIG. 3**).

[**0070**] **FIG. 7** is a table representing the symbol offset address table **328** of **FIG. 3**. The symbol offset address table **328** cross-references symbol identifiers with corresponding offset addresses, and with corresponding code section identifiers in memory. Thus, when the system seeks to execute the "X" symbol in symbol library one, the symbol offset address table **328** is consulted to locate the exact address of the symbol, with respect to the code section in which it is arranged.

[**0071**] Returning to **FIG. 3**, the first plurality of symbol libraries typically all include read-write data that must be consulted or set in the execution of these symbol libraries. For example, a symbol library may include an operation dependent upon a conditional statement. The read-write data section is consulted to determine the status required to complete the conditional statement. The present invention groups the read-write data from all the symbol libraries into a shared read-write section. In some aspects of the invention, the read-write data **330** is arranged in the patch manager code section **308**. Alternately (not shown), the read-write data can be arranged in a different code section, code section n (**306**), for example.

[**0072**] The first plurality of symbol libraries also includes symbol accessor code arranged in a code section to calculate the address of a sought symbol. The symbol accessor code can be arranged and stored at an address in a separate code section, code section two (**304**), for example. However, as shown, the symbol accessor code **332** is arranged and stored at an address in the patch manager code section **308**. The system **300** further comprises a first location for storage of the symbol accessor code address. The first location can be a code section in the code storage section **112**, or in a separate memory section of the wireless device (not shown). The first location can also be arranged in the same code section as the read-write data. As shown, the first location **334** is stored in the patch manager code section **308** with the read-write data **330**, the symbol offset address table **328**, the code section address table **326**, and the symbol accessor code **332**, and the patch library (patch symbol library) **336**.

[**0073**] The symbol accessor code accesses the code section address table and symbol offset address tables to calculate, or find the address of a sought symbol in memory. That is, the symbol accessor code calculates the address of the sought symbol using a corresponding symbol identifier and a corresponding code section identifier. For example, if the "X" symbol in symbol library one is sought, the symbol accessor is invoked to seek the symbol identifier (symbol ID) "N_1", corresponding to the "X" symbol (see **FIG. 7**). The symbol accessor code consults the symbol offset address table to determine that the "X_1" symbol identifier has an offset of (03) from the start of code section one (see **FIG. 6**). The symbol accessor code is invoked to seek the code section identifier "CS_1", corresponding to code section one. The symbol accessor code consults the code section address table to determine the start address associated with code section identifier (code section ID) "CS_1". In this manner, the symbol accessor code determines that the symbol identifier "X_1" is offset (03) from the address of (00100), or is located at address (00103).

[**0074**] The symbol "X" is a reserved name since it is a part of the actual code. In other words, it has an absolute data associated with it. The data may be an address or a value. The symbol identifier is an alias created to track the symbol. The symbol offset address table and the code section address table both work with identifiers to avoid confusion with reserved symbol and code section names. It is also possible that the same symbol name is used across many symbol libraries. The use of identifiers prevents confusion between these symbols.

[**0075**] Returning to **FIG. 1**, the system **300** further comprises a read-write volatile memory **114**, typically random access memory (RAM). The read-write data **330**, code section address table **326**, the symbol offset address table **328**, the symbol accessor code **332**, and the symbol accessor code address **334** are loaded into the read-write volatile memory **114** from the patch manager code section for access during execution of the system software. As is well known, the access times for code stored in RAM is significantly less than the access to a nonvolatile memory such as Flash.

[**0076**] Returning to **FIG. 3**, it can be noted that the symbol libraries need not necessarily fill the code sections into which they are arranged, although the memory blocks are sized to exactly accommodate the corresponding code sections stored within. Alternately stated, each of the second plurality of code sections has a size in bytes that accommodates the arranged symbol libraries, and each of the contiguously addressed memory blocks have a size in bytes that accommodates corresponding code sections. For example, code section one **(302)** may be a 100 byte section to accommodate a symbol library having a length of 100 bytes. The first memory block would be 100 bytes to match the byte size of code section one. However, the symbol library loaded into code section **1** may be smaller than 100 bytes. As shown in **FIG. 3**, code section one **(302)** has an unused section **340**, as symbol library one **(310)** is less than 100 bytes. Thus, each of the second plurality of code sections may have a size larger than the size needed to accommodate the arranged symbol libraries. By “oversizing” the code sections, larger updated symbol libraries can be accommodated.

[**0077**] Contiguously addressed memory blocks refers to partitioning the physical memory space into logical blocks of variable size. Code sections and memory blocks are terms that are essentially interchangeable when the code section is stored in memory. The concept of a code section is used to identify a section of code that is perhaps larger than the symbol library, or the collection of symbol libraries in the code section as it is moved and manipulated.

[**0078**] As seen in **FIG. 3**, the system **300** includes a patch symbol library, which will be referred to herein as patch library **336**, to arrange new code sections in the code storage section with the current code sections. The arrangement of new code sections with current code sections in the code storage section forms updated executable system software. The patch manager **336** not only arranges new code sections in with the current code sections, it also replaces code sections with updated code sections.

[**0079**] Returning to **FIG. 4**, the file system section **110** of memory **108** receives new code sections, such as new code section **450** and updated patch manager code section **452**. The file system section also receives a first patch manager run time instruction (PMRTI) **454** including instructions for arranging the new code sections with the current code sections. As seen in **FIG. 1**, an airlink interface **150** receives new, or updated code sections, as well as the first PMRTI. Although the airlink interface **150** is being represented by an antenna, it should be understood that the airlink interface would also include an RF transceiver, baseband circuitry, and demodulation circuitry (not shown). The file system section **110** stores the new code sections received via the airlink interface **150**. The patch library **336**, executing from read-write volatile memory **114**, replaces a first code section in the code storage section, code section n **(306)** for example, with the new, or updated code section **450**, in response to the first PMRTI **454**. Typically, the patch manager code section **308** is replaced with the updated patch manager code section **452**. When code sections are being replaced, the patch library **336** over-writes the first code section, code section n **(306)** for example, in the code storage section **112** with the updated code sections, code section **450** for example, in the file system section **110**. In the extreme case, all the code sections in code storage section **112** are replaced with updated code sections. That is, the FSS **110** receives a second plurality of updated code sections (not shown), and the patch library **336** replaces the second plurality of code sections in the code storage section **112** with the second plurality of updated code sections. Of course, the FSS **110** must be large enough to accommodate the second plurality of updated code sections received via the airlink interface.

[**0080**] As noted above, the updated code sections being received may include read-write data code sections, code section address table code sections, symbol libraries, symbol offset address table code sections, symbol accessor code sections, or a code section with a new patch library. All these code sections, with their associated symbol libraries and symbols, may be stored as distinct and independent code sections. Then each of these code sections would be replaced with a unique updated code section. That is, an updated read-write code section would be received and would replace the read-write code section in the code storage section. An updated code section address table code section would be received and would replace the code section address table code section in the code storage section. An updated symbol offset address table code section would be received and would replace the symbol offset address table code section in the code storage section. An updated symbol accessor code section would be received and would replace the symbol accessor code section in the code storage section. Likewise, an updated patch manager code section (with a patch library) would be received and would replace the patch manager code section in the code storage section.

[**0081**] However, the above-mentioned code sections are typically bundled together in the patch manager code section. Thus, the read-write code section in the code storage section is replaced with the updated read-write code section from the file system section **110** when the patch manager code section **308** is replaced with the updated patch manger code section **450**. Likewise, the code section address table, the symbol offset address table, the symbol accessor code sections, as well as the patch library are replaced when the updated patch manager code section **450** is installed. The arrangement of the new read-write data, the new code section address table, the new symbol offset address table, the new symbol accessor code, and the new patch library as the updated patch manager code section **450**, together with the current code sections in the code storage section, forms updated executable system software.

[**0082**] When the file system section **110** receives an updated symbol accessor code address, the patch manager replaces the symbol accessor code address in the first location in memory with updated symbol accessor code address. As noted above, the first location in memory **334** is typically in the patch manager code section (see **FIG. 3**).

[**0083**] As seen in **FIG. 3**, the patch library **308** is also includes a compactor, or a compactor symbol library **342**.

The compactor **342** can also be enabled as a distinct and independent code section, however as noted above, it is useful and efficient to bundle the functions associated with system software upgrades into a single patch manager code section. Generally, the compactor **342** can be said to resize code sections, so that new sections can be arranged with current code sections in the code storage section **112**.

[**0084**] With the organization, downloading, and compaction aspects of the invention now established, the following discussion will center on the wireless communications device dynamic instruction set execution system **300**. The system **300** comprises executable system software and system data differentiated into code sections, as discussed in great detail, above. Further, the system **300** comprises dynamic instruction sets for operating on the system data and the system software, and controlling the execution of the system software. As seen in **FIG. 4**, a dynamic instruction set **470** is organized into the first PMRTI **454**. As seen in **FIG. 3**, the system also comprises a run-time engine for processing the dynamic instruction sets, enabled as run-time library **370**. As with the compactor library **342** and patch library **336** mentioned above, the run-time library **370** is typically located in the patch manager code section **308**. However, the run-time library **370** could alternately be located in another code section, for example the first code section **304**.

[**0085**] The dynamic instruction sets are a single, or multiple sets of instructions that include conditional operation code, and generally include data items. The run-time engine reads the operation code and determines what operations need to be performed. Operation code can be conditional, mathematical, procedural, or logical. The run-time engine, or run-time library **370** processes the dynamic instruction sets to perform operations such as mathematical or logical operations. That is, the run-time engine reads the dynamic instruction set **470** and performs a sequence of operations in response to the operation code. Although the dynamic instruction sets are not limited to any particular language, the operation code is typically a form of machine code, as the wireless device memory is limited and execution speed is important. The operation code is considered conditional in that it analyzes a data item and makes a decision as a result of the analysis. The run-time engine may also determine that an operation be performed on data before it is analyzed.

[**0086**] For example, the operation code may specify that a data item from a wireless device memory be compared to a predetermined value. If the data item is less than the predetermined value, the data item is left alone, and if the data item is greater than the predetermined value, it is replaced with the predetermined value. Alternately, the operation code may add a second predetermined value to a data item from the wireless device memory, before the above-mentioned comparison operation is performed.

[**0087**] As mentioned above, the file system section nonvolatile memory **110** receives the dynamic instruction sets through an interface such as the airlink **150**. As shown in **FIG. 1**, the interface can also be radio frequency (RF) hardline **160**. Then, the PMRTI can be received by the FSS **110** without the system software being operational, such as in a factory calibration environment. The PMRTI can also be received via a logic port interface **162** or an installable memory module **164**. The memory module **164** can be installed in the wireless device **104** at initial calibration, installed in the field, or installed during factory recalibration. Although not specially shown, the PMRTI can be received via an infrared or Bluetooth interfaces.

[**0088**] **FIGS. 8***a* and **8***b* are depictions of instructions being accessed by the run-time engine **370**. Shown in **FIG. 8***a* is a first instruction **800**, a second instruction **802**, and a jth instruction **804**, however, the dynamic instruction set is not limited to any particular number of instructions. The length of the operation code in each instruction is fixed. The run-time engine **370** captures the length of the instruction, as a measure of bytes or bits, determine if the instruction includes data items. The remaining length of the instruction, after the operation code is subtracted, includes the data items. The run-time engine extracts the data items from the instruction. As shown, the length **806** of the first instruction **800** is measured and data items **808** are extracted. Note that not all instructions necessary include data items to be extracted. The run-time engine **370** uses the extracted data **808** in performing the sequence of operations responsive to the operation code **810** in instruction **800**.

[**0089**] **FIG. 8***b* is a more detailed depiction of the first instruction **800** of **FIG. 8***a*. Using the first instruction **800** as an example, the instruction includes operation code **810** and data **808**. The instruction, and more specifically, the data item section **808** includes symbol identifiers, which act as a link to symbols in the wireless device code sections. As explained in detail above, the symbol identifiers are used with the code section address table **326** (see **FIG. 5**) and the symbol offset address table **328** (see **FIG. 7**) to locate the symbol corresponding to the symbol identifier. As shown, a symbol identifier "X_1" is shown in the first instruction **800**. The symbol offset address table **328** locates the corresponding symbol in a code section with the "CS_1" identifier and an offset of "3". The code section address table **326** gives the start address of code section one (**302**). In this manner, the symbol "X" is found (see **FIG. 6**).

[**0090**] After the run-time engine locates symbols corresponding to the received symbol identifiers using the code section address table and symbol offset address table, it extracts data when the located symbols are data items. For example, if the symbol "X" is a data item in symbol library one (**310**), the run-time engine extracts it. Alternately, the "X" symbol can be operation code, and the run-time engine executes the symbol "X" when it is located.

[**0091**] PMRTI can be used to update system data, or system data items. In some aspects of the invention system data is stored in a code section in the file system section **110**, code section **472** for example, see **FIG. 4**. The run-time engine accesses system data from code section **472** and analyzes the system data. The run-time engine processes the operation code of the dynamic instruction sets to perform mathematical or logical operation on data items, as described above. After the operation, the run-time engine processes the instructions to create updated system data. Note that the updated system data may include unchanged data items in some circumstances. The system data in the second code section **472** is replaced with the updated system data in response to the operation code. Thus, by the processing of instruction by the run-time engine, the system software is controlled to execute using the updated system data in code section **472**. In this manner, specifically targeted symbols in the system software can be updated, without replacing entire code sections. By the same process, the system data can be replaced in a code section in the code storage section **112**. For example, the system data can be stored in the third code section **344**, and the run-time engine can replace the system data in the third code section with updated system data in response to the operation code.

[**0092**] PMRTI can also be used to update data items in volatile memory **114**. As an example, the volatile memory **114** accept read-write data **330**, see **FIG. 1**. The read-write data can be from one, or from a plurality of code sections in the code storage section **112** and/or the FSS **110**. The run-time engine accesses the read-write data, analyzes the read-write data **330**, creates updated read-write data, and replaces the read-write data **330** in the volatile memory **114** with the updated read-write data in response to the operation code. Then, the system software is controlled to execute using the updated read-write data in volatile memory **114**.

[**0093**] In some aspects of the invention, the run-time engine monitors the execution of the system software. Performance monitoring is broadly defined to include a great number of wireless device activities. For example, data such as channel parameters, channel characteristics, system stack, error conditions, or a record of data items in RAM through a sequence of operations leading to a specific failure condition or reduced performance condition can be collected. It is also possible to use dynamic instructions sets to analyze collected performance data, provide updated data variants, and recapture data to study possible solutions to the problem. Temporary fixes can also be provisioned using PMRTI processes.

[**0094**] More specifically, the run-time engine collects performance data, and stores the performance data in the file system section in response to the operation code. Then, the system software is controlled to execute by collecting the performance data for evaluation of the system software. Evaluation can occur as a form of analysis performed by dynamic instruction set operation code, or it can be performed outside the wireless device. In some aspects of the invention, the run-time engine accesses the performance data that has been collected from the file system section and transmits the performance data via an airlink interface in response to the operation code. Collecting performance data from wireless devices in the field permits a manufacturer to thoroughly analyze problems, either locally or globally, without recalling the devices.

[**0095**] In some aspects of the invention, file system section **110** receives a patch manager run time instruction including a new code section. For example, a new code section **474** is shown in **FIG. 4**. Alternately, the new code section can be independent of the PMRTI, such as new code section n (**450**). For example, the new code section n (**450**) may have been received in earlier airlink communications, or have been installed during factory calibration. The run-time engine adds the new code section **474** (**450**) to the code storage section in response to the operation code. In some aspects of the invention, the new code section is added to an unused block in the code storage section **112**. Alternately, a compaction operation is required. Then, the system software is controlled to execute using the new code section **474** (**450**). In other aspects of the invention, the PMRTI **454** includes an updated code section **474**. Alternately, the new code section **450** is an updated code section independent of the PMRTI. The run-time engine replaces a code section in the code storage section, code section two (**304**) for an example, with the updated code section **474** (**450**) in response to the operation code. The system software is controlled to execute using the updated code section **474** (**450**). In some aspects of the invention a compaction operation is required to accommodate the updated code section. Alternately, the updated code section is added to an unused or vacant section of the code storage section.

[**0096**] As explained above, the addition of a new code section or the updating of a code section typically requires the generation of a new code section address table, as these operation involve either new and/or changed code section start addresses. Further, a compaction operation also requires a new code section address table. The compaction operations may be a result of the operation of the compactor **342**, explained above, or the result of PMRTI instructions that supply details as to how the compaction is to occur. When the PMRTI includes downloading and compaction instructions, the PMRTI typically also includes a new code section address table that becomes valid after the downloading and compaction operations have been completed.

[**0097**] **FIG. 9** is a schematic block diagram including features of **FIGS. 1-8*b*** presented for the purpose of illustrating the present invention system for managing system software download operations in a wireless communications device. The system **900** comprises an airlink interface **902**, equivalent the airlink interface **150** of **FIG. 1**, and executable system software and system data differentiated into code sections stored in nonvolatile memory permanent storage **904**, equivalent to memory **108** of **FIG. 1**. The nonvolatile permanent storage **904** includes a file system section **906** and code storage section **908**.

[**0098**] Dynamic instruction sets **910** for managing the downloading of system software updates are received via the airlink interface **902**. The dynamic instruction sets **910**, as well as new code sections **912**, are part of patch manager run time instructions **914**. Typically, the dynamic instruction sets **910** are stored in the file system section **906**. A run-time engine, or run-time library **916** processes the dynamic instruction sets **910**. As mentioned above, the run-time library **916** is typically part of the patch manager code section **918**. The executable system software and system data (code sections in permanent memory **904**) are updated in response to processing the dynamic instruction sets **910**. The dynamic instruction sets **910** include functional managers selected from the group including recovery status monitoring, back up, compacting, and update ordering.

[**0099**] The system **900** further comprises a recovery status table **920** cross-referencing new code section identifiers with their update status. The recovery status table **920** is shown as a separate code section in the file system section **906**. In some aspects of the invention the recovery status table **920** is loaded into volatile memory **922** when the system **900** is turned on. The table **920** is updated in volatile memory **922** and restored in permanent memory **904** when the system is turned off.

[**0100**] **FIG. 10** is the schematic block diagram of the system **900** of **FIG. 9** featuring the dynamic instruction set recovery status monitoring manager **1000** aspect of the dynamic instruction sets. The dynamic instruction set recovery status monitoring manager, hereafter referred to as the recovery status monitoring manager **1000**, reads the recovery status table **920** (see dotted arrow "1") in response to rebooting the wireless communications device, to determine if new code sections have been stored in permanent storage.

[0101] **FIG. 11** is a representation depicting an exemplary recovery status table **920** of **FIG. 9**. The table **920** shows that the code sections identified as CS_**1** and CS_**2** have been successfully moved from the file system section **906** to the code storage section **908**. However, the table indicates that it is unknown whether the code section identified as CS_n has been successfully stored. For example, the user may have turned off the wireless device before the storage operation was completed, or the wireless device battery died.

[0102] Returning to **FIG. 10**, recovery status monitoring manager **1000** stores the new code section in permanent storage if the new code sections have not been stored and updates the recovery status table when the new code sections have been stored. For example, the recovery status monitoring manager **1000** stores CS_n (**1002**) in code storage section **908** (see dotted arrow "2"), and then updates the recovery status table so that the CS_n status is changed to "loaded" (not shown). Note, that the patch manger functions mentioned above are typically used in the moving of code sections from the file system section **906** to the code storage section **908**.

[0103] In some aspects of the invention, the recovery status monitoring manager **1000** further determines the risk associated with storing each new code section and, if the risk of storing new code sections is high, takes safety precautions. For example, the recovery status monitoring manager **1000** takes safety precautions such as checking the battery for sufficient power to complete the new code storing process, warning the user of high-risk code storing operations, using prompts to verify user-initiated power downs, and preventing user-initiated power downs. Returning briefly to **FIG. 11**, the risk factor is represented as a column in the recovery status table.

[0104] The storage of some code sections involves the replacement of key code section in the system software with updated code sections. For example, the file system section **906** may receive new code sections such as a boot code section, a patch manager code section, a code section address table, a symbol offset address table, read-write data, and symbol accessor code addresses (not shown). The incomplete storage of any of these code sections may result the wireless device being completely non-operational upon turn-on. That is, the wireless device would likely have to be returned for reprogramming at a service center. Therefore, the recovery status monitoring manager **1000** determines the risk associated with storing each of these new code sections in the file system section, and takes safety precautions accordingly.

[0105] The file system section can potentially receive patch manager run time instructions including a new patch manager code section, CS_n (**1002**) for example. As described above, the patch manger code section includes a patch library for moving code sections in the file system section **906** into permanent storage, typically the code storage section **908**. In some aspects of the invention, the recovery status monitoring manager **1000** maintains a spare patch library **1004** in the file system section **906**. The recovery status monitoring manager **1000** reads the recovery status table **920** to determine if the new patch manager code section has been successfully stored in the code storage section in response to rebooting the wireless communications device. If the new patch manager code section **1002** has not been successfully stored in the code storage section, the spare patch library **1004** is used to move the new patch manager code section **1002** from the file system section **906** to code storage section **908**. Then, the new patch manager code section **1002** can be used for system software operations. Without the spare patch library **1004**, the wireless device would be unable to recover from the incomplete storage of a new patch manager code section.

[0106] **FIG. 12** is the schematic block diagram of the system **900** of **FIG. 9** featuring the dynamic instruction set back up manager **1200** aspect of the dynamic instruction sets. The dynamic instruction set back up manger is hereafter referred to as the back up manger **1200**. As the title suggests, the back up manger provides a system for recovering code sections or system data that has been replaced with code sections that are non-operational with the system software. For example, the file system section **906** receives an updated first code section **1202** to replace a first code section **1204** in the code storage section **908**. The back up manager **1200** moves the first code section **1204** from the code storage section **908** to the file system section **906** (see dotted line "1"), typically using libraries from the patch manger code section **1206**. Using libraries from the patch manger code section **1206**, the updated code section **1202** is moved from the file system section **906** to the code storage section **908** (see dotted line "2"). The back up manager **1200** determines if the updated first code section **1202** in the code storage section **908** operates with the system software within predetermined constraints. The back up manager **1200** replaces the updated first code section **1202** in the code storage section **908** with the first code section **1204** from the file system section **906**, if the updated first code section **1202** is determined to not operate with the system software within the predetermined constraints.

[0107] In some aspects of the invention, the file system section **906** receives a test code section **1208** with predetermined constraints. The back up manager **1200** determines if the updated first code section **1202** in the code storage section **908** operates with the system software within predetermined constraints by executing the test code section with the updated code section. The back up manager records the results of executing the test code section **1208**, and compares the recorded results with the predetermined constraints. In other aspects of the invention the file system section **906** receives an updated code section **1202** with a test code library. Then, the back up manager **1200** executes the test code library from the updated code section. That is, a separate test code section is not required as part of the patch manager run time instruction.

[0108] The file system section **906** can receive the test code section from a variety of sources such as an airlink interface (**902**, see **FIG. 9**), a user operated keyboard interface (not shown), a test port interface such as a logic port, serial port, or RF port, and even a memory module.

[0109] **FIG. 13** is the schematic block diagram of the system **900** of **FIG. 9** featuring the dynamic instruction compaction manager **1300** aspect of the dynamic instruction sets. As explained above, the compaction manager is responsible for manipulating code sections in the code storage section to fit new code sections, or to accommodate updated code sections that are larger than the code sections to be replaced. For example, the file system section **906** receives an updated first code section **1302**, having an updated code section size, to replace a first code section **1304** having a first size smaller than the updated first code section size. The compaction manager **1300** accesses a compaction library **1306** in a patch manager code section **1308** and resizes code sections in the code storage section **908** to accommodate the updated first code section **1302**.

[0110] As with the recovery status monitoring manager, the compaction manager **1300** determines the risk associated with compacting code sections in the code storage section and, if the risk of compacting code sections is high, takes safety precautions. For example, compacting the patch manger code section, or other critical parts of the system software is risky, as the wireless device may not be able to recover from an improper or uncompleted compaction operation. The compaction manager **1300** takes safety precautions such as checking the battery for sufficient power to complete the new code storing process, warning the user of high-risk code storing operations, using prompts to verify user-initiated power downs, and preventing user-initiated power downs.

[0111] **FIG. 14** is the schematic block diagram of the system **900** of **FIG. 9** featuring the dynamic instruction set update ordering manager **1400** aspect of the dynamic instruction sets. When multiple new or updated code sections are to be stored, the update ordering manger **1400** determines the order of storage. For example, the file system section **906** receives the update ordering dynamic instruction sets or update ordering manager **1400** with a plurality of new code sections, such as first new code section **1402**, second new code section **1404**, and third new code section **1406**. The update ordering manager **1400** moves the new code sections **1402-1406** from the file system storage **906** to the code storage section **908** in an order dictated by the ordering instruction **1400**.

[0112] As shown, the second new code section **1404** is moved first (dotted line "1"), the first new code section **1402** is moved second (dotted line "2"), and the third new code section **1406** is moved third (dotted line "3"). The move and store operations are accomplished with the help of libraries form the patch manger code section **1408**. In some aspects of the invention, the ordering manager **1400** determines the risk associated with storing each new code section **1402-1406** and orders the high risk code sections to be moved after lower risk storage sections. In this example, the update ordering manager **1400** has determined that the third new code section **1406** is the most risky to store.

[0113] **FIGS. 15*a*** and **15*b*** are flowcharts illustrating the present invention method for executing dynamic instruction sets in a wireless communications device. Although depicted as a sequence of numbered steps for clarity, no order should be inferred from the numbering (and the numbering in the methods presented below) unless explicitly stated. The method starts at Step **1500**. Step **1501*a*** forms the system software into symbol libraries, each symbol library comprising symbols having related functionality. Step **1501*b*** arranges the symbol libraries into code sections. Step **1502** executes system software. Step **1503** launches a run-time engine. Typically, launching a run-time engine includes invoking a run-time library from a first code section. The run-time engine can be launched from either volatile or nonvolatile memory. Step **1504**, following Step **1503**, receives the dynamic instruction sets. Receiving the dynamic instruction sets in Step **1504** includes receiving the dynamic instruction sets through an interface selected from the group including airlink, radio frequency (RF) hardline, installable memory module, infrared, and logic port interfaces. In some aspects of the invention, receiving the dynamic instruction set in Step **1504** includes receiving a patch manager run time instruction (PMRTI) in a file system section nonvolatile memory.

[0114] Step **1506** processes dynamic instruction sets. Processing dynamic instruction sets includes processing instructions in response to mathematical and logical operations. In some aspects of the invention, Step **1507** (not shown), following the processing of the dynamic instruction sets, deletes dynamic instruction sets. Step **1508** operates on system data and system software. Step **1510**, in response to operating on the system data and system software, controls the execution of the system software.

[0115] Typically, receiving the patch manager run time instructions in Step **1504** includes receiving conditional operation code and data items. Then, processing dynamic instruction sets in Step **1506** includes substeps. Step **1506*a*1** uses the run-time engine to read the patch manager run time instruction operation code. Step **1506*b*** performs a sequence of operations in response to the operation code.

[0116] In some aspects, arranging the symbol libraries into code sections in Step **1501*b*** includes starting symbol libraries at the start of code sections and arranging symbols to be offset from their respective code section start addresses. Then the method comprises further steps. Step **1501*c*** stores the start of code sections at corresponding start addresses. Step **1501*d*** maintains a code section address table (CSAT) cross-referencing code section identifiers with corresponding start addresses. Step **1501*e*** maintains a symbol offset address table (SOAT) cross-referencing symbol identifiers with corresponding offset addresses, and corresponding code section identifiers.

[0117] In some aspects of the invention, receiving the patch manager run time instruction in Step **1504** includes receiving symbol identifiers. Then, the method comprises a further step. Step **1506*a*2** locates symbols corresponding to the received symbol identifiers by using the code section address table and symbol offset address table. Performing a sequence of operations in response to the operation code in Step **1506*b*** includes substeps. Step **1506*b*1** extracts the data when the located symbols are data items. Step **1506*b*2** executes the symbols when the located symbols are instructions.

[0118] In some aspects of the invention, processing dynamic instruction sets in Step **1506*b*1** includes additional substeps. Step **1506*b*1*a*** uses the run-time engine to capture the length of the patch manager run time instruction. Step **1506*b*1*b*** extracts the data items from the patch manager run time instruction, in response to the operation code. Step **1506*b*1*c*** uses the extracted data in performing the sequence of operations responsive to the operation code.

[0119] **FIG. 16** is a flowchart illustrating an exemplary dynamic instruction set operation. Several of the Steps in **FIG. 16** are the same as in **FIG. 15**, and are not repeated here in the interest of brevity. Processing dynamic instruction sets in Step **1606** includes substeps. Step **1606***a* accesses system data stored in a second code section in the file system section. Step **1606***b* analyzes the system data. Step **1606***c* creates updated system data. Then, operating on system data and system software in Step **1608** includes replacing the system data in the second section with the updated system data, and controlling the execution of the system software in Step **1610** includes using the updated system data in the execution of the system software.

[0120] **FIG. 17** is a flowchart illustrating another exemplary dynamic instruction set operation. Several of the Steps in **FIG. 17** are the same as in **FIG. 15**, and are not repeated here in the interest of brevity. Step **1701***c* stores a plurality of code sections in a code storage section nonvolatile memory. Processing dynamic instruction sets in Step **1706** includes substeps. Step **1706***a* accesses system data stored in a third code section in the code storage section (CSS). Step **1706***b* analyzes the system data. Step **1706***c* creates updated system data. Operating on the system data and system software in Step **1708** includes replacing the system data in the third code section with the updated system data. Controlling the execution of the system software in Step **1710** includes using the updated system data in the execution of the system software.

[0121] **FIG. 18** is a flowchart illustrating a third exemplary dynamic instruction set operation. Several of the Steps in **FIG. 18** are the same as in **FIG. 15**, and are not repeated here in the interest of brevity. Step **1801***c* stores a plurality of code sections in a code storage section nonvolatile memory. Step **1801***d* loads read-write data into volatile memory. Processing dynamic instruction sets in Step **1806** includes substeps. Step **1806***a* accesses the read-write data in volatile memory. Step **1806***b* analyzes the read-write data. Step **1806***c* creates updated read-write data. Operating on the system data and system software in Step **1808** includes replacing the read-write data in volatile memory with the updated read-write data. Controlling the execution of the system software in Step **1810** includes using the updated read-write data in the execution of the system software.

[0122] **FIG. 19** is a flowchart illustrating a fourth exemplary dynamic instruction set operation. Several of the Steps in **FIG. 19** are the same as in **FIG. 15**, and are not repeated here in the interest of brevity. Processing dynamic instruction sets includes substeps. Step **1906***a,* in response to the operation code, monitors the execution of the system software. Step **1906***b* collects performance data. Step **1906***c* stores the performance data. Step **1906***d* transmits the stored data via an airlink interface. Operating on the system data and system software in Step **1908** includes using the performance data in the evaluation of system software. Step **1910** controls the execution of the system software.

[0123] **FIG. 20** is a flowchart illustrating a fifth exemplary dynamic instruction set operation. Several of the Steps in **FIG. 20** are the same as in **FIG. 15**, and are not repeated here in the interest of brevity. Step **2001***c* stores a plurality of code sections in a code storage section nonvolatile memory. Receiving patch manager run time instructions in Step **2003** includes receiving a new code section. Operating on the system data and system software in Step **2008** includes adding the new code section to the code storage section, and controlling the execution of the system software in Step **2010** includes using the new code section in the execution of the system software.

[0124] Alternately, receiving a new code section in Step **2003** includes receiving an updated code section. Then, operating on the system data and system software in Step **2008** includes replacing a fourth code section in the code storage section with the updated code section.

[0125] **FIG. 21** is a flowchart illustrating the present invention method for managing system software download operations in a wireless communications device. The method starts at Step **2100**. Step **2102** forms the system software into symbol libraries, each symbol library comprising symbols having related functionality. Step **2104** arranges the symbol libraries into code sections stored in a code storage section of nonvolatile memory. Step **2106** executes system software. Step **2108** launches a run-time engine. Step **2110** receives patch manager run time instructions (PMRTIs) in a file system section (FSS) nonvolatile memory, the patch manger run time instructions including dynamic instruction sets and new code sections. Step **2112** processes dynamic instruction sets. Step **2114**, in response to processing the dynamic instruction sets, manages the downloading of system software updates received via an airlink interface. Step **2116** executes updated system software.

[0126] Managing the downloading of system software updates received via an airlink interface in Step **2114** includes processing dynamic instruction set management functions selected from the group including recovery status monitoring, back up, compacting, and update ordering.

[0127] **FIG. 22** is a flowchart illustrating additional details of **FIG. 21** that highlight the recovery status monitoring aspect of the invention. Processing recovery status monitoring dynamic instruction sets in Step **2112** includes substeps. Step **2200** maintains a recovery status table cross-referencing new code section identifiers with their update status. Step **2202**, in response to rebooting the wireless communications device, reads the recovery status table to determine if new code sections have been stored in permanent storage. Step **2204**, if the new code sections have not been stored, stores the new code section in permanent storage. Step **2206** updates the recovery status table when the new code sections have been stored.

[0128] Some aspects of the invention include additional steps. Step **2202***a* determines the risk associated with storing each new code section. Step **2202***b* takes safety precautions if the risk of storing new code sections is high. Taking safety precautions in Step **2202***b* includes taking safety precautions selected from the group of checking the battery for sufficient power to complete the new code storing process, warning the user of high-risk code storing operations, using prompts to verify user-initiated power downs, and preventing user-initiated power downs.

[0129] Determining the risk associated with storing each new code section in Step **2202***a* includes determining the risk associated with new code sections selected from the group including a boot code section, a patch manager code section, a code section address table, a symbol offset address table, read-write data, and symbol accessor code addresses.

[0130] In some aspects of the invention, forming the system software into symbol libraries (Step **2102**, see **FIG. 21**) includes forming a patch manager code section with a patch library for moving code sections in the file system section into permanent storage. Receiving the patch manager run time instructions in a file system section nonvolatile memory (Step **2110**, se **FIG. 21**) includes receiving a new patch manager code section. Then, processing recovery status monitoring dynamic instruction sets includes further substeps. Step **2202***c* maintains a spare patch library in the file system section. Step **2202** reads the recovery status table to determine if the new patch manager code section has been successfully stored in the code storage section, in response to rebooting the wireless communications device. Step **2202***d* uses the spare patch library to move the new patch manager code section from the file system section to code storage section, if the new patch manager code section has not been successfully stored in the code storage section.

[0131] **FIG. 23** is a flowchart illustrating additional details of **FIG. 21** that highlight the back up aspect of the invention. Receiving new code sections (in Step **2110**, see **FIG. 21**) includes receiving an updated first code section to replace a first code section in the code storage section. Then, processing back up management dynamic instruction sets in Step **2112** includes substeps. Step **2300** moves the first code section from the code storage section to the file system section. Step **2302** determines if the updated first code section in the code storage section operates with the system software within predetermined constraints. Step **2304** replaces the updated first code section in the code storage section with the first code section from the file system section, if the updated first code section is determined to not operate with the system software within the predetermined constraints.

[0132] In some aspects of the invention, receiving new code sections (Step **2110**, **FIG. 21**) includes receiving a test code section with predetermined constraints. Then, determining if the updated first code section in the code storage section operates with the system software within predetermined constraints in Step **2302** includes substeps. Step **2302***a* executes the test code section with the updated code section. Step **2302***b* records the results of executing the test code section. Step **2302***c* compares the recorded results with the predetermined constraints.

[0133] In some aspects, receiving new code sections (Step **2110**, **FIG. 21**) includes receiving an updated code section with a test code library. Then, determining if the updated first code section in the code storage section operates with the system software within predetermined constraints in Step **2302** includes executing the test code library from the updated code section. Receiving new code sections (Step **2110**, **FIG. 21**) includes receiving a test code section with predetermined constraints from a source selected from the group including an airlink interface, a user operated keyboard interface, and a test port interface.

[0134] **FIG. 24** is a flowchart illustrating additional details of **FIG. 21** that highlight the compaction aspect of the invention. Receiving new code sections (Step **2110**, **FIG. 21**) includes receiving an updated first code section, having an updated code section size, to replace a first code section having a first size smaller than the updated first code section size. Processing compaction management dynamic instruction sets in Step **2112** includes substeps. Step **2400** accesses a compaction library in a patch manager code section. Step **2402** resizes code sections in the code storage section to accommodate the updated first code section.

[0135] In some aspects of the invention a further step, Step **2400***a* determines the risk associated with compacting code sections in the code storage section. Step **2400***b* takes safety precautions if the risk of compacting code sections is high. Taking safety precautions in Step **2400***b* includes taking safety precautions selected from the group of checking the battery for sufficient power to complete the new code storing process, warning the user of high-risk code storing operations, using prompts to verify user-initiated power downs, and preventing user-initiated power downs.

[0136] **FIG. 25** is a flowchart illustrating additional details of **FIG. 21** that highlight the update ordering aspect of the invention. Receiving dynamic instruction sets (Step **2110**, **FIG. 21**) includes receiving an update ordering instruction, and receiving new code sections includes receiving a plurality of new code sections. Processing update ordering management dynamic instruction sets in Step **2112** includes moving the new code sections from the file system storage to the code storage section in an order dictated by the ordering instruction.

[0137] In some aspects of the invention, processing update ordering dynamic instruction sets in Step **2112** includes substeps. Step **2500** determines the risk associated with storing each new code section. Step **2502** orders the high risk code sections to be moved after lower risk storage sections.

[0138] A system and method have been provided for executing dynamic instruction sets in a wireless communications device, so as to aid in the process of managing the downloading of software upgrades. The system is easily updateable because of the arrangement of symbol libraries in code sections, with tables to access the start addresses of the code sections in memory and the offset addresses of symbols in the symbol libraries. The use on dynamic instruction sets permits custom modifications to be performed to each wireless device, based upon specific characteristics of that device. A few general examples have been given illustrating possible uses for the dynamic instructions sets. However, the present invention is not limited to just these examples. Other variations and embodiments of the invention will occur to those skilled in the art.

We claim:

1. In a wireless communications device, a method for managing system software download operations, the method comprising:

executing system software;

launching a run-time engine;

processing dynamic instruction sets; and,

in response to processing the dynamic instruction sets, managing the downloading of system software updates received via an airlink interface.

2. The method of claim 1 further comprising:

executing updated system software.

3. The method of claim 1 further comprising:

forming the system software into symbol libraries, each symbol library comprising symbols having related functionality;

arranging the symbol libraries into code sections stored in a code storage section of nonvolatile memory; and,

receiving patch manager run time instructions (PMRTIs) in a file system section (FSS) nonvolatile memory, the patch manger run time instructions including dynamic instruction sets and new code sections.

4. The method of claim 3 wherein managing the downloading of system software updates received via an airlink interface includes processing dynamic instruction set management functions selected from the group including recovery status monitoring, back up, compacting, and update ordering.

5. The method of claim 4 wherein processing recovery status monitoring dynamic instruction sets includes:

maintaining a recovery status table cross-referencing new code section identifiers with their update status;

in response to rebooting the wireless communications device, reading the recovery status table to determine if new code sections have been stored in permanent storage;

if the new code sections have not been stored, storing the new code section in permanent storage; and,

when the new code sections have been stored, updating the recovery status table.

6. The method of claim 5 wherein processing recovery status monitoring dynamic instruction sets further includes:

determining the risk associated with storing each new code section; and,

if the risk of storing new code sections is high, taking safety precautions.

7. The method of claim 6 wherein taking safety precautions includes taking safety precautions selected from the group of checking the battery for sufficient power to complete the new code storing process, warning the user of high-risk code storing operations, using prompts to verify user-initiated power downs, and preventing user-initiated power downs.

8. The method of claim 7 wherein determining the risk associated with storing each new code section includes determining the risk associated with new code sections selected from the group including a boot code section, a patch manager code section, a code section address table, a symbol offset address table, read-write data, and symbol accessor code addresses.

9. The method of claim 8 wherein forming the system software into symbol libraries includes forming a patch manager code section with a patch library for moving code sections in the file system section into permanent storage;

wherein receiving the patch manager run time instructions in a file system section nonvolatile memory includes receiving a new patch manager code section;

wherein processing recovery status monitoring dynamic instruction sets further includes:

maintaining a spare patch library in the file system section;

in response to rebooting the wireless communications device, reading the recovery status table to determine if the new patch manager code section has been successfully stored in the code storage section; and,

using the spare patch library to move the new patch manager code section from the file system section to code storage section, if the new patch manager code section has not been successfully stored in the code storage section.

10. The method of claim 4 wherein receiving new code sections includes receiving an updated first code section to replace a first code section in the code storage section;

wherein processing back up management dynamic instruction sets includes:

moving the first code section from the code storage section to the file system section;

determining if the updated first code section in the code storage section operates with the system software within predetermined constraints; and,

replacing the updated first code section in the code storage section with the first code section from the file system section, if the updated first code section is determined to not operate with the system software within the predetermined constraints.

11. The method of claim 10 wherein receiving new code sections includes receiving a test code section with predetermined constraints;

wherein determining if the updated first code section in the code storage section operates with the system software within predetermined constraints includes:

executing the test code section with the updated code section;

recording the results of executing the test code section; and,

comparing the recorded results with the predetermined constraints.

12. The method of claim 11 wherein receiving new code sections includes receiving an updated code section with a test code library; and,

wherein determining if the updated first code section in the code storage section operates with the system software within predetermined constraints includes executing the test code library from the updated code section.

13. The method of claim 11 wherein receiving new code sections includes receiving a test code section with predetermined constraints from a source selected from the group including an airlink interface, a user operated keyboard interface, and a test port interface.

14. The method of claim 4 wherein receiving new code sections includes receiving an updated first code section, having an updated code section size, to replace a first code section having a first size smaller than the updated first code section size;

wherein processing compaction management dynamic instruction sets includes:

accessing a compaction library in a patch manager code section; and,

resizing code sections in the code storage section to accommodate the updated first code section.

15. The method of claim 14 wherein processing compaction management dynamic instruction sets further includes:

determining the risk associated with compacting code sections in the code storage section; and,

if the risk of compacting code sections is high, taking safety precautions.

16. The method of claim 15 wherein taking safety precautions includes taking safety precautions selected from the group of checking the battery for sufficient power to complete the new code storing process, warning the user of high-risk code storing operations, using prompts to verify user-initiated power downs, and preventing user-initiated power downs.

17. The method of claim 4 wherein receiving dynamic instruction sets includes receiving an update ordering instruction, and wherein receiving new code sections includes receiving a plurality of new code sections; and,

wherein processing update ordering management dynamic instruction sets includes moving the new code sections from the file system storage to the code storage section in an order dictated by the ordering instruction.

18. The method of claim 17 wherein processing update ordering dynamic instruction sets further includes:

determining the risk associated with storing each new code section; and,

ordering the high risk code sections to be moved after lower risk storage sections.

19. In a wireless communications device, a method for managing system software download operations, the method comprising:

executing system software;

launching a run-time engine;

processing dynamic instruction sets; and,

in response to processing the dynamic instruction sets, managing the downloading of system software updates received via an airlink interface using management functions selected from the group including recovery status monitoring, back up, compacting, and update ordering.

20. In a wireless communications device, a system for managing system software download operations, the system comprising:

an airlink interface;

executable system software and system data differentiated into code sections stored in nonvolatile memory permanent storage;

dynamic instruction sets for managing the downloading of system software updates received via the airlink interface; and,

a run-time engine for processing the dynamic instruction sets.

21. The system of claim 20 wherein the executable system software and system data are updated in response to processing the dynamic instruction sets.

22. The system of claim 20 wherein the executable system software is formed into symbol libraries, each symbol library comprising symbols having related functionality, arranged into code sections stored in a code storage section; and,

the system further comprising:

a file system section of nonvolatile memory receiving patch manager run time instructions (PMRTIs) including dynamic instruction sets and new code sections.

23. The system of claim 22 wherein the dynamic instruction sets include functional managers selected from the group including recovery status monitoring, back up, compacting, and update ordering.

24. The system of claim 23 further comprising:

a recovery status table cross-referencing new code section identifiers with their update status; and,

wherein the dynamic instruction set recovery status monitoring manager reads the recovery status table in response to rebooting the wireless communications device, to determine if new code sections have been stored in permanent storage, wherein the dynamic instruction set recovery status monitoring manager stores the new code section in permanent storage if the new code sections have not been stored and updates the recovery status table when the new code sections have been stored.

25. The system of claim 24 wherein the dynamic instruction set recovery status monitoring manager further determines the risk associated with storing each new code section and, if the risk of storing new code sections is high, takes safety precautions.

26. The system of claim 25 wherein the dynamic instruction set recovery status monitoring manager takes safety precautions selected from the group of checking the battery for sufficient power to complete the new code storing process, warning the user of high-risk code storing operations, using prompts to verify user-initiated power downs, and preventing user-initiated power downs.

27. The system of claim 26 wherein the file system section receives new code sections selected from the group including a boot code section, a patch manager code section, a code section address table, a symbol offset address table, read-write data, and symbol accessor code addresses; and,

wherein the dynamic instruction set recovery status monitoring manager determines the risk associated with storing each of the new code sections in the file system section.

28. The system of claim 27 wherein the executable system software includes a patch manager code section with a patch library for moving code sections in the file system section into permanent storage;

wherein the file system section receives patch manager run time instructions including a new patch manager code section; and,

wherein the dynamic instruction set recovery status monitoring manager maintains a spare patch library in the file system section, reads the recovery status table to determine if the new patch manager code section has been successfully stored in the code storage section in response to rebooting the wireless communications device, and uses the spare patch library to move the new patch manager code section from the file system section to code storage section, if the new patch manager code section has not been successfully stored in the code storage section.

29. The system of claim 23 wherein the file system section receives an updated first code section to replace a first code section in the code storage section; and,

wherein the dynamic instruction set back up manager moves the first code section from the code storage section to the file system section, determines if the updated first code section in the code storage section operates with the system software within predetermined constraints, and replaces the updated first code section in the code storage section with the first code section from the file system section, if the updated first code section is determined to not operate with the system software within the predetermined constraints.

30. The system of claim 29 wherein the file system section receives a test code section with predetermined constraints; and,

wherein the dynamic instruction set back up manager determines if the updated first code section in the code storage section operates with the system software within predetermined constraints by executing the test code section with the updated code section, recording the results of executing the test code section, and comparing the recorded results with the predetermined constraints.

31. The system of claim 30 wherein the file system section receives an updated code section with a test code library; and,

wherein the dynamic instruction set back up manager executes the test code library from the updated code section.

32. The system of claim 30 wherein the file system section receives the test code section from a source selected from the group including the airlink interface, a user operated keyboard interface, and a test port interface.

33. The system of claim 23 wherein the file system section receives an updated first code section, having an updated code section size, to replace a first code section having a first size smaller than the updated first code section size; and,

wherein the dynamic instruction set compaction manager accesses a compaction library in a patch manager code section and resizes code sections in the code storage section to accommodate the updated first code section.

34. The system of claim 33 wherein the dynamic instruction set compaction manager determines the risk associated with compacting code sections in the code storage section and, if the risk of compacting code sections is high, takes safety precautions.

35. The system of claim 34 wherein the dynamic instruction set compaction manager takes safety precautions selected from the group of checking the battery for sufficient power to complete the new code storing process, warning the user of high-risk code storing operations, using prompts to verify user-initiated power downs, and preventing user-initiated power downs.

36. The system of claim 23 wherein the file system section receives a plurality of new code sections with the update ordering dynamic instruction sets; and,

wherein the dynamic instruction set update ordering manager moves the new code sections from the file system storage to the code storage section in an order dictated by the ordering instruction.

37. The system of claim 36 wherein the dynamic instruction set update ordering manager determines the risk associated with storing each new code section and orders the high risk code sections to be moved after lower risk storage sections.

38. In a wireless communications device, a system for managing system software download operations, the system comprising:

an airlink interface;

executable system software and system data differentiated into code sections stored in nonvolatile memory permanent storage and updated in response to processing the dynamic instruction sets;

dynamic instruction sets for managing the downloading of system software updates received via the airlink interface using functional managers selected from the group including recovery status monitoring, back up, compacting, and update ordering;

a run-time engine for processing the dynamic instruction sets; and,

a file system section of nonvolatile memory receiving patch manager run time instructions (PMRTIs) including dynamic instruction sets and new code sections.

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