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(54) SELF-FORMING COMMUNICATION AND CONTROL SYSTEM

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(60) Provisional application No. 63/626,222, filed on Jan. 29, 2024.

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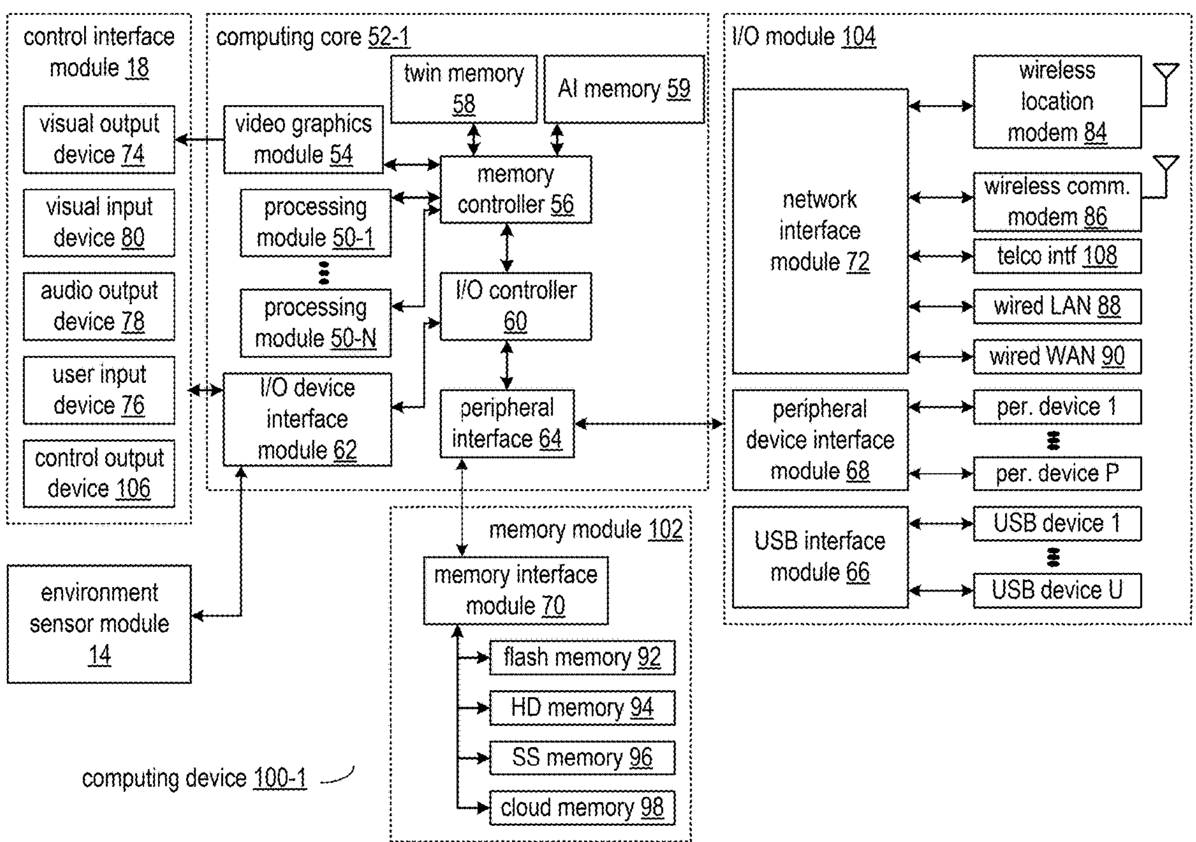
CPC ***G16H 40/40*** (2018.01); ***G16H 10/60*** (2018.01); ***G16H 20/10*** (2018.01)

(57) **ABSTRACT**

A method for execution by a computer includes detecting an object of a medical treatment environment based on environment signaling of the medical treatment environment to produce identified medical treatment devices and object profile information. The method further includes facilitating object tracking of the identified medical treatment devices within the medical treatment environment. The method further includes storing patient care tracking information for the identified medical treatment devices within a digital twin memory to facilitate subsequent management of patient care provided the identified medical treatment devices.



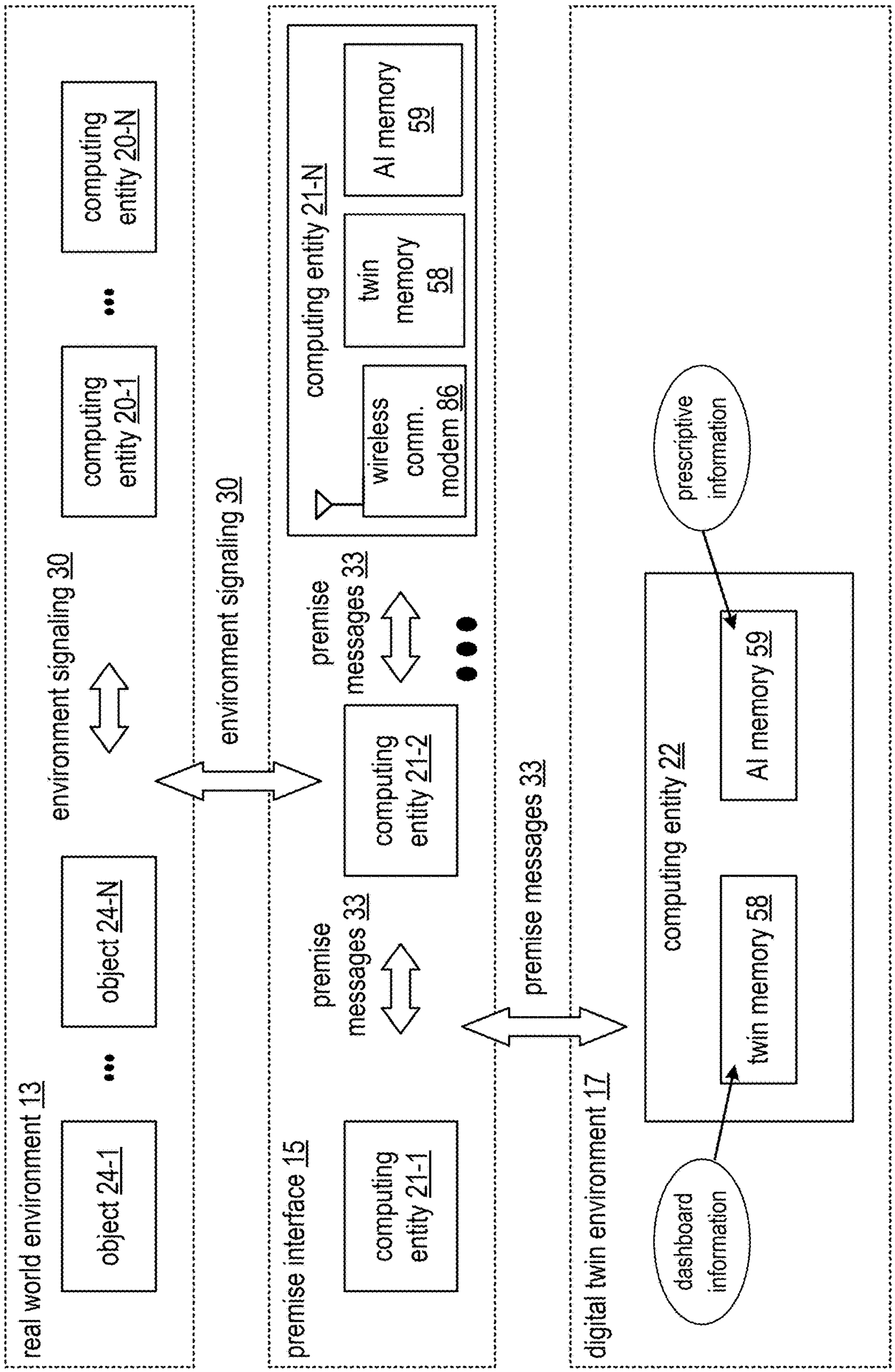

real world environment 13
object 24-1
object 24-N
environment signaling 30
computing entity 20-1
computing entity 20-N
environment signaling 30
premise interface 15
computing entity 21-1
premise messages 33
computing entity 21-2
premise messages 33
computing entity 21-N
wireless comm. modem 86
twin memory 58
AI memory 59
premise messages 33
digital twin environment 17
computing entity 22
twin memory 58
AI memory 59
dashboard information
prescriptive information

FIG. 1

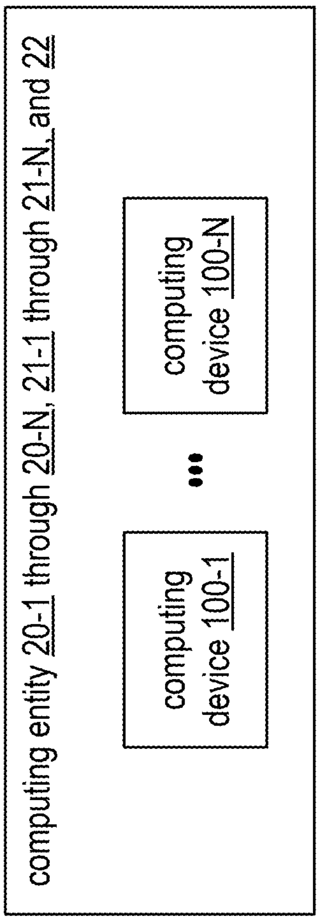

computing entity 20-1 through 20-N, 21-1 through 21-N, and 22
computing device 100-1
computing device 100-N

FIG. 2A

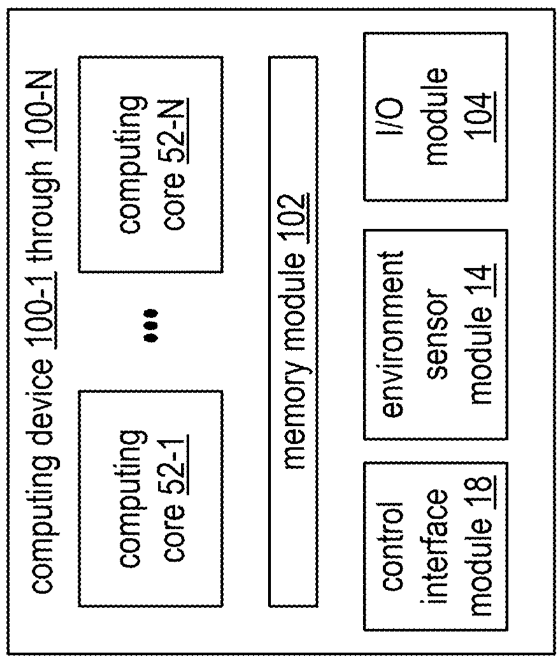

computing device 100-1 through 100-N
computing core 52-1
computing core 52-N
memory module 102
control interface module 18
environment sensor module 14
I/O module 104

FIG. 2B

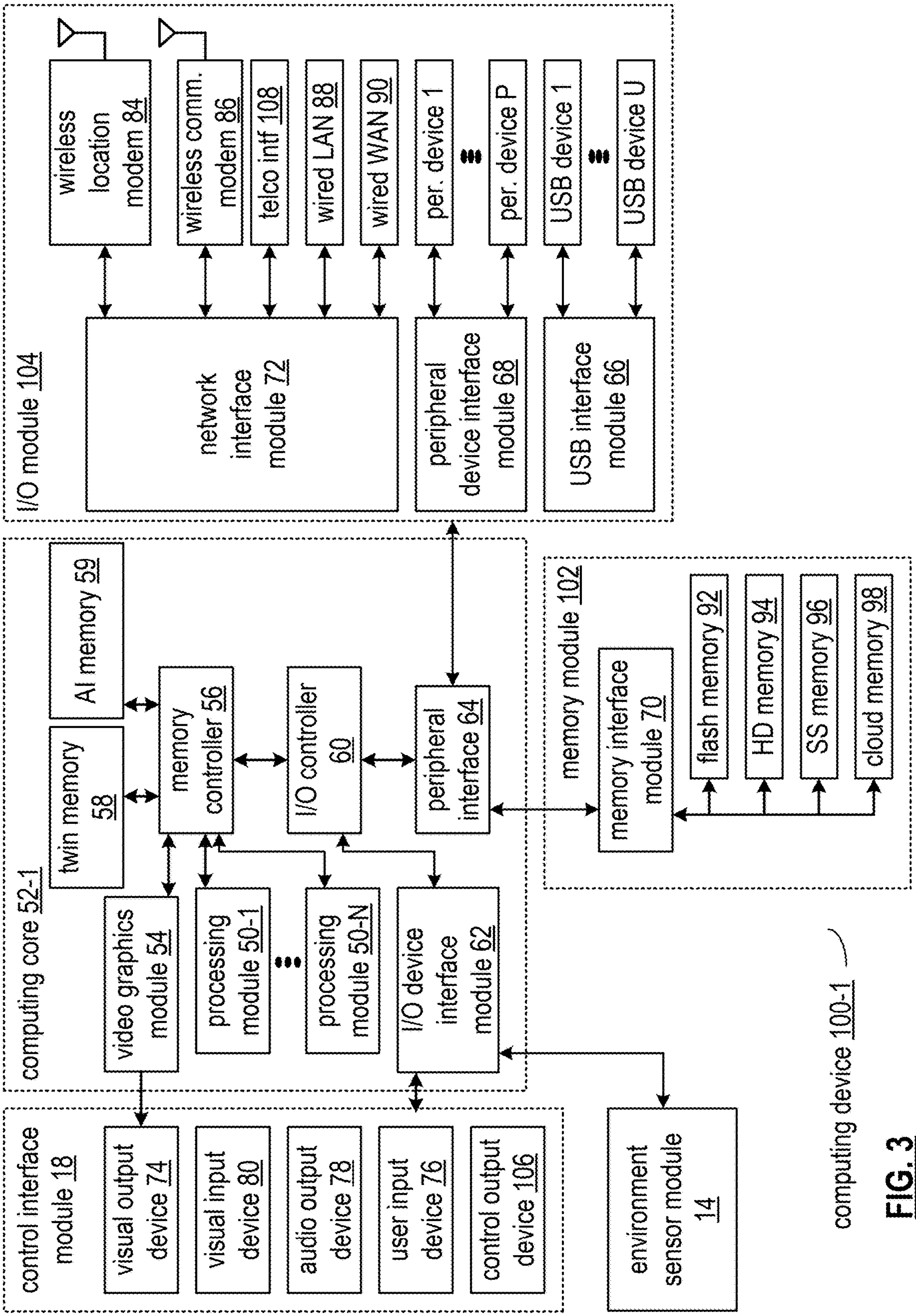

I/O module 104
wireless location modem 84
wireless comm. modem 86
telco intf 108
wired LAN 88
wired WAN 90
per. device 1
per. device P
USB device 1
USB device U
network interface module 72
peripheral device interface module 68
USB interface module 66
computing core 52-1
twin memory 58
AI memory 59
memory controller 56
I/O controller 60
peripheral interface 64
video graphics module 54
processing module 50-1
processing module 50-N
I/O device interface module 62
memory module 102
memory interface module 70
flash memory 92
HD memory 94
SS memory 96
cloud memory 98
control interface module 18
visual output device 74
visual input device 80
audio output device 78
user input device 76
control output device 106
environment sensor module 14
computing device 100-1

FIG. 3

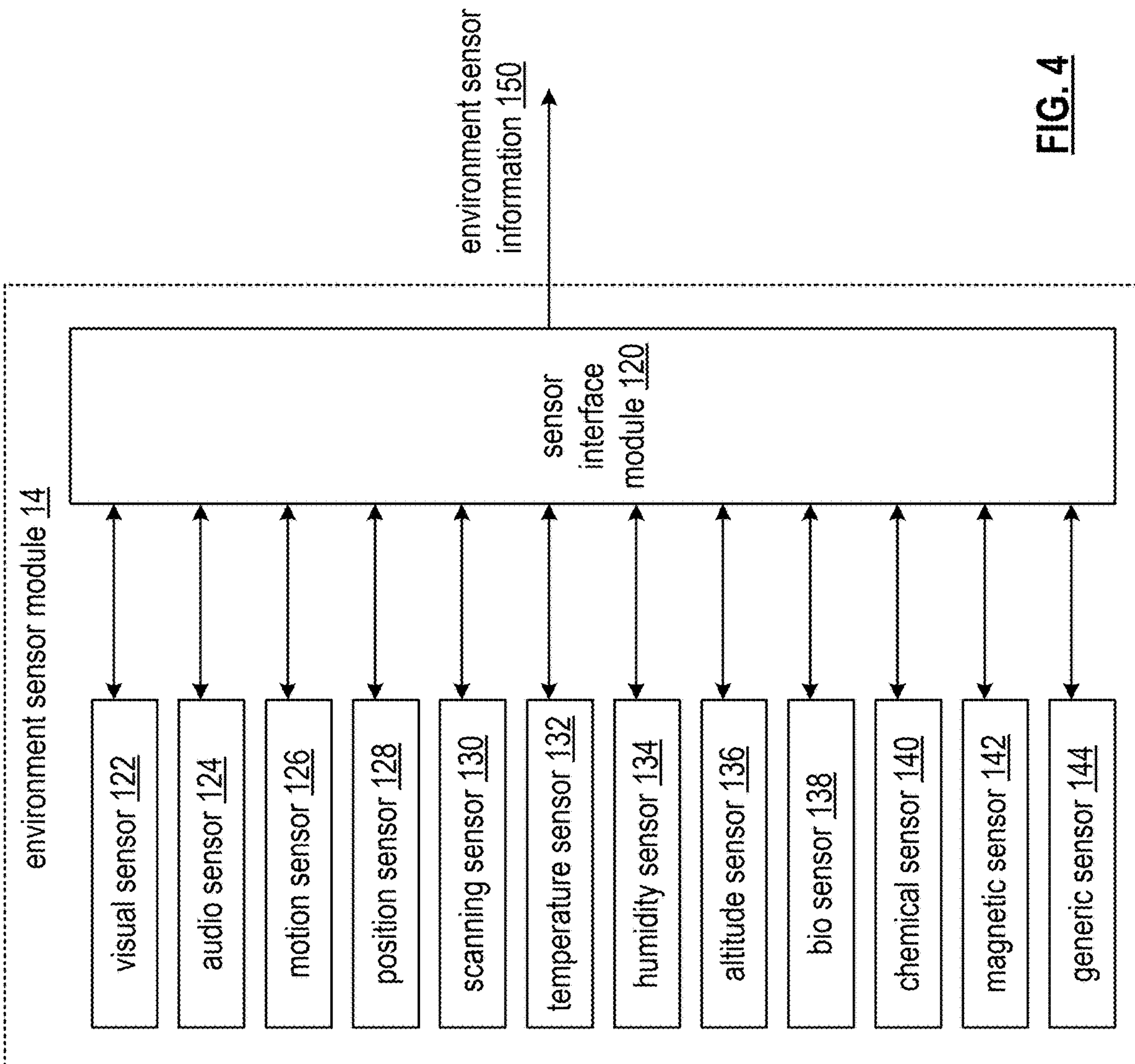

environment sensor information 150
environment sensor module 14
sensor interface module 120
visual sensor 122
audio sensor 124
motion sensor 126
position sensor 128
scanning sensor 130
temperature sensor 132
humidity sensor 134
altitude sensor 136
bio sensor 138
chemical sensor 140
magnetic sensor 142
generic sensor 144

FIG. 4

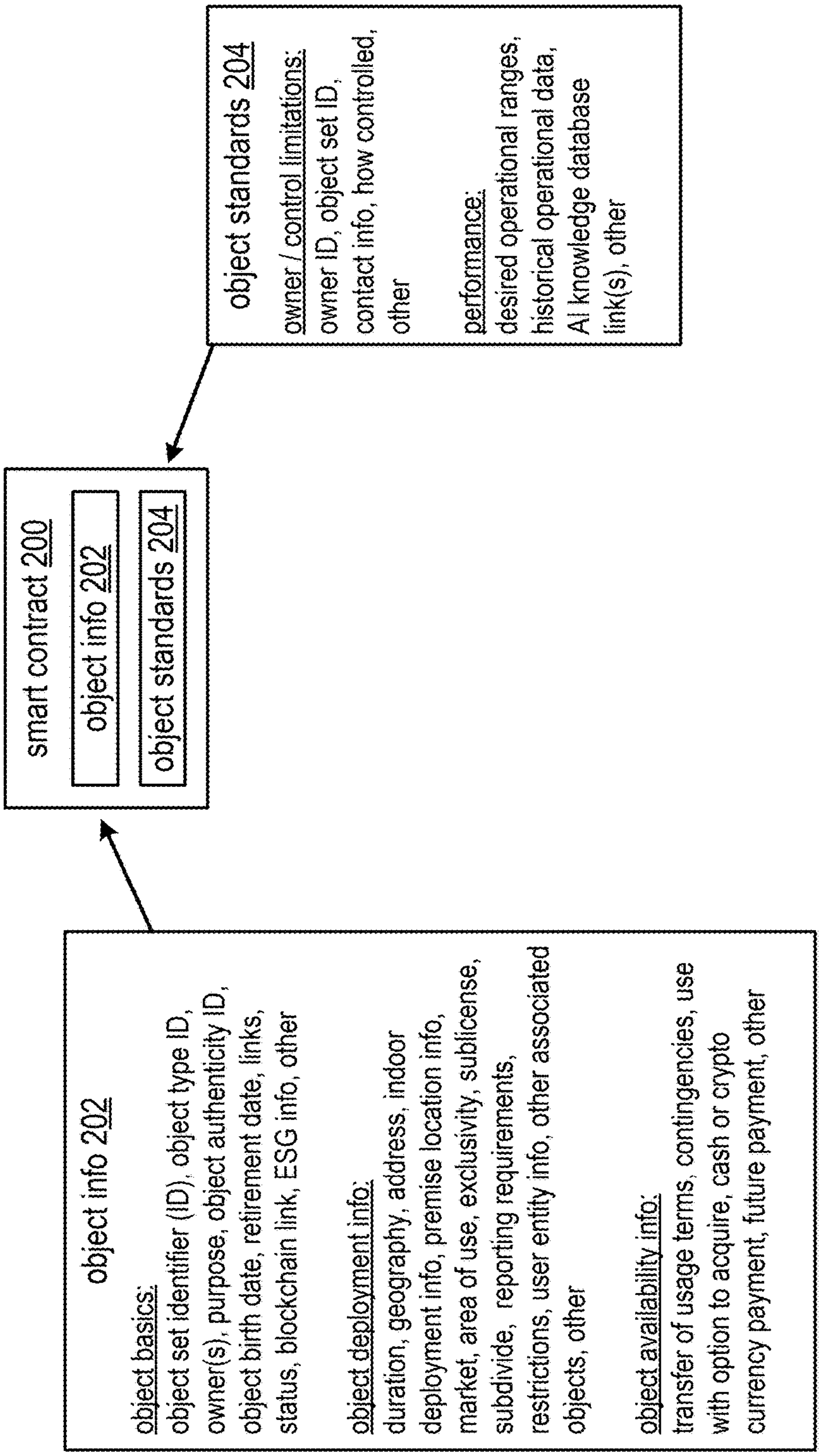

smart contract 200
object info 202
object standards 204
object standards 204
owner / control limitations:
owner ID, object set ID, contact info, how controlled, other
performance:
desired operational ranges, historical operational data, AI knowledge database link(s), other
object info 202
object basics:
object set identifier (ID), object type ID, owner(s), purpose, object authenticity ID, object birth date, retirement date, links, status, blockchain link, ESG info, other
object deployment info:
duration, geography, address, indoor deployment info, premise location info, market, area of use, exclusivity, sublicense, subdivide, reporting requirements, restrictions, user entity info, other associated objects, other
object availability info:
transfer of usage terms, contingencies, use with option to acquire, cash or crypto currency payment, future payment, other

FIG. 5A

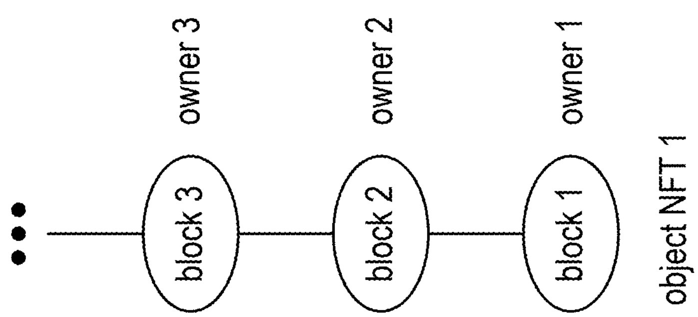

block 3
block 2
block 1
owner 3
owner 2
owner 1
object NFT 1

FIG. 5B

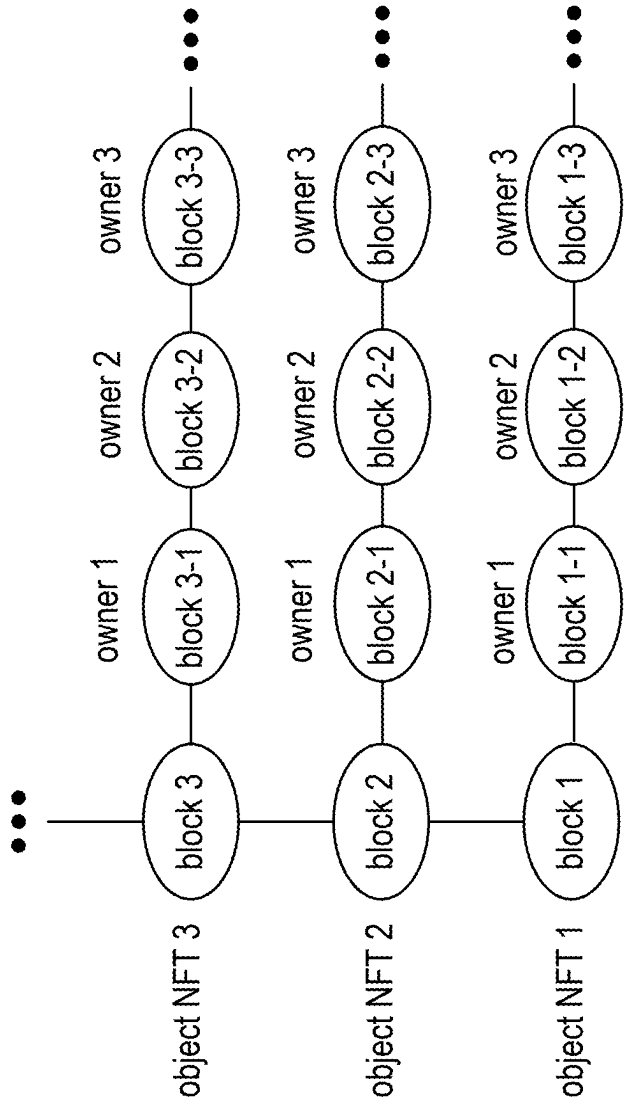

object NFT 3
object NFT 2
object NFT 1
block 3
block 2
block 1
owner 1
owner 2
owner 3
block 3-1
block 3-2
block 3-3
block 2-1
block 2-2
block 2-3
block 1-1
block 1-2
block 1-3

FIG. 5C

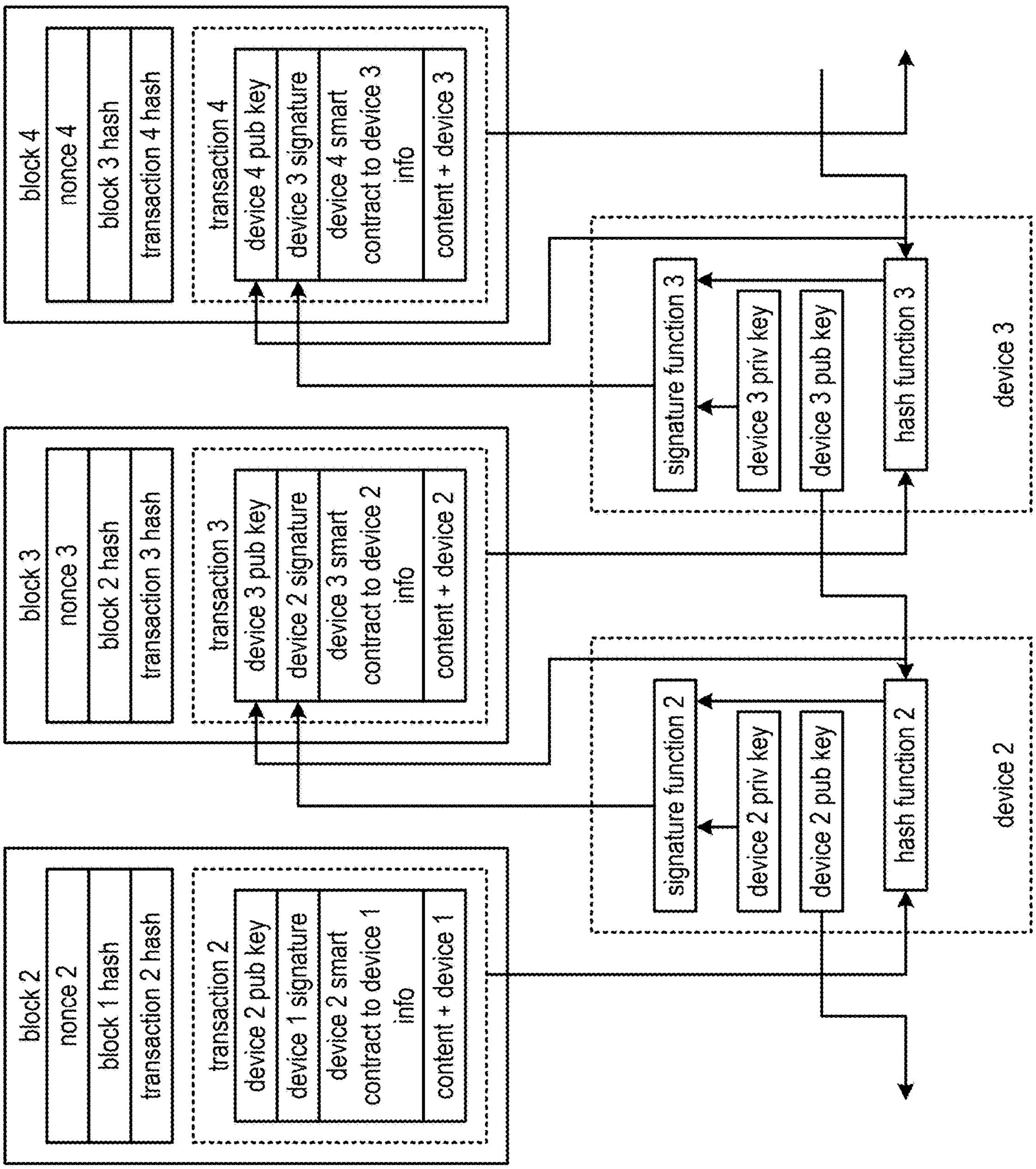

block 4
nonce 4
block 3 hash
transaction 4 hash
transaction 4
device 4 pub key
device 3 signature
device 4 smart contract to device 3 info
content + device 3
block 3
nonce 3
block 2 hash
transaction 3 hash
transaction 3
device 3 pub key
device 2 signature
device 3 smart contract to device 2 info
content + device 2
block 2
nonce 2
block 1 hash
transaction 2 hash
transaction 2
device 2 pub key
device 1 signature
device 2 smart contract to device 1 info
content + device 1
signature function 3
device 3 priv key
device 3 pub key
hash function 3
device 3
signature function 2
device 2 priv key
device 2 pub key
hash function 2
device 2

FIG. 5D

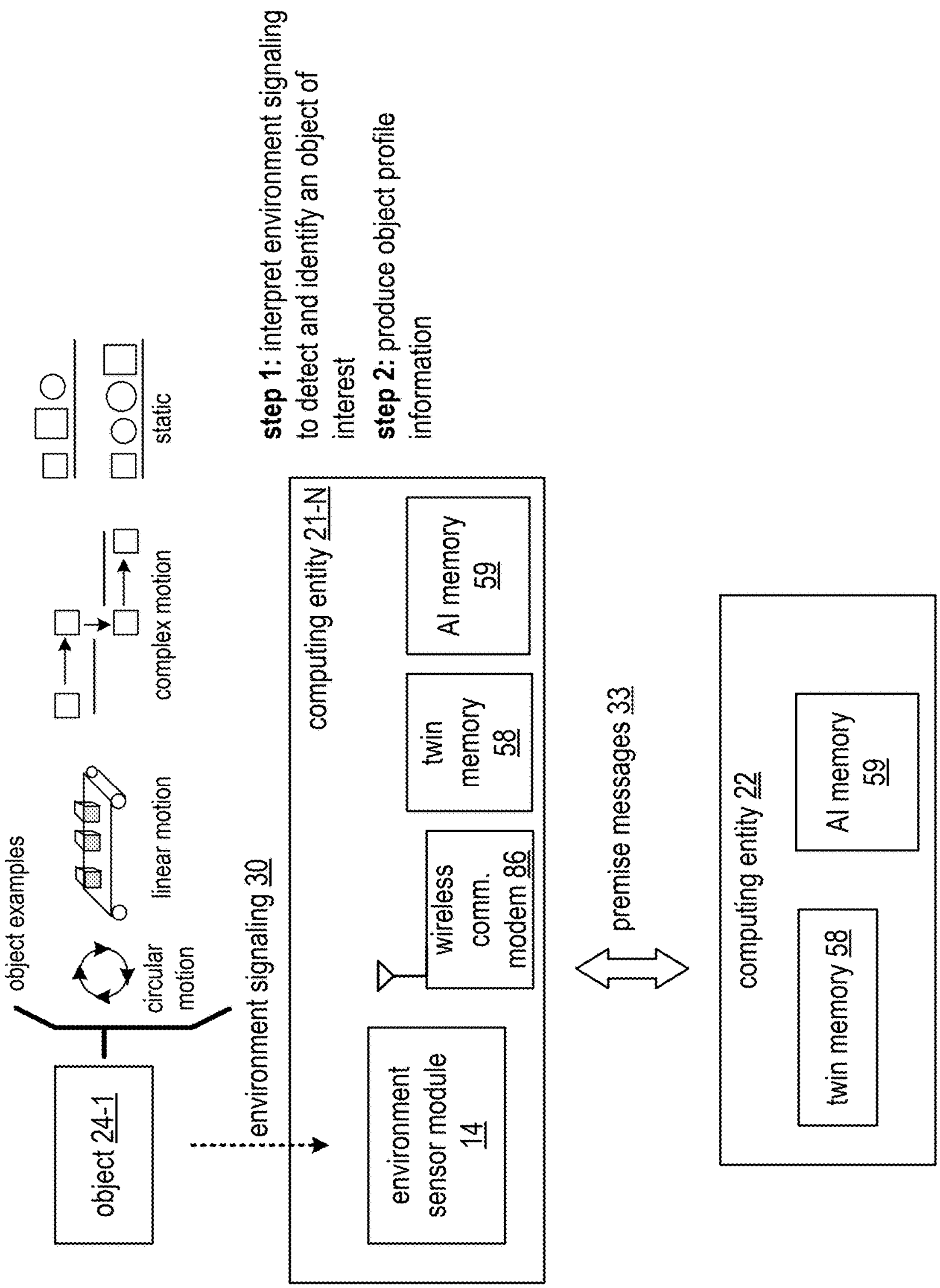

object examples
circular motion
linear motion
complex motion
static
step 1: interpret environment signaling to detect and identify an object of interest
step 2: produce object profile information
object 24-1
environment signaling 30
computing entity 21-N
environment sensor module 14
wireless comm. modem 86
twin memory 58
AI memory 59
premise messages 33
computing entity 22
twin memory 58
AI memory 59

FIG. 6A

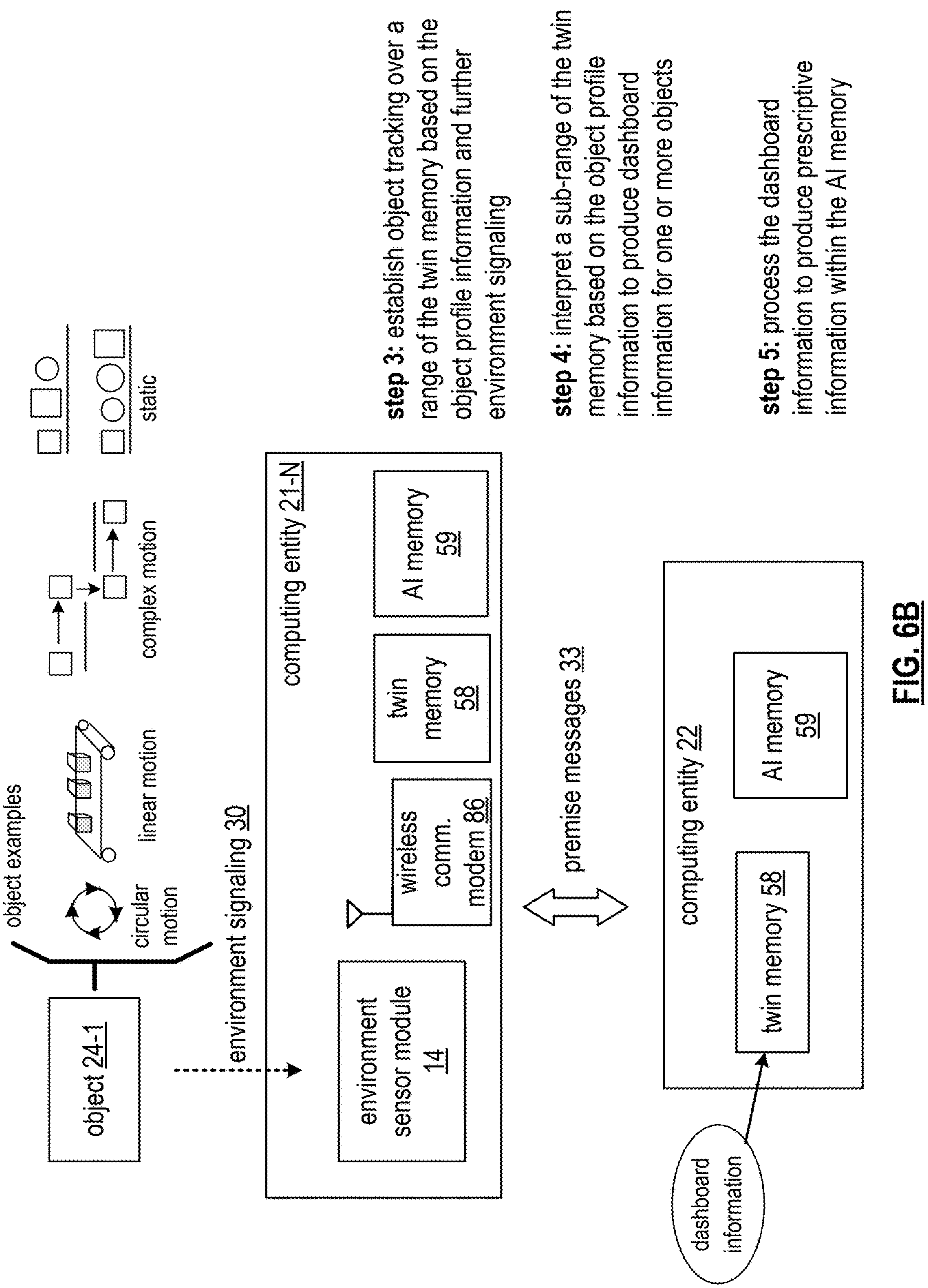

object examples
circular motion
linear motion
complex motion
static
object 24-1
environment signaling 30
computing entity 21-N
environment sensor module 14
wireless comm. modem 86
twin memory 58
AI memory 59
premise messages 33
computing entity 22
twin memory 58
AI memory 59
dashboard information
step 3: establish object tracking over a range of the twin memory based on the object profile information and further environment signaling
step 4: interpret a sub-range of the twin memory based on the object profile information to produce dashboard information for one or more objects
step 5: process the dashboard information to produce prescriptive information within the AI memory

FIG. 6B

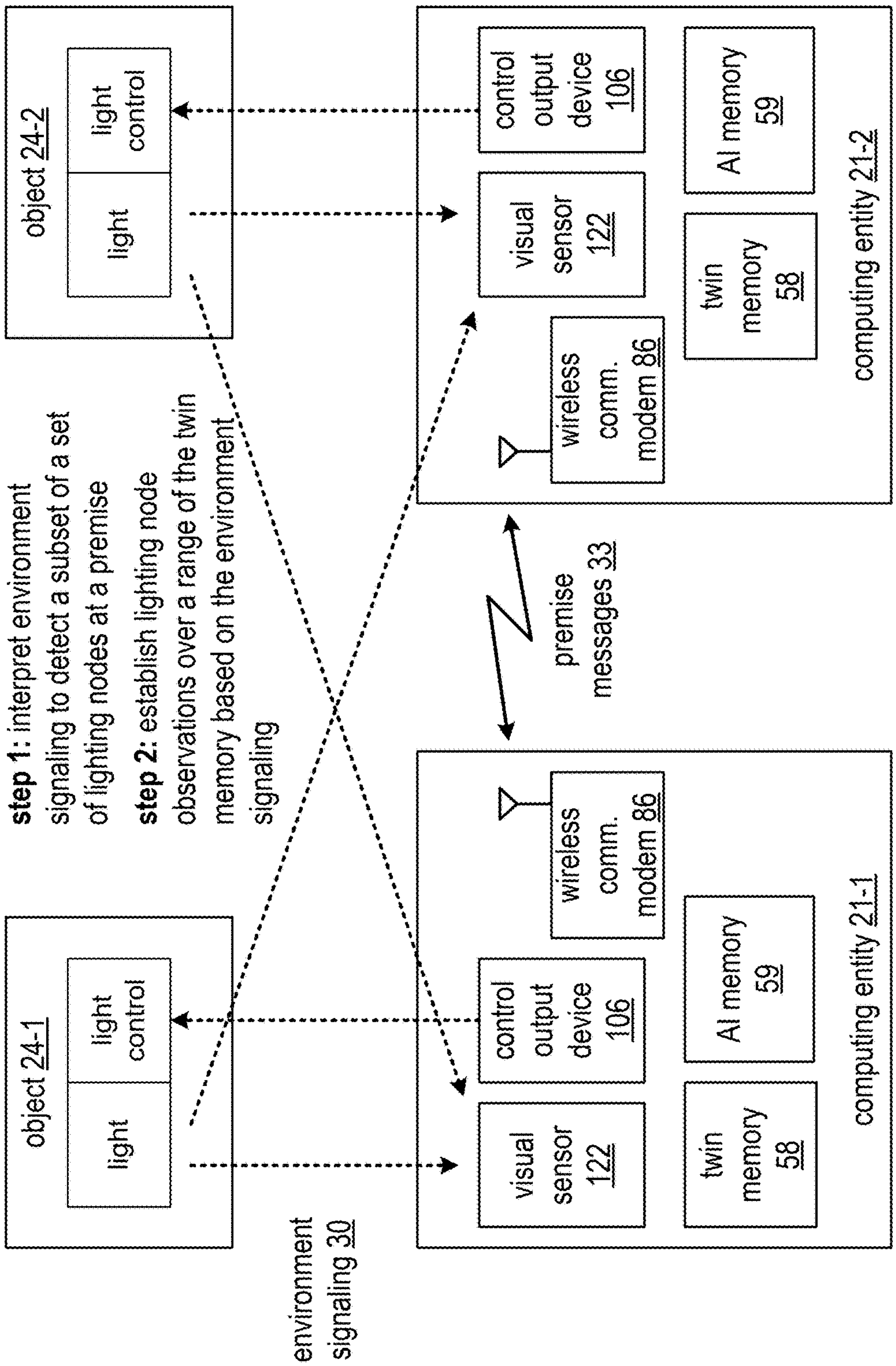
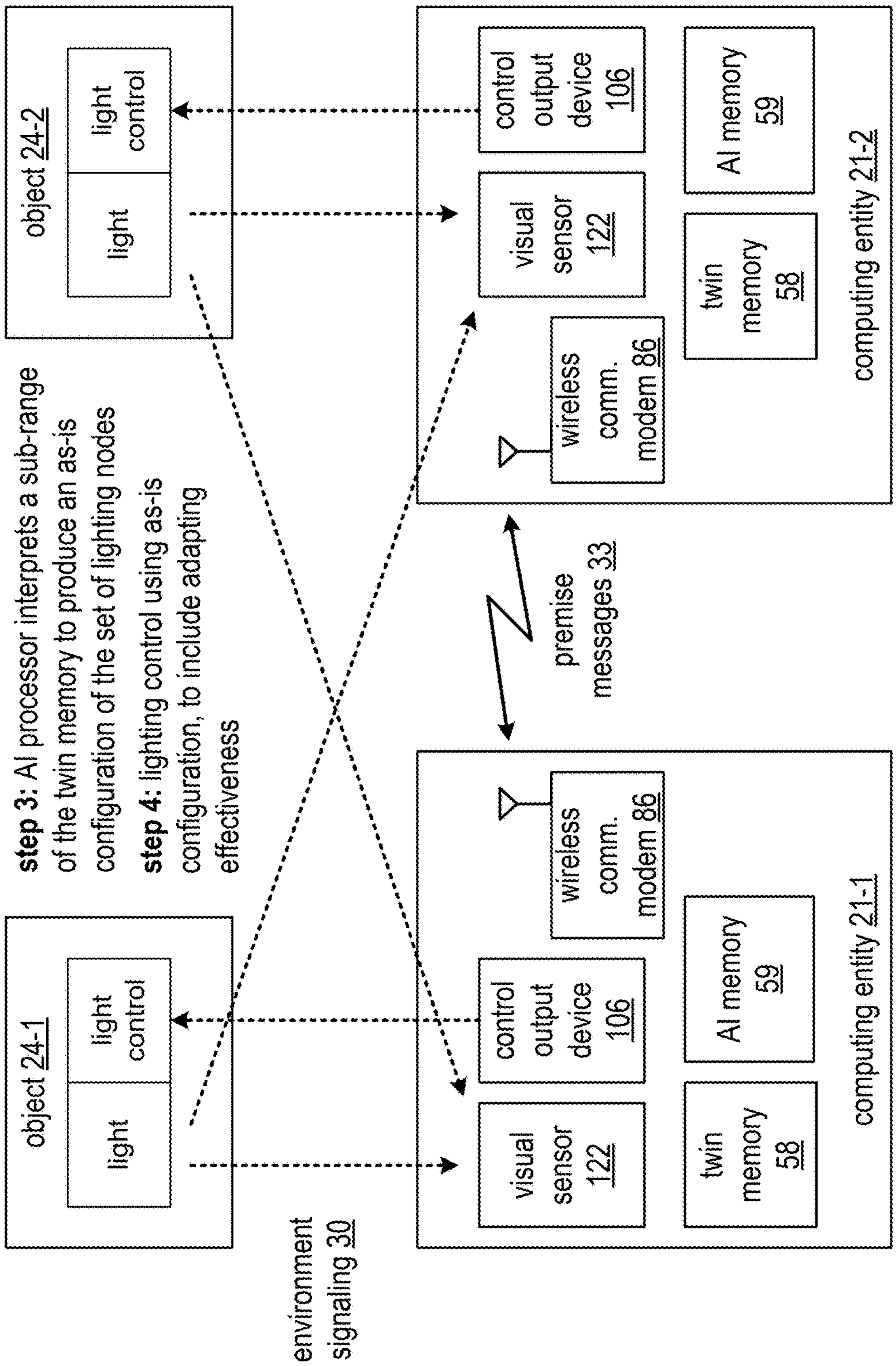

object 24-2
light
light control
step 1: interpret environment signaling to detect a subset of a set of lighting nodes at a premise
step 2: establish lighting node observations over a range of the twin memory based on the environment signaling
object 24-1
light
light control
environment signaling 30
control output device 106
visual sensor 122
wireless comm. modem 86
AI memory 59
twin memory 58
computing entity 21-2
premise messages 33
visual sensor 122
control output device 106
wireless comm. modem 86
AI memory 59
twin memory 58
computing entity 21-1

FIG. 7A



object 24-2
light
light control
step 3: AI processor interprets a sub-range of the twin memory to produce an as-is configuration of the set of lighting nodes
step 4: lighting control using as-is configuration, to include adapting effectiveness
object 24-1
light
light control
environment signaling 30
control output device 106
visual sensor 122
wireless comm. modem 86
AI memory 59
twin memory 58
computing entity 21-2
premise messages 33
wireless comm. modem 86
control output device 106
visual sensor 122
AI memory 59
twin memory 58
computing entity 21-1

FIG. 7B

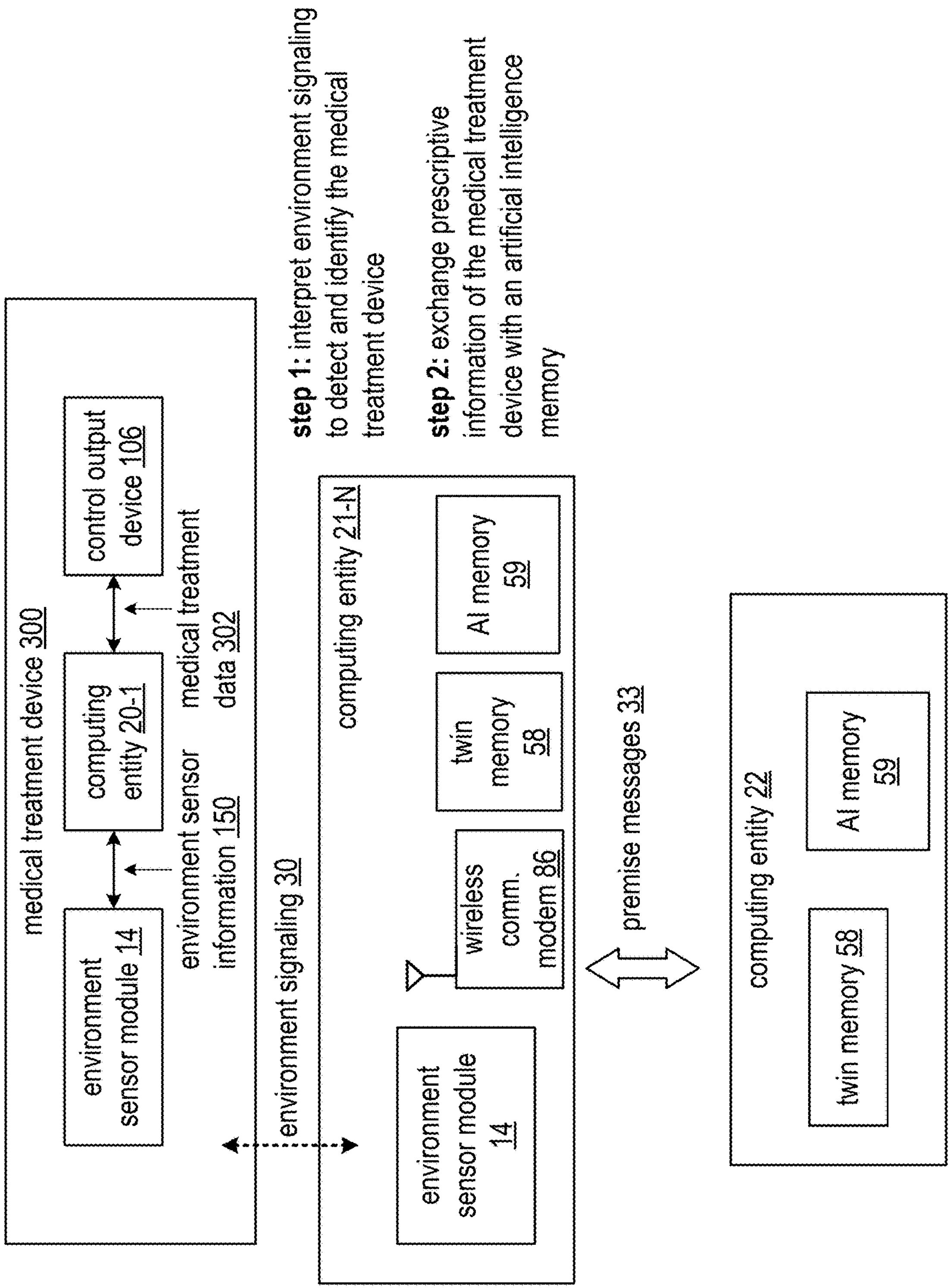
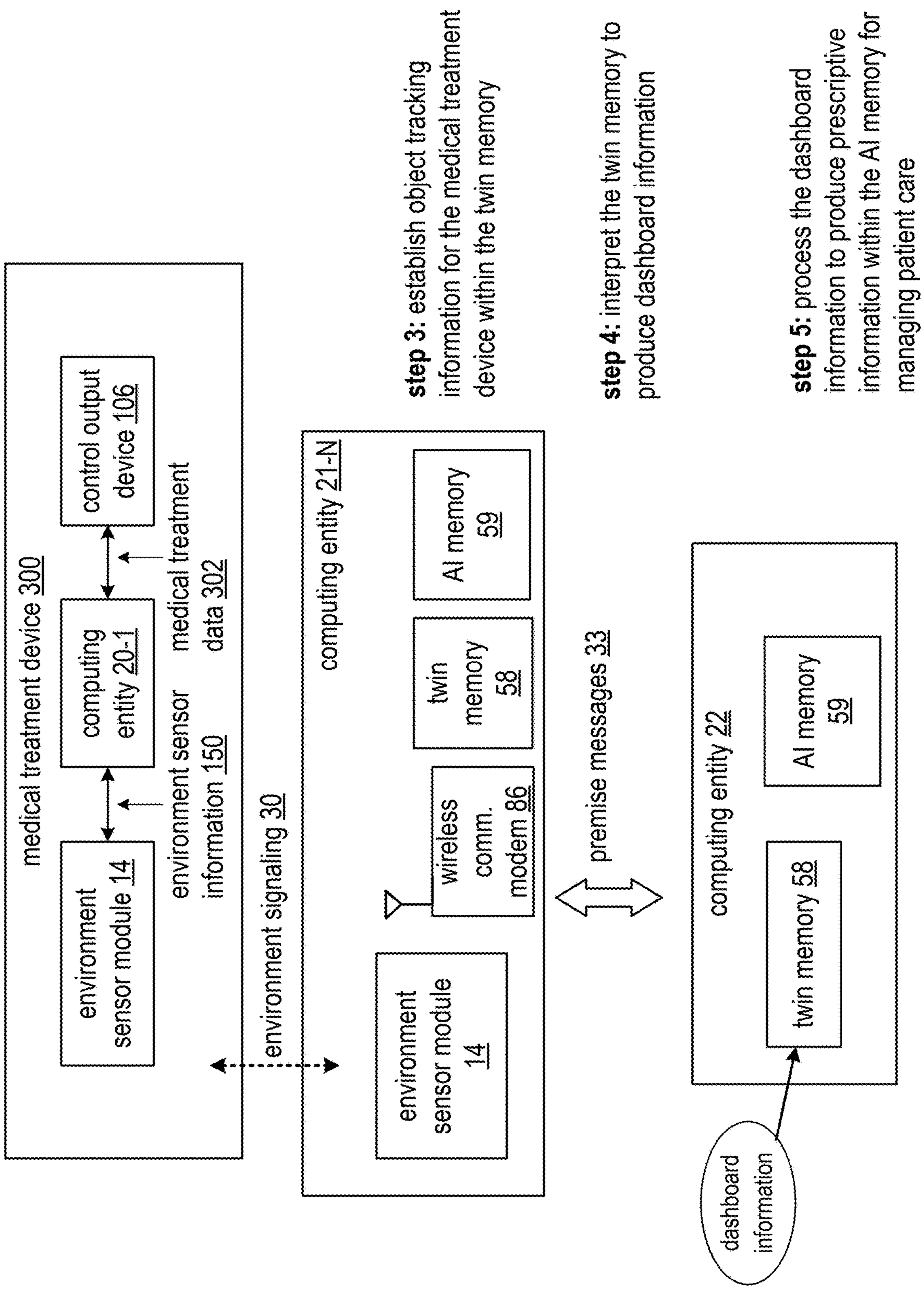

medical treatment device 300
environment sensor module 14
computing entity 20-1
control output device 106
environment sensor information 150
medical treatment data 302
environment signaling 30
computing entity 21-N
environment sensor module 14
wireless comm. modem 86
twin memory 58
AI memory 59
premise messages 33
computing entity 22
twin memory 58
AI memory 59
step 1: interpret environment signaling to detect and identify the medical treatment device
step 2: exchange prescriptive information of the medical treatment device with an artificial intelligence memory

FIG. 8A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environment sensor module 14
computing entity 20-1
control output device 106
environment sensor information 150
medical treatment data 302
environment signaling 30
computing entity 21-N
environment sensor module 14
wireless comm. modem 86
twin memory 58
AI memory 59
premise messages 33
computing entity 22
twin memory 58
AI memory 59
dashboard information
step 3: establish object tracking information for the medical treatment device within the twin memory
step 4: interpret the twin memory to produce dashboard information
step 5: process the dashboard information to produce prescriptive information within the AI memory for managing patient care

FIG. 8B

SELF-FORMING COMMUNICATION AND CONTROL SYSTEM

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present U.S. Utility Patent Application claims priority pursuant to 35 U.S.C. § 120 as a continuation-in-part of U.S. Utility application Ser. No. 19/076,195, entitled "SELF-FORMING COMMUNICATION AND CONTROL SYSTEM" filed Mar. 11, 2025, pending, which claims priority to 35 U.S.C. § 120 as a continuation-in-part of U.S. Utility application Ser. No. 19/033,901, entitled "SELF-FORMING COMMUNICATION AND CONTROL SYSTEM" filed Jan. 22, 2025, pending, which claims priority pursuant to 35 U.S.C. § 119(e) to U.S. Provisional Application No. 63/626,222, entitled "SELF-FORMING COMMUNICATION AND CONTROL SYSTEM", filed Jan. 29, 2024, expired, all of which are hereby incorporated herein by reference in their entirety and made part of the present U.S. Utility Patent Application for all purposes.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

[0002] Not Applicable.

INCORPORATION-BY-REFERENCE OF MATERIAL SUBMITTED ON A COMPACT DISC

[0003] Not Applicable.

BACKGROUND OF THE INVENTION

Technical Field of the Invention

[0004] This invention relates generally to computer systems and more particularly to computer systems associated with digital twin solutions.

Description of Related Art

[0005] Computer systems communicate data, process data, and/or store data. Such computer systems include computing devices that range from wireless smart phones, wireless mesh nodes, programmable logic controllers (PLC), various lighting and equipment controllers, laptops, tablets, personal computers (PC), work stations, personal three-dimensional (3-D) content viewers, and video game devices, to data centers where data servers store and provide access to digital content. Some digital content is utilized to represent various aspects of real-world objects in a format commonly referred to as a digital twin.

[0006] A variety of digital twin computing systems utilize digital mapping and monitoring techniques. For example, a floor plan of a distribution center is utilized to build a digital representation. As another example, a series of wirelessly meshed sensor and control nodes are deployed in the distribution center to monitor on-going distribution operations and to control aspects of the operation to affect certain desired outcomes, e.g., energy efficiency, speed of product flow, and production waste levels.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING(S)

[0007] FIG. **1** is a schematic block diagram of an embodiment of a computing system in accordance with the present invention;

[0008] FIG. **2**A is a schematic block diagram of an embodiment of a computing entity of a computing system in accordance with the present invention;

[0009] FIG. **2**B is a schematic block diagram of an embodiment of a computing device of a computing system in accordance with the present invention;

[0010] FIG. **3** is a schematic block diagram of another embodiment of a computing device of a computing system in accordance with the present invention;

[0011] FIG. **4** is a schematic block diagram of an embodiment of an environment sensor module of a computing system in accordance with the present invention;

[0012] FIG. **5**A is a schematic block diagram of a data structure for a smart contract in accordance with the present invention;

[0013] FIGS. **5**B and **5**C are schematic block diagrams of organization of object distributed ledgers in accordance with the present invention;

[0014] FIG. **5**D is a schematic block diagram of an embodiment of a blockchain associated with an object distributed ledger in accordance with the present invention;

[0015] FIGS. **6**A-**6**B are schematic block diagrams of another embodiment of a computing system illustrating an example of a self-forming communication and control system in accordance with the present invention;

[0016] FIGS. **7**A-**7**B are schematic block diagrams of another embodiment of a computing system illustrating an example of a self-forming communication and control system in accordance with the present invention; and

[0017] FIGS. **8**A-**8**B are schematic block diagrams of another embodiment of a computing system illustrating an example of a self-forming communication and control system in accordance with the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0018] FIG. **1** is a schematic block diagram of an embodiment of a computing system that includes a real-world environment **13**, a premise interface **15**, and a digital twin environment **17**. The real-world environment **13** includes objects **24-1** through **24**-N and computing entities **20-1** through **20**-N. The premise interface **15** includes computing entities **21-1** through **21**-N. The digital twin environment **17** includes at least one computing entity **22**.

[0019] The objects **24-1** through **24**-N include anything physical and real. Examples of an object includes people, equipment, lights, lighting controllers, heating and air conditioning systems, building materials, furniture, personal items, tools, vehicles, manufacturing machines, storage systems, inventory handling equipment, retail inventory, industrial inventory, and anything else found in the real-world. The objects provide and accept environment signaling **30** to and from the premise interface **15**.

[0020] The environment signaling **30** includes emission (e.g., direct such as from a light emitting diode (LED), or indirect such as a reflection from another source of emission) of all formats like sound, light, other wireless, solids, liquids, and gasses. Certain objects have control capabilities to accept the environment signaling **30** such as a lighting controller to receive and interpret commands from the premise interface **15** to turn on, turn off, or set an illumination level.

[0021] The environment signaling further more specifically includes at least one of an unencoded direct electromagnetic emission, an unencoded indirect electromagnetic emission, an encoded electromagnetic emission, an encoded electronic signal, an unencoded mechanical wave, and an encoded mechanical wave. The unencoded direct electromagnetic emission includes a light source or radio frequency carrier wave that is received substantially directly from the source without reflection. The unencoded indirect electromagnetic emission includes a light source or radio frequency carrier wave that is received substantially indirectly (e.g., reflected off another object between the source and the object) from the source without reflection. The encoded electromagnetic emission includes a light source or radio frequency carrier wave that is modulated with information and is received either directly or indirectly from the source (e.g., without or with reflection). The encoded electronic signal includes a signal on a wire that is modulated with information (e.g., an ethernet cable communication data packets). The unencoded mechanical wave includes a sound wave that is not modulated with information and is received either directly or indirectly from the source (e.g., without or with acoustic reflection). The encoded mechanical wave includes a sound wave that is modulated with information and is received either directly or indirectly from the source (e.g., without or with acoustic reflection).

[0022] The computing entities include various components as is further discussed with reference to FIGS. **2**A, **2**B, **3**, and **4**. For example, a typical computing entity includes a wireless communication modem **86** to communicate with other computing entities, a twin memory **58** to store executable software and parameters associated with providing of a digital twin representation of the objects **24-1** through **24**-N, and an Artificial Intelligence (AI) memory **59** to store executable software and parameters associated with providing AI processing of the digital twin representation.

[0023] The computing entities **20-1** through **20**-N of the real-world environment **13** are associated with the objects **24-1** through **24**-N and are capable of exchanging the environment signaling **30** to and from the objects as well as with the premise interface **15**. For example, the computing entity **20-1** gathers manufacturing operating data of a subset of objects when the computing entity **20-1** functions as a programmable logic controller (PLC) at a factory premise where the subset of objects includes factory implements. The computing entity **20-1** provides a representation of the manufacturing operating data as the environment signaling **30** to the premise interface **15**. As another example, the computing entity **20-1** interprets commands for another subset of objects from further environment signaling **30** received from the premise interface **15** and issues more environment signaling **30** to some of the subset of objects that includes a representation of the commands.

[0024] The computing entities **21-1** through **21**-N of the premise interface **15** are deployed around a premise that includes the real-world environment **13**. In an embodiment, the computing entities **21-1** through **21**-N form a mesh network where each computing entity of the premise interface **15** is a node of the mesh network to provide connectivity for essentially every object and computing entity of the real-world environment **13**. For example, computing entity **21-1** and **21-2** establish a wireless link, via the wireless communication modems **86**, with each other to convey premise messages **33** between them and the computing entity **21-2** establishes another wireless link to relay some of those premise messages **33** between the computing entity **21-2** and computing entity **21**-N when a yet another wireless link can not be established directly between computing entity **21-1** and computing entity **21**-N.

[0025] The premise messages **33** includes signaling to establish and maintain the mesh network and payload data associated with the environment signaling **30**. The computing entities **21-1** through **21**-N of the premise interface **15** further communicate premise messages **33** with the at least one computing entity **22** of the digital twin environment **17**. For example, computing entity **21-2** communicates a representation of substantially all of the environment signaling **30** associated with the real-world environment **13** with the computing entity **22**.

[0026] The computing entity **22** of the digital twin environment **17** functions to process premise messages **33** representing status and operations of the real-world environment **13** to produce dashboard information within the twin memory **58**. The dashboard information includes a digital twin representative of the premise. For example, a set of files representing layout of the premise indicating near real time status and data associated with the objects **24-1** through **24**-N. As another example, information from the premise is summarized by computing entity **20-1** when the computing entity **20-1** serves as a factory PLC.

[0027] The computing entity **22** of the digital twin environment **17** further functions to process the dashboard information to produce prescriptive information within the AI memory **59**. The prescriptive information includes one or more of an interpretation of a portion of the dashboard information (e.g., a summary), an evaluation of some of the dashboard information vs a standard (e.g., achieving goals), and advice and/or instructions (e.g., recommended or actual manual/automated actions) to cause change with regards to one or more of the objects in the real-world environment **13**.

[0028] In an embodiment, one or more of the computing entities serve as an object authenticity computing entity (e.g., where tasks include authenticating validity and information with regards to an object or computing entity of the real-world environment **13**). In an embodiment, any of the computing entities serve as blockchain nodes and/or as object ledger computing entities and/or object ledger computing devices of an object distributed ledger utilized to house and transfer data and information of the computing system via tokens in a trusted way with high levels of security. A technological improvement is provided over prior art communication and computing systems associated with data management since only the device possessing control over a token may modify the token as part of such a tightly integrated overall data management process. Only a present trusted device may pass the control to a next trusted device that is part of the overall data management process.

[0029] FIG. **2**A is a schematic block diagram of an embodiment of the computing entity (e.g., **20-1** through **20**-N; **21-1** through **21**-N; and **22**) of the computing system of FIG. **1**. The computing entity includes one or more computing devices **100-1** through **100**-N. A computing device is any electronic device that communicates data, processes data, represents data (e.g., user interface) and/or stores data.

[0030] Computing devices include portable computing devices and fixed computing devices. Examples of portable computing devices include an embedded controller, a mesh network node device, a smart sensor, a social networking device, a gaming device, a smart phone, a laptop computer, a tablet computer, a video game controller, and/or any other portable device that includes a computing core. Examples of fixed computing devices includes a personal computer, a computer server, a cable set-top box, a fixed display device, an appliance, and industrial controller, a video game counsel, a home entertainment controller, a critical infrastructure controller, and/or any type of home, office or cloud computing equipment that includes a computing core.

[0031] FIG. **2**B is a schematic block diagram of an embodiment of a computing device (e.g., **100-1** through **100**-N) of the computing entity of FIG. **2**A that includes one or more computing cores **52-1** through **52**-N, a memory module **102**, a control interface module **18**, an environment sensor module **14**, and an input/output (I/O) module **104**. In alternative embodiments, the control interface module **18**, the environment sensor module **14**, the I/O module **104**, and the memory module **102** may be standalone (e.g., external to the computing device). An embodiment of the computing device is discussed in greater detail with reference to FIG. **3**.

[0032] FIG. **3** is a schematic block diagram of another embodiment of the computing device **100-1** of the computing system **10** that includes the control interface module **18**, the environment sensor module **14**, the computing core **52-1**, the memory module **102**, and the I/O module **104**. The control interface module **18** includes one or more visual output devices **74** (e.g., video graphics display, 3-D viewer, touchscreen, LED, etc.), one or more visual input devices **80** (e.g., a still image camera, a video camera, a 3-D video camera, photocell, etc.), and one or more audio output devices **78** (e.g., speaker(s), headphone jack, earphone, a motor, etc.). The control interface module **18** further includes one or more user input devices **76** (e.g., keypad, keyboard, touchscreen, voice to text, a push button, a microphone, a card reader, a door position switch, a biometric input device, etc.) and one or more control output devices **106** (e.g., lighting control, environmental control, servos, motors, lifts, pumps, actuators, and anything to control real-world object and devices).

[0033] The computing core **52-1** includes a video graphics module **54**, one or more processing modules **50-1** through **50**-N, a memory controller **56**, one or more twin memories **58** and one or more AI memories **59** (e.g., RAM), one or more input/output (I/O) device interface modules **62**, an input/output (I/O) controller **60**, and a peripheral interface **64**. A processing module is as defined at the end of the detailed description and includes a computing processor and an AI processor.

[0034] The memory module **102** includes a memory interface module **70** and one or more memory devices, including flash memory devices **92**, hard drive (HD) memory **94**, solid state (SS) memory **96**, and cloud memory **98**. The cloud memory **98** includes an on-line storage system and an on-line backup system.

[0035] The I/O module **104** includes a network interface module **72**, a peripheral device interface module **68**, and a universal serial bus (USB) interface module **66**. Each of the I/O device interface module **62**, the peripheral interface **64**, the memory interface module **70**, the network interface module **72**, the peripheral device interface module **68**, and the USB interface modules **66** includes a combination of hardware (e.g., connectors, wiring, etc.) and operational instructions stored on memory (e.g., driver software) that are executed by one or more of the processing modules **50-1** through **50**-N and/or a processing circuit within the particular module.

[0036] The I/O module **104** further includes one or more wireless location modems **84** (e.g., global positioning satellite (GPS), Wi-Fi, angle of arrival, time difference of arrival, signal strength, dedicated wireless location, etc.) and one or more wireless communication modems **86** (e.g., a cellular network transceiver, a wireless data network transceiver, a Wi-Fi transceiver, a Bluetooth transceiver, a 315 MHz transceiver, a zig bee transceiver, a 60 GHz transceiver, a Wirepas meshing module, etc.). The I/O module **104** further includes a telco interface **108** (e.g., to interface to a public switched telephone network), a wired local area network (LAN) **88** (e.g., optical, electrical), and a wired wide area network (WAN) **90** (e.g., optical, electrical). The I/O module **104** further includes one or more peripheral devices (e.g., peripheral devices **1**-P) and one or more universal serial bus (USB) devices (USB devices **1**-U). In other embodiments, the computing device **100-1** may include more devices or fewer devices and modules than shown in this example embodiment.

[0037] FIG. **4** is a schematic block diagram of an embodiment of the environment sensor module **14** of the computing device of FIG. **2**B that includes a sensor interface module **120** to output environment sensor information **150** based on information communicated with a set of sensors. The set of sensors includes a visual sensor **122** (e.g., 2-D camera, 3-D camera, 360° view camera, a camera array, an optical spectrometer, a photocell, etc.) and an audio sensor **124** (e.g., a microphone, a microphone array, a vibration detector). The set of sensors further includes a motion sensor **126** (e.g., a solid-state Gyro, a vibration detector, a laser motion detector) and a position sensor **128** (e.g., a Hall effect sensor, an image detector, a GPS receiver, a radar system).

[0038] The set of sensors further includes a scanning sensor **130** (e.g., CAT scan, MRI, x-ray, ultrasound, radio scatter, particle detector, laser measure, further radar) and a temperature sensor **132** (e.g., thermometer, thermal coupler). The set of sensors further includes a humidity sensor **134** (moisture level detector, resistance based, capacitance based) and an altitude sensor **136** (e.g., pressure based, GPS-based, laser-based).

[0039] The set of sensors further includes a biosensor **138** (e.g., enzyme, microbial) and a chemical sensor **140** (e.g., mass spectrometer, gas, polymer). The set of sensors further includes a magnetic sensor **142** (e.g., Hall effect, piezo electric, coil, magnetic tunnel junction) and any generic sensor **144** (e.g., including a hybrid combination of two or more of the other sensors).

[0040] FIG. **5**A is a schematic block diagram of a data structure for a smart contract **200** that includes object information **202** and object standards **204**. The object information **202** includes object basics (e.g., including links to blockchains and electronic assets), object deployment information, and object availability information. FIG. **5**A illustrates examples of each category of the object information

202. The object standards 204 includes owner information and performance associated with the smart contract. FIG. 5A further illustrates examples of each of the categories of the object standards 204. Further examples are referenced below.

[0041] FIGS. 5B and 5C are schematic block diagrams of organization of object distributed ledgers. FIG. 5B illustrates an example where a single blockchain serves as the object distributed ledger linking a series of blocks of the blockchain, where each block is associated with a different owner (e.g., different owners over time for a particular object represented by a nonfungible token). FIG. 5C illustrates another example where a first blockchain links a series of blocks of different non-fungible tokens for different sets of objects. Each block forms a blockchain of its own where each further block (e.g., to the right) of its own is associated with a different owner over time for the set of objects associated with the non-fungible token.

[0042] FIG. 5D is a schematic block diagram of an embodiment of a content blockchain of an object distributed ledger, where the content includes a smart contract to support operation of an object in the real-world environment and/or a meshing node in the premise interface. A securely passing process is utilized for secure passing of a token (e.g., a block, a smart contract, etc.) between a previous "owner" and a "new owner." A technological improvement is provided over prior art communication and computing systems associated with data management since only a device possessing control over the token may modify the token as part of such a tightly integrated overall digital records process described in this section for the present invention. Only a present trusted device may pass the control to a next trusted device that is part of this records management process.

[0043] The computing system of FIG. 1 utilizes blockchain-encoded records to securely represent assets of the computing system. The assets include physical assets like any of the objects and computing devices and virtual assets like a model of a portion of the premise and a representation of a software process (e.g., an AI software module associated with optimizing operation of a bank of lighting controllers).

[0044] In an embodiment, a blockchain of the blockchain-encoded records is utilized to record steps of an asset lifecycle for an asset such as creation, initial and subsequent ownership (e.g., by a controlling entity), deployment, configuration, establishing trust, service-life utilization, and decommissioning. For instance, a new blockchain is created when a new computing system is deployed for a new premise to enjoy the benefits of a digital twin solution. A new block representing a new or transferred asset of the computing system is created by an associated computing entity on behalf of an initial owner. The blockchain is updated when the asset transitions through the lifecycle. The blockchain is updated when control (e.g., ownership) of the asset is changed.

[0045] The blockchain includes a plurality of blocks 2-4. Each block includes a header section and a transaction section. The header section includes one or more of a nonce, a hash of a preceding block of the blockchain, where the preceding block was under control of a preceding device (e.g., a real-world environment computing entity, a premise interface computing entity, a blockchain node computing device, a meshing node, the computing entity of the digital twin environment, etc.) in a chain of control of the blockchain, and a hash of a current block (e.g., a current transaction section), where the current block is under control of a current device in the chain of control of the blockchain.

[0046] The transaction section includes one or more of a public key of the current device, a signature of the preceding device, smart contract content, change of control from the preceding device to the current device, and content information from the previous block as received by the previous device plus content added by the previous device when transferring the current block to the current device.

[0047] FIG. 5D further includes computing devices 2-3 (e.g., devices #2 and #3) to facilitate illustration of generation of the blockchain. Each device includes a hash function, a signature function, and storage for a public/private key pair generated by the device.

[0048] In an example of operation of the generating of the blockchain, when the device 2 has control of the blockchain and is passing control of the blockchain to the device 3 (e.g., the device 3 is transacting a transfer of content from device 2), the device 2 obtains the device 3 public key from device 3, performs a hash function 2 over the device 3 public key and the transaction 2 to produce a hashing resultant (e.g., preceding transaction to device 2) and performs a signature function 2 over the hashing resultant utilizing a device 2 private key to produce a device 2 signature.

[0049] Having produced the device 2 signature, the device 2 generates the transaction 3 to include the device 3 public key, the device 2 signature, device 3 content request to 2 information, and the previous content plus content from device 2. The device 3 content request to device 2 information includes one or more of a detailed content request, a query request, background content, and specific instructions from device 3 to device 2 for access to an object. The previous content plus content from device 2 includes one or more of content from an original source, content from any subsequent source after the original source, an identifier of a source of content, a serial number of the content, an expiration date of the content, content utilization rules, and results of previous blockchain validations.

[0050] Having produced the transaction 3 section of the block 3 a processing module (e.g., of the device 2, of the device 3, of a transaction mining computing entity, of another computing device), generates the header section by performing a hashing function over the transaction section 3 to produce a transaction 3 hash, performing the hashing function over the preceding block (e.g., block 2) to produce a block 2 hash. The performing of the hashing function may include generating a nonce such that when performing the hashing function to include the nonce of the header section, a desired characteristic of the resulting hash is achieved (e.g., a desired number of preceding zeros is produced in the resulting hash which is subsequently verified, and where the number of zeros is adapted for a subset of blocks).

[0051] Having produced the block 3, the device 2 sends the block 3 to the device 3, where the device 3 initiates control of the blockchain. Having received the block 3, the device 3 validates the received block 3. The validating includes one or more of verifying the device 2 signature over the preceding transaction section (e.g., transaction 2) and the device 3 public key utilizing the device 2 public key (e.g., a re-created signature function result compares favorably to device 2 signature) and verifying that an extracted device 3 public key of the transaction 3 compares favorably to the device 3 public key held by the device 3. The device 3 considers the received block **3** validated when the verifications are favorable (e.g., the authenticity of the associated content is trusted). A technological improvement is provided over prior art communication and computing systems associated with data management since only the device possessing control over a block may modify the block as part of such a tightly integrated overall data management process. Only a present trusted device may pass the control to a next trusted device that is part of the overall data management process. Only blocks with nonces of an expected number of zeros are trusted.

[0052] The method described above in conjunction with a processing module of any computing entity of the computing system can alternatively be performed by other specialty modules of the computing system of FIG. **1** or by other specialty devices. In addition, at least one memory section that is non-transitory (e.g., a non-transitory computer readable storage medium, a non-transitory computer readable memory organized into a first memory element, a second memory element, a third memory element, a fourth element section, a fifth memory element, a sixth memory element, etc.) that stores operational instructions can, when executed by one or more processing modules of the one or more computing entities of the computing system, cause one or more computing devices of the computing system to perform any or all of the method steps described above.

[0053] FIGS. **6**A-**6**B are schematic block diagrams of another embodiment of a computing system illustrating an example of a self-forming communication and control system. The computing system includes the object **24-1** of FIG. **1**, the computing entity **21**-N of FIG. **1**, and the computing entity **22** of FIG. **1**. The object **24-1** includes a physical object such as material in a factory premise where the material includes one or more of factory machinery, work in progress, and finished goods of inventory. The factory includes production steps where the material is moving or in a static condition. When moving, the movement includes one or more of circular motion (e.g., a circular motion vector), linear motion (e.g., a uniform motion vector), and complex motion (e.g., varying vectors).

[0054] FIG. **6**A illustrates an example of operation of a method for processing data of the self-forming communication and control system where a first step includes the processor of the computing entity **21**-N executing environment interpretation software from a first memory causing the processor to detect and identify a plurality of objects including object **24-1** of an environment based on environment signaling **30** of the environment and premise messages exchanged with another processor to produce an identified object identifier for each object of the identified plurality of objects. The objects include at least one of a physical object and a virtual object. The physical object within the environment when the environment includes a physical environment and a virtual object within the environment when the environment includes a virtual environment. The premise messages include object profile information for each identified object. The object profile information includes one or more of object basics, object deployment information, and object availability information. For example, the processor interprets environment signaling **30** from a visual sensor **122** of the environment sensor module **14** that reveals an image of object **24-1**. As another example, the processor interprets premise messages **33** from another processor of the environment to recover the object profile information.

[0055] The detecting of the object includes a variety of sub-steps. A first sub-step includes the processor obtaining the environment signaling of the environment from an environment sensor module. For example, an image sensor of the environment sensor module **14** captures imagery of the object **24-1**, such as widgets moving down a conveyor belt.

[0056] A second sub-step includes the processor indicating the physical object as the detected object when identifying a physical object pattern from at least one of an unencoded direct electromagnetic emission, an unencoded indirect electromagnetic emission, and an unencoded mechanical wave of the environment signaling. For example, the processor utilizes object image detecting software to detect the object **24-1** based on the image from the image sensor (e.g., unencoded direct electromagnetic emission such as light). The detecting includes at least one of detecting a specific object, object type, and an unknown object. The image detecting software further includes a variety of approaches including comparing pixels of the captured image to pixels of a stored image recovered from the twin memory **58**. A second approach includes utilizing machine learning to detect the object when a likelihood of detection is greater than a threshold level when comparing the image from the image sensor to knowledge of the AI memory **59**.

[0057] Alternatively, the second sub-step includes the processor indicating the virtual object as the detected object when identifying a virtual object pattern from at least one of an encoded electromagnetic emission, an encoded electronic signal, and an encoded mechanical wave of the environment signaling. For example, the processor interprets data from the wireless communication modem **86** that results from the wireless communication modem **86** receiving an encoded electronic admission (e.g., an encoded wireless signal from a device associated with the object **24-1**). As another example, the process interprets the data from the network interface module **72** of FIG. **3** from the wired LAN **88** sourced by a device (e.g., a factory computer) associated with the object **24-1**.

[0058] In an embodiment, the first step further includes the processor of the computing entity **21**-N executing object learning software from a fourth memory causing the processor to interpret other environment signaling for a corresponding plurality of other objects (e.g., of the environment or another environment) associated with a particular identifier value within the environment to produce other object tracking information. For example, the processor tracks other similar objects to establish an artificial intelligence (AI) memory.

[0059] Having gathered the other object tracking information, the processor of the computing entity **21**-N stores the other object tracking information in the AI memory as a plurality of historical object behavior observations associated with the corresponding plurality of other objects to establish a memory learnings of the AI memory. From time to time, the processor of the computing entity **21**-N recovers a portion of the plurality of historical object behavior observations from the AI memory and infers the object learnings based on an interpretation of the portion of the plurality of historical object behavior observations as prescriptive information, the object learnings predicting future object behavior of the identified plurality of objects. The prescriptive information includes one or more of object learnings based on an interpretation of a plurality of historical object behavior observations associated with a corresponding plurality of other objects each of the other objects associated with the particular identifier value and, in an embodiment, an evaluation of the object learnings against a standard.

[0060] Having detected the object **24-1**, the first step of the example method of operation further includes the processor of the computing entity **21**-N executing object identification software from the first memory to facilitate intercommunication between the environment interpretation software and the object identification software to produce an identified object and object profile information based on the detected object and an object knowledge database (e.g., the memory **58**, the AI memory **59**). The object profile information includes the object information **202** of FIG. **5**A, and further includes object basics, object deployment information, and object availability information.

[0061] In an embodiment, the producing of the identified object includes a series of sub-steps. A first sub-step includes the processor accessing a portion of the twin memory **58** (e.g., hereafter interchangeably referred to as twin memory or digital twin memory) that includes an object knowledgebase based on the detected object (e.g., utilizing identity of the detected object as an index into the knowledgebase). A second sub-step includes the processor comparing an attribute of detection of the detected object to the portion of the digital twin memory that includes the object knowledgebase to produce the identified object. For example, the processor compares the widget detected object to the portion of the twin memory and matches to a particular widget (e.g., a candy) as the identified object.

[0062] A third sub-step includes the processor accessing the portion of the digital twin memory that includes the object knowledgebase based on the detected object to further produce object profile information for the identified object. For example, the processor accesses the twin memory **58** to retrieve the object profile information with regards to the particular widget. For instance, the object profile information includes parameters associated with the candy such as volume per unit of time ranges, weight ranges, size information, expected movement vector information while on the conveyor or other device within manufacturing, etc.

[0063] As another example, the processor sources the object profile information from the object knowledgebase based on one or more of the identified object and the environment signaling **30**. The object knowledgebase within the AI memory **59** includes information stored as knowledge with regards to objects that is part of one or more AI computing entities. For example, the processor applies machine learning to the detected object while accessing the object knowledgebase stored in the AI memory **59** to produce the identified object. The processor indexes the twin memory **58** utilizing the identified object to recover the object profile information (e.g., retrieve, generate using a portion affiliated with the identified object of the object knowledgebase as new object profile information based on most recent observations).

[0064] In another embodiment utilizing the AI memory **59**, the processor of computing entity **21**-N executes profile generation software from a second memory to facilitate intercommunication between the environment interpretation software and the profile generation software causing the processor to produce the object profile information for the identified object based on a particular identifier value of the identified object. In an embodiment, the processor further exchanges prescriptive information associated with each identified object with the AI memory **59**. For example, the processor recovers the prescriptive information from the AI memory **59** when the processor requires the prescriptive information associated with the identified object. As another example, the processor updates the prescriptive information within the AI memory **59** when the processor has produced updated prescriptive information.

[0065] From time to time, the processor updates the object profile information. For example, the processor of the computing entity **21**-N executes further profile generation software from the second memory causing the processor to produce updated object profile for at least some of the plurality of objects based on the corresponding particular identifier value of each identified object and updated prescriptive information associated with the particular identified object within the AI memory **59**. The updated object profile information includes one or more of updated object basics, updated object deployment information, and updated object availability information. The updated prescriptive information includes one or more of updated object learnings based on another interpretation of the plurality of historical object behavior observations associated with the corresponding plurality of other objects each of the other objects associated with the particular identifier value and another evaluation of the updated object learnings against the standard.

[0066] FIG. **6**B further illustrates the example of operation of the method for processing data of the self-forming communication and control system where a third step includes the processor of the computing entity **21**-N executing object tracking software from a third memory to facilitate intercommunication between the profile generation software and the object tracking software causing the processor to interpret further environment signaling for the plurality of objects within the environment using the object profile information to produce object tracking information for storage within the digital twin memory **58**. The object tracking information is available to be subsequently recovered from the digital twin memory **58** and utilized to virtually represent the plurality of objects within a virtual representation of the environment.

[0067] For example, the processor stores the object tracking information in the twin memory **58** of the computing entity **21**-N along with timestamp information, indexed by at least one of time, object type, object identifier (ID), premise ID, or any other feasible index to facilitate subsequent generation of dashboard information and more. As another example, the processor issues premise messages **33** to the computing entity **22**, where the premise messages **33** includes the object tracking information for storage in the twin memory **58** of the computing entity **22**.

[0068] A fourth step of the example includes the processor of computing entity **21**-N executing dashboard software from a fifth memory to facilitate intercommunication between the object tracking software and the dashboard software causing the processor to interpret a portion of the object tracking information for the plurality of objects recovered from the digital twin memory to produce dashboard information. The dashboard information comprising a representation of status of the plurality of objects based on the further environment signaling and in accordance with the object profile information. Examples include graphical representations of an image of the object, the number of revolutions per unit of time over several observation timeframes, the counts of passing objects that are similar within another timeframe, the complex motion pattern, and any other representation of the real-world environment.

[0069] The fourth step further includes the processor of computing entity **21**-N executing further dashboard software from the fifth memory causing the processor to obtain the portion of the object tracking information that corresponds to the further environment signaling for a particular identified object recovered from the digital twin memory. The processor interprets the portion of the object tracking information in accordance with the object profile information to produce the dashboard information. For example, the processor generates a tabular output indicating position information of the identified object over a series of time frames. As another example, the processor generates an animated representation of the identified object along with summary metrics indicating volume per unit of time for similar objects (e.g., pieces of candy moving down a conveyor belt or chute).

[0070] In yet another example, the processor selects a portion of the object tracking information based on detecting an anomaly and interpreting the selected portion of the object tracking information recovered from the twin memory **58** utilizing the object profile information (e.g., expected movement, graphic backgrounds, graphic foregrounds, etc.) to produce the dashboard information to bring attention to the anomaly. The processor stores the dashboard information in the digital twin memory **58** for subsequent utilization including providing a graphic output to a user interface output device, processing the dashboard information by an AI processor to provide a high level summary and/or to produce prescriptive information (e.g., corrective actions to abate the anomaly), and sending the dashboard information to another computing entity.

[0071] A fifth step of the example includes the processor of computing entity **21**-N executing prescriptive software from a sixth memory to facilitate intercommunication between the dashboard software and the prescriptive software causing the processor to process a portion of the dashboard information to produce the prescriptive information within the AI memory **59**. The prescriptive information comprising one or more of an interpretation of the portion of the dashboard information, an evaluation of the portion of the dashboard information against the standard, and adaptive processor-executable instructions for use with the object profile information and the further environment signaling to cause change with regards to the plurality of objects within the environment.

[0072] The processing of the portion of the dashboard information to produce the prescriptive information includes a series of sub-steps. In a first sub-step the processor obtains the portion of the dashboard information corresponding to a prescriptive timeframe from the digital twin memory. For example, the processor accesses the twin memory **58** to obtain the portion of the dashboard information for a timeframe associated with the example anomaly.

[0073] In a second sub-step the processor processes the portion of the dashboard information in accordance with the object profile information to produce preliminary prescriptive information. The preliminary prescriptive information indicates issues, high level suggested actions, course corrections, etc. associated with the example anomaly. For example, the processor applies generative AI to the portion of the dashboard information in accordance with the object profile information to identify high level information and suggestions.

[0074] In a third sub-step the processor determines a format for the prescriptive information based on the preliminary prescriptive information and an object knowledgebase of the AI memory. For example, the processor applies the generative AI to the preliminary prescriptive information in accordance with the object profile information to obtain more the format that is more granular for the situation.

[0075] In a fourth sub-step the processor interprets the portion of the dashboard information in accordance with the format for the prescriptive information to produce the prescriptive information. For example, the processor once again utilizes the generative AI approach to process the portion of the dashboard information utilizing the format to produce the prescriptive information that carries a more targeted outcome. In a fifth sub-step the processor stores the prescriptive information within the AI memory **59** to facilitate even better future prescriptive information and to provide an output for the present system. A technological improvement is provided by the self-forming communication and control system such that subsequent monitoring by the premise interface **15** of FIG. **1** alone can suffice to abate issues (e.g., without processing at the digital twin environment **17** level) and provide summary information to the digital twin environment **17**.

[0076] The fifth step of the example further includes the processor of computing entity **21**-N executing further prescriptive software from the sixth memory causing the processor to determine tracking parameters of the object tracking of the plurality of objects based on the object profile information. For example, recovering the tracking parameters from the AI memory **59** associated with previously successful tracking scenarios.

[0077] The processor determines signaling parameters of the further environment signaling based on the identified object and generates the processor-executable instructions based on the tracking parameters and the signaling parameters to facilitate subsequent collection of the further environment signaling associated with the identified object to provide the object tracking of the identified object within the environment. For example, establish what types of signaling to expect of the further environment signaling for the identified object by extracting the signaling parameters for the identified object from the twin memory **58**. As another example, the processor utilizes generative AI and the knowledgebase of the AI memory **59** to predict what present and/or future types of signaling to expect of the further environment signaling for the identified object.

[0078] The fifth step of the example further includes the processor of computing entity **21**-N executing further prescriptive software from the sixth memory causing the processor to obtain the portion of the dashboard information corresponding to a prescriptive timeframe from the digital twin memory, process the portion of the dashboard information in accordance with the object profile information to produce preliminary prescriptive information, determine a format for the prescriptive information based on the preliminary prescriptive information and an object knowledgebase of the AI memory, interpret the portion of the dashboard information in accordance with the format for the prescriptive information to produce the prescriptive information, and store the prescriptive information within the AI memory **59**.

[0079] In an embodiment, the processor of the computing entity **22** issues further premise messages **33** to the computing entity **21**-N (e.g., and others) to include the prescriptive information for storage in the AI memory **59** of the computing entity **21**-N and others. In the embodiment, the computing entity **21**-N issues environment signaling **30** to a device associated with the object **24-1** to facilitate commands when the prescriptive information includes adaptations to abate issues and improve results.

[0080] The method described above in conjunction with a processing module of any computing entity of the computing system can alternatively be performed by other specialty modules of the computing system of FIG. **1** or by other specialty devices. In addition, at least one memory section that is non-transitory (e.g., a non-transitory computer readable storage medium, a non-transitory computer readable memory organized into a first memory element, a second memory element, a third memory element, a fourth element section, a fifth memory element, a sixth memory element, etc.) that stores operational instructions can, when executed by one or more processing modules of the one or more computing entities of the computing system, cause one or more computing devices of the computing system to perform any or all of the method steps described above.

[0081] FIGS. **7**A-**7**B are schematic block diagrams of another embodiment of a computing system illustrating an example of a self-forming communication and control system. The computing system includes the object **24-1** of FIG. **1**, the object **24-2** of FIG. **1**, the computing entity **21-1** of FIG. **1**, and the computing entity **21-2** of FIG. **1**. The objects **24-1** and **24-2** each include a lighting controller with a unique lighting controller identifier (ID) and a light controlled by the lighting controller.

[0082] FIG. **7**A illustrates an example of operation of a method for processing data of the self-forming communication and control system where a first step includes the processor of the computing entity **21-1** executing environment interpretation software from a first memory causing the processor to detect a set of lighting objects of an environment based on at least one of environment signaling **30** of the environment and premise messages **33** exchanged with another processor (e.g., of computing entity **21-2**) to produce a set of detected lighting objects. Each lighting object of the set of lighting objects includes an illumination component (e.g., a set of lights) and a lighting control component (e.g., a lighting controller).

[0083] The detecting of the set of lighting objects includes a variety of sub-steps. A first sub-step includes the processor obtaining the environment signaling of the environment from an environment sensor module. For example, an image sensor of the environment sensor module **14** captures imagery of the object **24-1**, such as a lighting fixture and/or light from a lighting fixture.

[0084] A second sub-step includes the processor indicating the physical object as the detected object when identifying a physical object pattern from at least one of an unencoded direct electromagnetic emission, an unencoded indirect electromagnetic emission, and an unencoded mechanical wave of the environment signaling. For example, the processor utilizes object image detecting software to detect the object **24-1** based on the image from the image sensor (e.g., unencoded direct electromagnetic emission such as light). The detecting includes at least one of detecting a specific object, object type, and an unknown object. The image detecting software further includes a variety of approaches including comparing pixels of the captured image to pixels of a stored image recovered from the twin memory **58**. A second approach includes utilizing machine learning to detect the object when a likelihood of detection is greater than a threshold level when comparing the image from the image sensor to knowledge of the AI memory **59**.

[0085] Alternatively, the second sub-step includes the processor indicating a virtual object as the detected object when identifying a virtual object pattern from at least one of an encoded electromagnetic emission, an encoded electronic signal, and an encoded mechanical wave of the environment signaling. For example, the processor interprets data from the wireless communication modem **86** that results from the wireless communication modem **86** receiving an encoded electronic admission (e.g., an encoded wireless signal from a light control associated with the object **24-1**). As another example, the process interprets the data from the network interface module **72** of FIG. **3** from the wired LAN **88** sourced by a device (e.g., a light control) associated with the object **24-1**.

[0086] As yet another example, the processor interprets output of visual sensor **122** that portrays unique patterns of light from lights within visual range of the visual sensor **122** (e.g., encoded unique identifier that correlates to identifier information of the premise messages **33**, simple timed flash pattern, etc.) as the environment signaling **30** from each of objects **24-1** and **24-2** to detect the lighting objects. As a still further example, the processor interprets premise messages **33** via the wireless communication modem **86** to identify lighting controllers common to a premise as the set of detected lighting objects. Some lighting controllers may not be in visual range of the visual sensor **122** but nevertheless are detectable by way of interpreting the premise messages **33**.

[0087] Having produced the set of detected lighting objects for the premise of the computing entity **21-1**, a second step of the example method of operation includes the processor establishing lighting observations. The establishing includes a series of sub-steps. A first sub-step includes the processor executing instruction generation software from a second memory to facilitate intercommunication between the environment interpretation software and the instruction generation software to generate processor-executable instructions for use by the processor to subsequently monitor at least one of further environment signaling of the environment and further premise messages associated with the set of detected lighting objects. The instructions pertain to observing the lighting of the set of detected lighting objects within the environment in a format ready to use by the processor such as one or more of timestamping when, if possible, a particular light is on or off, when some light is on or off and what relative level of illumination.

[0088] The generation of the instructions includes a series of sub-steps. A first sub-step includes determining monitoring parameters for the processor to subsequently monitor the set of detected lighting objects based on the as-is configuration information. For example, utilizing an image sensor to look for illumination patterns. A second sub-step includes determining signaling parameters of the further environment signaling based on as-is configuration information. For example, determining which image sensors are associated with which lighting objects to monitor other lighting objects that are within range to visually monitor in accordance with the as-is configuration information.

A third sub-step includes determining messaging parameters of the further premise messages based on the as-is configuration information. For example, determining formatting of expected further premise messages **33** between the set of lighting objects. A fourth sub-step includes generating the processor-executable instructions based on the monitoring parameters, the signaling parameters, and the messaging parameters to produce the processor-executable instructions to facilitate subsequent collection of the further environment signaling associated with the set of detected lighting objects. For example, pseudocode steps are generated based on the various parameters. As another example, actual executable software for the processor is generated based on the various parameters. Alternatively, or in addition to, the generation includes extracting instructions from the AI memory based on as-is configuration information for the set of detected lighting objects, generating new instructions based on the as-is configuration information and previous instructions from the AI memory for similar objects, and decoding the instructions from at least one of the environment signaling **30** and the premise messages **33**.

[0089] A third step of the example of operation includes the processor executing object monitor software from a third memory to facilitate intercommunication between the instruction generation software and the object monitor software to store object monitor information for the set of detected lighting objects within a digital twin memory by applying the processor-executable instructions to the at least one of the further environment signaling of the environment and the further premise messages associated with the set of detected lighting objects. The object monitor information includes observations of the lights with regards to on/off times and the illumination levels in accordance with the instructions.

[0090] The obtaining and storing of the object monitor information includes a series of sub-steps. A first sub-step includes obtaining the further environment signaling over a pattern development timeframe. For example, the visual sensor **122** of the computing entity **21-1** monitors environment signaling **30** from the object **24-1** and the object **24-2** over the pattern development timeframe (e.g., 5 minutes to collect enough lighting samples to enable determining the as-is configuration information. A second sub-step includes obtaining the further premise messages over the pattern development timeframe. For example, the wireless communication modem **86** of the computing entity **21-1** monitors, for at least the pattern development timeframe, the further premise messages **33** from the computing entity **21-2** to produce the further premise messages.

[0091] A third sub-step includes interpreting the further environment signaling and the further premise messages utilizing the processor-executable instructions to produce the object monitor information. For example, a composite of the further environment signaling and the further premise messages produces the object monitor information. A fourth sub-step includes storing the object monitor information in a portion of the digital twin memory associated with the set of detected lighting objects. For example, the computing entity **21-1** stores the object monitor information in this twin memory **58**, indexed by at least one of time, object type, object identifier (ID), premise ID, lights on/off, illumination levels, lighting types, lighting locations in the premise, or any other feasible index to facilitate subsequent generation of dashboard information and/or configuration information.

[0092] FIG. **7**B further illustrates the example of operation of the method for processing data of the self-forming communication and control system where a fourth step includes the processor of the computing entity executing configuration software from a fourth memory to facilitate intercommunication between the object monitor software and the configuration software to interpret a portion of the object monitor information for the set of detected lighting objects from the digital twin memory to produce the as-is configuration information for the set of detected lighting objects. The as-is configuration information includes spatial placement information of at least some of the set of detected lighting objects, such as absolute locations in the premise and relative locations with reference to any other object or device in the premise. A technological improvement is provided in this auto-detection over determining or manually entering the as-is configuration. Subsequent modifications to the configuration can be automatically detected.

[0093] The processor produces the as-is configuration information utilizing a series of sub-steps. A first sub-step includes determining a test pattern for the set of detected lighting objects. The test pattern includes an illumination and de-illumination sequence to discern spatial relationships between the set of detected lighting objects. For example, turning off the light next to another light to make sure that the 2 are especially next to each other.

[0094] A second sub-step includes facilitating initiation of the test pattern by the set of detected lighting objects for a testing timeframe. For example, the computing entity **21-1** utilizes the control output device **106** to send environmental signaling **30** that includes the test pattern to the lake control of the objects **24-1** and **24-2**.

[0095] A third sub-step includes interpreting the portion of the object monitor information for the set of detected lighting objects from the digital twin memory that corresponds to the testing timeframe to produce the spatial placement information. For example, inferring the spatial placement information based on lighting patterns initiated and received as indicated by the object monitor information.

[0096] Alternatively, or in addition to, another approach includes selecting a portion of the object monitor information based on detecting a lighting anomaly (e.g., error, user input, improper illumination, etc.) and interpreting the selected portion of the object monitor information recovered from the twin memory **58** utilizing the as-is configuration information (e.g., typical lighting deployments, etc.) to produce the as-is configuration information. The processor stores the as-is configuration information in the digital twin memory **58** for subsequent utilization including providing a graphic output to a user interface output device, processing the as-is configuration information by an AI processor to provide a high level summary and/or to produce prescriptive information (e.g., general lighting control, corrective actions to abate the anomaly), and sending the as-is configuration information to another computing entity.

[0097] A fifth step of the example method of operation includes the computing entity **21-1** executing dashboard software from a fifth memory to facilitate intercommunication between the object monitor software and the dashboard software to interpret a portion of the object monitor information for the set of detected lighting objects from the digital twin memory to produce dashboard information in accordance with the as-is configuration information. The dashboard information comprising a representation of status of the set of detected lighting objects based on the at least one of the further environment signaling of the environment and the further premise messages associated with the set of detected lighting.

[0098] The producing of the dashboard information includes a series of sub-steps. A first sub-step includes obtaining the portion of the object monitor information that corresponds to the further environment signaling for the set of detected lighting objects from the digital twin memory. For example, the computing entity **21-1** extracts the object monitor information from the twin memory **58**. A second sub-step includes interpreting the portion of the object monitor information in accordance with the as-is configuration information to produce the dashboard information. For example, a graphic is rendered to represent the spatial placement information of the set of detected lighting objects along with a representation of an illumination level (e.g., real-time or historical based on a desired time frame). As another example, the graphic is further rendered to indicate areas of concern such as poor illumination, no illumination, requested but unfulfilled illumination, unrequested over illumination, and any other anomaly of concern.

[0099] Having produced the as-is configuration information, a sixth step of the example method operation includes the processor executing lighting control software from a sixth memory to facilitate intercommunication between the object monitor software and the lighting control software to facilitate control of at least some of the set of detected lighting objects utilizing the as-is configuration information. The processor facilitates the control to achieve a target level of energy efficiency, such as, that compared to control without the as-is configuration information. Instances of control to achieve the target level of energy efficiency include turning off unneeded lights, adjusting the illumination level to balance making operational and energy requirements, and even changing a lighting pattern randomly to affect mood.

[0100] The processor facilitates the control utilizing a variety of approaches including selecting the portion of the as-is configuration information based on detecting a lighting anomaly and interpreting the selected portion of the as-is configuration information recovered from the twin memory **58** utilizing the as-is configuration information (e.g., what control aspects may abate the anomaly) to produce environment signaling **30** that includes a lighting command for a lighting controller. As another example, the processor issues premise message **33** to the computing entity **21-2** to facilitate the processor of computing entity **21-2** issuing environment signaling **30** to object **24-2** to control the light associated with object **24-2**. As yet another example, the processor facilitates the control to shape a light pattern based in a user request. As a still further example, the processor facilitates the control to determine where a lighting object should be installed, moved, or decommissioned.

[0101] Having processed lighting control software, a seventh step of the example of operation includes executing prescriptive software from a seventh memory to facilitate intercommunication between the dashboard software and the prescriptive software to process a portion of the dashboard information to produce prescriptive information within an artificial intelligence (AI) memory. The prescriptive information comprising one or more of an interpretation of the portion of the dashboard information, an evaluation of the portion of the dashboard information against a standard, and adaptive processor-executable instructions for use with the as-is configuration information and the further environment signaling to cause to facilitate the control of the at least some of the set of detected lighting objects.

[0102] The executing the prescriptive software from the seventh memory includes a series of sub-steps. A first sub-step includes obtaining the portion of the dashboard information corresponding to a prescriptive timeframe from the digital twin memory. For example, the computing entity **21-1** recovers a portion of the dashboard information from the twin memory **58** for a time frame of the last 30 minutes.

[0103] A second sub-step includes the processing of the portion of the dashboard information in accordance with the as-is configuration information to produce preliminary prescriptive information. For example, the portion of the dashboard information is compared to expected operational results based on the as-is configuration information.

[0104] A third sub-step includes determining a format for the prescriptive information based on the preliminary prescriptive information and an object knowledgebase of the AI memory **59**. For example, the prescriptive information indicates to add additional lighting fixtures when the format includes enablement of adding more lighting fixtures. As another example, the prescriptive information indicates to change the lighting pattern for existing lighting when the format includes utilizing existing resources in a more optimal fashion to save on energy costs.

[0105] A fourth sub-step includes interpreting the portion of the dashboard information in accordance with the format for the prescriptive information to produce the prescriptive information. For example, generating instructions with regards to the adding more lighting fixtures. As another example of facilitating control of the existing set of detected lighting objects to optimize energy efficiency. A fifth sub-step includes storing the prescriptive information within the AI memory **59**. For example, the computing entity **21-1** stores the prescriptive information within the AI memory **59** of the computing entity **21-1** and issues the prescriptive information via a premise message **33** to the computing entity **21-2** to facilitate storage of the prescriptive information in the AI memory **59** of the computing entity **21-2**.

[0106] The method described above in conjunction with a processing module of any computing entity of the computing system can alternatively be performed by other specialty modules of the computing system of FIG. **1** or by other specialty devices. In addition, at least one memory section that is non-transitory (e.g., a non-transitory computer readable storage medium, a non-transitory computer readable memory organized into a first memory element, a second memory element, a third memory element, a fourth element section, a fifth memory element, a sixth memory element, etc.) that stores operational instructions can, when executed by one or more processing modules of the one or more computing entities of the computing system, cause one or more computing devices of the computing system to perform any or all of the method steps described above.

[0107] FIGS. **8**A-**8**B are schematic block diagrams of another embodiment of a computing system illustrating an example of a self-forming communication and control system. The computing system includes at least one medical treatment device **300**, the computing entity **21**-N of FIG. **1**, and the computing entity **22** of FIG. **1**. The medical treatment device **300** includes environment sensor module **14** of FIG. **2**B, the computing entity **20-1** of FIG. **1**, and the control output device **106** of FIG. **3**.

[0108] The medical treatment device **300** includes a variety of implementations to monitor and treat human patients within a medical treatment environment (e.g., a hospital, a care facility, a home). The monitoring includes the computing entity **20-1** interpreting environment sensor information **150** (e.g., brain waves, heartbeat electrical impulses, temperature, etc.) from the environment sensor module **14** to broadly produce vital signs of a human patient. The treating includes the computing entity **20-1** issuing medical treatment data is **302** to the control output device **106** to facilitate medical treatment of the human patient (e.g., administer medications, provide physical therapy assistance, apply an electrical current to the human patient, provide a visual, audible, and/or haptic/mechanical message to the human patient, etc.).

[0109] FIG. **8**A illustrates an example of operation of a method for processing data of the self-forming communication and control system where a first step includes the processor of the computing entity **21**-N executing environment interpretation software from a first memory causing the processor to detect and identify a plurality of (e.g., in some embodiments, one or more) medical treatment devices **300** of a medical treatment environment based on at least one of environment signaling **30** of the medical treatment environment and premise messages **33** exchanged with another processor to produce an identified medical treatment device identifier for each medical treatment device of the identified plurality of medical treatment devices.

[0110] Each medical treatment device of the plurality of medical treatment devices includes at least one of a physical object within the medical treatment environment when the medical treatment environment includes a physical environment and a virtual object within the medical treatment environment when the medical treatment environment includes a virtual environment. The environment signaling comprising at least one of an unencoded direct electromagnetic emission, an unencoded indirect electromagnetic emission, an encoded electromagnetic emission, an encoded electronic signal, an unencoded mechanical wave, and an encoded mechanical wave. The premise messages comprising object profile information for each identified medical treatment device, the object profile information comprising one or more of object basics (e.g., model identifier, capabilities, etc.), object deployment information (e.g., including indoor location information), and object availability information (e.g., including an operational status).

[0111] The detecting and identifying the plurality of medical treatment devices includes a series of sub-steps. A first sub-step includes the processor obtaining the environment signaling **30** of the medical treatment environment from the environment sensor module **14** of the medical treatment device **300** and/or of the computing entity **21-1**. A second sub-step includes the processor indicating the physical object as a particular identified medical treatment device when identifying a physical object pattern from at least one of the unencoded direct electromagnetic emission, the unencoded indirect electromagnetic emission, and the unencoded mechanical wave of the environment signaling. In an example of the identifying, the processor interprets environment signaling **30** from a visual sensor **122** of the environment sensor module **14** of the computing entity **21-1** that reveals an image of the medical treatment device **300**. In another example, the processor interprets environment signaling **30** from the medical treatment device **300** and extracts the identifier of the medical treatment device **300** from the environment signaling **30**. As yet another example, the processor interprets premise messages **33** from another processor of the medical treatment environment to recover the identifier.

[0112] A third sub-step of the detecting and identifying includes the processor indicating the virtual object as a particular detected object when identifying a virtual object pattern from at least one of the encoded electromagnetic emission, the encoded electronic signal, and the encoded mechanical wave of the environment signaling. For example, the processor interprets premise messages **33** from another computing entity that is running a simulation of a virtual medical treatment device. The processor indicates the virtual object when the interpretation reveals that the other computing entity is running the simulation of the virtual medical treatment device.

[0113] Having detected and identified the plurality of medical treatment devices, a second step of the example method of operation includes the processor of the computing entity **21-1** executing profile generation software to facilitate intercommunication between the environment interpretation software and the profile generation software causing the processor to exchange prescriptive information associated with each identified medical treatment device identifier with the artificial intelligence (AI) memory **59**. The prescriptive information includes object learnings based on an interpretation of a plurality of historical patient care observations associated with at least one medical treatment device of the plurality of medical treatment devices and a plurality of other medical treatment devices associated with another medical treatment environment (e.g., how the medical treatment devices have been acquired, deployed, utilized, stored, idled, misplaced, repaired, which patients have been treated, outcomes of patient treatment etc.).

[0114] In an embodiment, the example method includes the processor executing profile generation software causing the processor to produce updated object profile information for at least some of the plurality of medical treatment devices based on corresponding identified medical treatment device identifiers and updated prescriptive information associated with a particular identified medical treatment device of the plurality of medical treatment devices within the AI memory **59**. The updated object profile information includes one or more of updated object basics, updated object deployment information, and updated object availability information. The updated prescriptive information includes one or more of updated object learnings based on another interpretation of the plurality of historical patient care observations associated with the corresponding plurality of other medical treatment devices associated with the other medical treatment environment each of the other medical treatment devices associated with the other medical treatment environment and an evaluation of the updated object learnings against a standard.

[0115] In yet another embodiment, the example method includes the processor further executing the environment interpretation software causing the processor to access a portion of the digital twin memory **58** that includes an object knowledgebase based on a particular identified medical treatment device and compare an attribute of detection of the particular identified medical treatment device to the portion of the digital twin memory that includes the object knowledgebase to produce the particular identified medical treatment device. The processor further accesses the portion of the digital twin memory that includes the object knowledgebase based on the particular identified medical treatment device to produce the object profile information.

[0116] In a still further embodiment, the example method includes the processor executing AI optimization software causing the processor to manage the patient care provided by at least some of the plurality of medical treatment devices by a series of sub-steps. In a first sub-step, includes the processor obtaining a portion of recovered prescriptive information associated with a first medical treatment device of the plurality of medical devices from the AI memory. For example, the processor accesses the AI memory **59** to recover the prescriptive information associated with the medical treatment device **300**.

[0117] A second sub-step includes the processor identifying a historical operational trend for the first medical device based on the portion of recovered prescriptive information. For example, the processor identifies knowledge of the AI memory **59** that includes everything historically that the first medical device has been utilized for and what resulted in terms of performance and patient outcome results.

[0118] A third sub-step includes the processor detecting a patient care performance metric of the historical operational trend for the first medical device that is outside of an expected performance range. For example, the processor detects that the first medical device is underperforming with regards to detection of patient status information and/or inducement of a favorable patient outcome results.

[0119] A fourth sub-step includes the processor identifying an optimization for the first medical device based on the patient care performance metric of the historical operational trend for the first medical device that is outside of the expected performance range and a historical remediation of the portion of recovered prescriptive information that is expected to produce a future patient care performance metric of a future historical operational trend for the first medical device that is inside of the expected performance range. For example, the processor identifies the optimization for the underperformance where the optimization has been used previously with success.

[0120] A fifth sub-step includes the processor generating the object command information based on the optimization for the first medical device. For example, the processor formats a set of steps associated with the optimization that is compatible with at least one of the environment signaling **30** and the premise messages **33**.

[0121] A sixth sub-step includes the processor facilitating communication of the object command information to the first medical device. For example, the processor utilizes the wireless communication modem **86** to communicate the at least one of the environment signaling **30** and the premise messages **33** to the medical treatment device **300** to invoke the optimization. The medical treatment device **300** utilizes the steps of the optimization as part of the management of the patient care provided by medical treatment device **300**.

[0122] FIG. **8**B further illustrates the example method of operation, having exchanged the prescriptive information, a third step includes the processor of the computing entity **21**-N executing object tracking software to facilitate intercommunication between the profile generation software and the object tracking software causing the processor to exchange further environment signaling for the plurality of medical treatment devices within the medical treatment environment using the object profile information and at least some of the prescriptive information to produce patient care tracking information in response to object command information for storage within the digital twin memory **58**. The patient care tracking information is available to be subsequently recovered from the digital twin memory **58** and utilized to virtually represent patient care provided by at least some of the plurality of medical treatment devices within a virtual representation of the medical treatment environment and to subsequently generate the object command information. The object command information includes one or more of device configuration parameters (e.g., software options, hardware options), device deployment instructions (e.g., location of use, a patient ID, duration of a deployment, etc.), and device operational steps (e.g., specific tasks for execution based on any number of environment conditions and trajectory of care guidance). For example, the object tracking information depicts icons for each medical treatment device along with indoor location information and patient care status in the virtual representation. As another example, the object tracking information further includes a schedule for future utilization of the medical treatment device. As yet another example, the object command information includes instructions and parameters to manage patient care of an infant rather than an adult.

[0123] In another embodiment, the method includes the processor executing ledger software to facilitate intercommunication between the object tracking software and the ledger software causing the processor to memorialize the patient care tracking information in an object distributed ledger as generally discussed with reference to FIGS. **5**A-**5**D. The memorializing of the object tracking information includes a series of sub-steps. A first sub-step includes the processor obtaining a portion of the object distributed ledger (e.g., from the twin memory **58**). A second sub-step includes the processor hashing a portion of the patient care tracking information utilizing a receiving public key associated with the object distributed ledger (e.g., a public key of a next controlling computing entity of the object distributed ledger) to produce a next transaction hash value.

[0124] A third sub-step includes the processor encrypting the next transaction hash value utilizing a private key of the processor (e.g., of the computing entity **21**-N) to produce a next transaction signature. A fourth sub-step includes the processor generating a next block of a blockchain of the object distributed ledger to include the portion of the patient care tracking information and the next transaction signature. A fifth sub-step includes the processor causing inclusion of the next block in the object distributed ledger (e.g., as previously discussed with reference to FIG. **5**D). For instance, the processor facilitates adding the next block to the object distributed ledger within the twin memory **58** and/or the AI memory **59** of the computing entity **21**-N. In another instance, the processor of the computing entity **22** facilitates adding the next block to the object distributed ledger within one or more of the twin memory **58** the AI memory **59** of the computing entity **22**. In yet another instance, the facilitation includes adding the next block to a copy of the object distributed ledger stored in one or more of the medical treatment devices.

[0125] In an embodiment, the processor of the computing entity **21**-N executes object learning software causing the processor to interpret other environment signaling for the corresponding plurality of other medical treatment devices associated with the other medical treatment environment to produce other patient care tracking information. The processor stores the other patient care tracking information in the AI memory **59** as the plurality of historical patient care observations associated with the corresponding plurality of other medical treatment devices. The processor recovers a portion of the plurality of historical patient care observations from the AI memory **59** and infers the object learnings based on an interpretation of the portion of the plurality of historical patient care observations as the prescriptive information. The object learnings providing guidance for future patient care provided by the plurality of medical treatment devices.

[0126] In an embodiment, the processor of the computing entity **21**-N executes object control software causing the processor to manage the patient care provided by at least some of the plurality of medical treatment devices by a series of sub-steps. A first sub-step includes the processor obtaining a portion of the patient care tracking information from the digital twin memory. For example, the processor identifies a first medical treatment device (e.g., medical treatment device **300**) to be managed (e.g., after receiving an activation signal that the medical treatment device **300** is now being utilized to treat a patient, a schedule, a list).

[0127] A second sub-step includes the processor identifying a historical operational trend for a first medical device of the plurality of medical devices based on the object tracking information. For example, the processor identifies previous utilizations of the medical treatment device **300** and extracts the historical operational trend from the object tracking information for the medical treatment device **300** with regards to patients.

[0128] A third sub-step includes the processor detecting a patient care performance metric of the historical operational trend for the first medical device that is outside of an expected performance range. For example, the processor detects that the operation of the medical treatment device **300** is not producing a favorable patient outcome fast enough.

[0129] A fourth sub-step includes the processor identifying an optimization for the first medical device based on the patient care performance metric of the historical operational trend for the first medical device that is outside of the expected performance range. For example, the processor looks up an optimization known to cure the producing of a favorable patient outcome more quickly.

[0130] A fifth sub-step includes the processor generating the object command information based on the optimization for the first medical device. For example, the processor formats a set of steps associated with the optimization that is compatible with at least one of the environment signaling **30** and the premise messages **33**.

[0131] A sixth sub-step includes the processor facilitating communication of the object command information to the first medical device. For example, the processor utilizes the wireless communication modem **86** to communicate the at least one of the environment signaling **30** and the premise messages **33** to the medical treatment device **300** to invoke the optimization. The medical treatment device **300** utilizes the steps of the optimization as part of the management of the patient care provided by medical treatment device **300**.

[0132] A fourth step of the example method of operation includes the processor of at least one of the computing entity **21**-N and the computing entity **22** executing dashboard software to facilitate intercommunication between the object tracking software and the dashboard software causing the processor to interpret a portion of the patient care tracking information for the plurality of medical treatment devices recovered from the digital twin memory **58** of at least one of the computing entity **21**-N and the computing entity **22** to produce dashboard information. The dashboard information includes a representation of status of patient care associated with each identified medical treatment device of the plurality of medical treatment devices based on the further environment signaling and in accordance with the object profile information. For instance, the processor of the computing entity **22** accesses the digital twin memory **58** of the computing entity **21**-N via premise messages **33** to recover the portion of the patient care tracking information to produce the dashboard information.

[0133] In an embodiment, the processor executes further dashboard software to obtain the portion of the patient care tracking information that corresponds to the further environment signaling for a particular identified medical treatment device recovered from the digital twin memory **58**. The processor interprets the portion of the patient care tracking information in accordance with the object profile information to produce the dashboard information.

[0134] Having produced the dashboard information, a fifth step of the example method includes the processor of the computing entity **22** executing prescriptive software to facilitate intercommunication between the dashboard software and the prescriptive software causing the processor to process a portion of the dashboard information to produce the prescriptive information within the AI memory, **59** of the computing entity **22**. The prescriptive information includes one or more of an interpretation of the portion of the dashboard information, an evaluation of the portion of the dashboard information against a standard, and adaptive processor-executable instructions for use with the object profile information and the further environment signaling to cause change with regards to patient care associated with the identified plurality of medical treatment devices within the medical treatment environment. For instance, the processor determines instructions to redeploy a set of medical treatment devices from one area of the medical treatment environment to another area. As another instance, the processor determines instructions to update software associated with a subset of the medical treatment devices of the plurality of medical treatment devices. In yet another instance, the processor determines instructions to immediately deploy a particular medical treatment device to an emergency situation, where the location of the medical treatment device is the closest of the plurality of medical treatment devices to a location of the emergency situation.

[0135] In an embodiment, the fifth step includes the processor executing further prescriptive software causing the processor to determine tracking parameters (e.g., combination of one or more of expected wireless attributes, visual attributes, audio attributes, motion attributes, expected utilization attributes etc.) of object tracking of the identified plurality of medical treatment devices based on the object profile information and determine signaling parameters of the further environment signaling based on the identified medical treatment device (e.g., which wireless access format).

[0136] The processor generates the processor-executable instructions based on the tracking parameters and the signaling parameters to facilitate subsequent collection of the further environment signaling associated with the identified medical treatment device to provide the object tracking of the identified plurality of medical treatment devices within the medical treatment environment. For example, the processor updates the wireless communication modem **86** to enable receiving the further environment signaling.

[0137] In an embodiment, the example fifth step further includes the processor of at least one of the computing entity **21**-N and the computing entity **22** executing further prescriptive software causing the processor to obtain the portion of the dashboard information corresponding to a prescriptive timeframe from the digital twin memory and process the portion of the dashboard information in accordance with the object profile information to produce preliminary prescriptive information. The processor determines a format for the prescriptive information based on the preliminary prescriptive information and an object knowledgebase of the AI memory. The processor interprets the portion of the dashboard information in accordance with the format for the prescriptive information to produce the prescriptive information and stores the prescriptive information within the AI memory. Alternatively, or in addition to, the processor facilitates storage of the prescriptive information in the object distributed ledger as yet another next block as previously discussed such that at least one medical treatment device can utilize the object distributed ledger to enhance the patent care.

[0138] It is noted that terminologies as may be used herein such as bit stream, stream, signal sequence, etc. (or their equivalents) have been used interchangeably to describe digital information whose content corresponds to any of a number of desired types (e.g., data, video, speech, text, graphics, audio, etc. any of which may generally be referred to as 'data').

[0139] As may be used herein, the terms "substantially" and "approximately" provides an industry-accepted tolerance for its corresponding term and/or relativity between items. For some industries, an industry-accepted tolerance is less than one percent and, for other industries, the industry-accepted tolerance is 10 percent or more. Other examples of industry-accepted tolerance range from less than one percent to fifty percent. Industry-accepted tolerances correspond to, but are not limited to, component values, integrated circuit process variations, temperature variations, rise and fall times, thermal noise, dimensions, signaling errors, dropped packets, temperatures, pressures, material compositions, and/or performance metrics. Within an industry, tolerance variances of accepted tolerances may be more or less than a percentage level (e.g., dimension tolerance of less than +/−1%). Some relativity between items may range from a difference of less than a percentage level to a few percent. Other relativity between items may range from a difference of a few percent to magnitude of differences.

[0140] As may also be used herein, the term(s) "configured to", "operably coupled to", "coupled to", and/or "coupling" includes direct coupling between items and/or indirect coupling between items via an intervening item (e.g., an item includes, but is not limited to, a component, an element, a circuit, and/or a module) where, for an example of indirect coupling, the intervening item does not modify the information of a signal but may adjust its current level, voltage level, and/or power level. As may further be used herein, inferred coupling (i.e., where one element is coupled to another element by inference) includes direct and indirect coupling between two items in the same manner as "coupled to".

[0141] As may even further be used herein, the term "configured to", "operable to", "coupled to", or "operably coupled to" indicates that an item includes one or more of power connections, input(s), output(s), etc., to perform, when activated, one or more its corresponding functions and may further include inferred coupling to one or more other items. As may still further be used herein, the term "associated with", includes direct and/or indirect coupling of separate items and/or one item being embedded within another item.

[0142] As may be used herein, the term "compares favorably", indicates that a comparison between two or more items, signals, etc., provides a desired relationship. For example, when the desired relationship is that signal **1** has a greater magnitude than signal **2**, a favorable comparison may be achieved when the magnitude of signal **1** is greater than that of signal **2** or when the magnitude of signal **2** is less than that of signal **1**. As may be used herein, the term "compares unfavorably", indicates that a comparison between two or more items, signals, etc., fails to provide the desired relationship.

[0143] As may be used herein, one or more claims may include, in a specific form of this generic form, the phrase "at least one of a, b, and c" or of this generic form "at least one of a, b, or c", with more or less elements than "a", "b", and "c". In either phrasing, the phrases are to be interpreted identically. In particular, "at least one of a, b, and c" is equivalent to "at least one of a, b, or c" and shall mean a, b, and/or c. As an example, it means: "a" only, "b" only, "c" only, "a" and "b", "a" and "c", "b" and "c", and/or "a", "b", and "c".

[0144] As may also be used herein, the terms "processing module", "processing circuit", "processor", "processing circuitry", and/or "processing unit" may be a single processing device or a plurality of processing devices. Such a processing device may be a microprocessor, micro-controller, digital signal processor, artificial intelligence (AI) processor, c), microcomputer, central processing unit, field programmable gate array, programmable logic device, state machine, logic circuitry, analog circuitry, digital circuitry, and/or any device that manipulates signals (analog and/or digital) based on hard coding of the circuitry and/or operational instructions. The processing module, module, processing circuit, processing circuitry, and/or processing unit may be, or further include, memory and/or an integrated memory element, which may be a single memory device, a plurality of memory devices, and/or embedded circuitry of another processing module, module, processing circuit, processing circuitry, and/or processing unit. Such a memory device may be a read-only memory, random access memory, volatile memory, non-volatile memory, static memory, dynamic memory, flash memory, cache memory, and/or any device that stores digital information. Note that if the processing module, module, processing circuit, processing circuitry, and/or processing unit includes more than one processing device, the processing devices may be centrally located (e.g., directly coupled together via a wired and/or wireless bus structure) or may be distributedly located (e.g., cloud computing via indirect coupling via a local area network and/or a wide area network). Further note that if the processing module, module, processing circuit, processing circuitry and/or processing unit implements one or more of its functions via a state machine, analog circuitry, digital circuitry, and/or logic circuitry, the memory and/or memory element storing the corresponding operational instructions may be embedded within, or external to, the circuitry comprising the state machine, analog circuitry, digital circuitry, and/or logic circuitry. Still further note that, the memory element may store, and the processing module, module, processing circuit, processing circuitry and/or processing unit executes, hard coded and/or operational instructions corresponding to at least some of the steps and/or functions illustrated in one or more of the Figures. Such a memory device or memory element can be included in an article of manufacture.

[0145] One or more embodiments have been described above with the aid of method steps illustrating the performance of specified functions and relationships thereof. The boundaries and sequence of these functional building blocks and method steps have been arbitrarily defined herein for convenience of description. Alternate boundaries and sequences can be defined so long as the specified functions and relationships are appropriately performed. Any such alternate boundaries or sequences are thus within the scope and spirit of the claims. Further, the boundaries of these functional building blocks have been arbitrarily defined for convenience of description. Alternate boundaries could be defined as long as the certain significant functions are appropriately performed. Similarly, flow diagram blocks may also have been arbitrarily defined herein to illustrate certain significant functionality.

[0146] To the extent used, the flow diagram block boundaries and sequence could have been defined otherwise and still perform the certain significant functionality. Such alternate definitions of both functional building blocks and flow diagram blocks and sequences are thus within the scope and spirit of the claims. One of average skill in the art will also recognize that the functional building blocks, and other illustrative blocks, modules, and components herein, can be implemented as illustrated or by discrete components, application specific integrated circuits, processors executing appropriate software and the like or any combination thereof.

[0147] In addition, a flow diagram may include a “start” and/or “continue” indication. The “start” and “continue” indications reflect that the steps presented can optionally be incorporated in or otherwise used in conjunction with one or more other routines. In addition, a flow diagram may include an “end” and/or “continue” indication. The “end” and/or “continue” indications reflect that the steps presented can end as described and shown or optionally be incorporated in or otherwise used in conjunction with one or more other routines. In this context, “start” indicates the beginning of the first step presented and may be preceded by other activities not specifically shown. Further, the “continue” indication reflects that the steps presented may be performed multiple times and/or may be succeeded by other activities not specifically shown. Further, while a flow diagram indicates a particular ordering of steps, other orderings are likewise possible provided that the principles of causality are maintained.

[0148] The one or more embodiments are used herein to illustrate one or more aspects, one or more features, one or more concepts, and/or one or more examples. A physical embodiment of an apparatus, an article of manufacture, a machine, and/or of a process may include one or more of the aspects, features, concepts, examples, etc. described with reference to one or more of the embodiments discussed herein. Further, from figure to figure, the embodiments may incorporate the same or similarly named functions, steps, modules, etc. that may use the same or different reference numbers and, as such, the functions, steps, modules, etc. may be the same or similar functions, steps, modules, etc. or different ones.

[0149] Unless specifically stated to the contra, signals to, from, and/or between elements in a figure of any of the figures presented herein may be analog or digital, continuous time or discrete time, and single-ended or differential. For instance, if a signal path is shown as a single-ended path, it also represents a differential signal path. Similarly, if a signal path is shown as a differential path, it also represents a single-ended signal path. While one or more particular architectures are described herein, other architectures can likewise be implemented that use one or more data buses not expressly shown, direct connectivity between elements, and/or indirect coupling between other elements as recognized by one of average skill in the art.

[0150] The term “module” is used in the description of one or more of the embodiments. A module implements one or more functions via a device such as a processor or other processing device or other hardware that may include or operate in association with a memory that stores operational instructions. A module may operate independently and/or in conjunction with software and/or firmware. As also used herein, a module may contain one or more sub-modules, each of which may be one or more modules.

[0151] As may further be used herein, a computer readable memory includes one or more memory elements. A memory element may be a separate memory device, multiple memory devices, or a set of memory locations within a memory device. Such a memory device may be a read-only memory, random access memory, volatile memory, non-volatile memory, static memory, dynamic memory, flash memory, cache memory, a quantum register or other quantum memory and/or any other device that stores data in a non-transitory manner. Furthermore, the memory device may be in a form of a solid-state memory, a hard drive memory or other disk storage, cloud memory, thumb drive, server memory, computing device memory, and/or other non-transitory medium for storing data. The storage of data includes temporary storage (i.e., data is lost when power is removed from the memory element) and/or persistent storage (i.e., data is retained when power is removed from the memory element). As used herein, a transitory medium shall mean one or more of: (a) a wired or wireless medium for the transportation of data as a signal from one computing device to another computing device for temporary storage or persistent storage; (b) a wired or wireless medium for the transportation of data as a signal within a computing device from one element of the computing device to another element of the computing device for temporary storage or persistent storage; (c) a wired or wireless medium for the transportation of data as a signal from one computing device to another computing device for processing the data by the other computing device; and (d) a wired or wireless medium for the transportation of data as a signal within a computing device from one element of the computing device to another element of the computing device for processing the data by the other element of the computing device. As may be used herein, a non-transitory computer readable memory is substantially equivalent to a computer readable memory. A non-transitory computer readable memory can also be referred to as a non-transitory computer readable storage medium.

[0152] While particular combinations of various functions and features of the one or more embodiments have been expressly described herein, other combinations of these features and functions are likewise possible. The present disclosure is not limited by the particular examples disclosed herein and expressly incorporates these other combinations.

What is claimed is:

1. A computerized method for processing data of a self-forming communication and control system, the method comprising:

executing, by a processor, environment interpretation software from a first non-transitory memory causing the processor to detect and identify a plurality of medical treatment devices of a medical treatment environment based on at least one of environment signaling of the medical treatment environment and premise messages exchanged with another processor to produce an identified medical treatment device identifier for each medical treatment device of the identified plurality of medical treatment devices, each medical treatment device of the plurality of medical treatment devices comprising at least one of a physical object within the medical treatment environment when the medical treatment environment includes a physical environment and a virtual object within the medical treatment environment when the medical treatment environment includes a virtual environment, the environment signaling comprising at least one of an unencoded direct electromagnetic emission, an unencoded indirect electromagnetic emission, an encoded electromagnetic emission, an encoded electronic signal, an unencoded mechanical wave, and an encoded mechanical wave, the premise messages comprising object profile information for each identified medical treatment device, the object profile information comprising one or more of object basics, object deployment information, and object availability information;

executing, by the processor, profile generation software from a second non-transitory memory to facilitate intercommunication between the environment interpretation software and the profile generation software causing the processor to exchange prescriptive information associated with each identified medical treatment device identifier with an artificial intelligence (AI) memory, the prescriptive information comprising object learnings based on an interpretation of a plurality of historical patient care observations associated with at least one medical treatment device of the plurality of medical treatment devices and a plurality of other medical treatment devices associated with another medical treatment environment; and

executing, by the processor, object tracking software from a third non-transitory memory to facilitate intercommunication between the profile generation software and the object tracking software causing the processor to exchange further environment signaling for the plurality of medical treatment devices within the medical treatment environment using the object profile information and at least some of the prescriptive information to produce patient care tracking information in response to object command information for storage within a digital twin memory, wherein the patient care tracking information is available to be subsequently recovered from the digital twin memory and utilized to virtually represent patient care provided by at least some of the plurality of medical treatment devices within a virtual representation of the medical treatment environment and to subsequently generate the object command information.

2. The method of claim **1** further comprising:

executing, by the processor, object learning software from a fourth non-transitory memory causing the processor to:

interpret other environment signaling for the corresponding plurality of other medical treatment devices associated with the other medical treatment environment to produce other patient care tracking information,

store the other patient care tracking information in the AI memory as the plurality of historical patient care observations associated with the corresponding plurality of other medical treatment devices,

recover a portion of the plurality of historical patient care observations from the AI memory, and

infer the object learnings based on an interpretation of the portion of the plurality of historical patient care observations as the prescriptive information, the object learnings providing guidance for future patient care provided by the plurality of medical treatment devices.

3. The method of claim **1** further comprising:

executing, by the processor, further profile generation software from the second non-transitory memory causing the processor to produce updated object profile information for at least some of the plurality of medical treatment devices based on corresponding identified medical treatment device identifiers and updated prescriptive information associated with a particular identified medical treatment device of the plurality of medical treatment devices within the AI memory, the updated object profile information comprising one or more of updated object basics, updated object deployment information, and updated object availability information, the updated prescriptive information comprising one or more of updated object learnings based on another interpretation of the plurality of historical patient care observations associated with the corresponding plurality of other medical treatment devices associated with the other medical treatment environment each of the other medical treatment devices associated with the other medical treatment environment and an evaluation of the updated object learnings against a standard.

4. The method of claim 1 further comprising:

executing, by the processor, dashboard software from a fifth non-transitory memory to facilitate intercommunication between the object tracking software and the dashboard software causing the processor to interpret a portion of the patient care tracking information for the plurality of medical treatment devices recovered from the digital twin memory to produce dashboard information, the dashboard information comprising a representation of status of patient care associated with each identified medical treatment device of the plurality of medical treatment devices based on the further environment signaling and in accordance with the object profile information.

5. The method of claim 4 further comprising:

executing, by the processor, further dashboard software from the fifth non-transitory memory causing the processor to:

obtain the portion of the patient care tracking information that corresponds to the further environment signaling for a particular identified medical treatment device recovered from the digital twin memory, and

interpret the portion of the patient care tracking information in accordance with the object profile information to produce the dashboard information.

6. The method of claim 4 further comprising:

executing, by the processor, prescriptive software from a sixth non-transitory memory to facilitate intercommunication between the dashboard software and the prescriptive software causing the processor to process a portion of the dashboard information to produce the prescriptive information within the AI memory, the prescriptive information comprising one or more of an interpretation of the portion of the dashboard information, an evaluation of the portion of the dashboard information against a standard, and adaptive processor-executable instructions for use with the object profile information and the further environment signaling to cause change with regards to the patient care associated with the identified plurality of medical treatment devices within the medical treatment environment.

7. The method of claim 6 further comprising:

executing, by the processor, further prescriptive software from the sixth non-transitory memory causing the processor to:

determine tracking parameters of object tracking of the identified plurality of medical treatment devices based on the object profile information,

determine signaling parameters of the further environment signaling based on the identified medical treatment device, and

generate the processor-executable instructions based on the tracking parameters and the signaling parameters to facilitate subsequent collection of the further environment signaling associated with the identified medical treatment device to provide the object tracking of the identified plurality of medical treatment devices within the medical treatment environment.

8. The method of claim 6 further comprising:

executing, by the processor, further prescriptive software from the sixth non-transitory memory causing the processor to:

obtain the portion of the dashboard information corresponding to a prescriptive timeframe from the digital twin memory,

process the portion of the dashboard information in accordance with the object profile information to produce preliminary prescriptive information,

determine a format for the prescriptive information based on the preliminary prescriptive information and an object knowledgebase of the AI memory,

interpret the portion of the dashboard information in accordance with the format for the prescriptive information to produce the prescriptive information, and

store the prescriptive information within the AI memory.

9. The method of claim 1, wherein the processor further executes the environment interpretation software from the first non-transitory memory causing the processor to detect the plurality of medical treatment devices of the medical treatment environment based on the environment signaling of the medical treatment environment to produce the identified plurality of medical treatment devices by:

obtaining the environment signaling of the medical treatment environment from an environment sensor module;

indicating the physical object as a particular identified medical treatment device when identifying a physical object pattern from at least one of the unencoded direct electromagnetic emission, the unencoded indirect electromagnetic emission, and the unencoded mechanical wave of the environment signaling; and

indicating the virtual object as a particular detected object when identifying a virtual object pattern from at least one of the encoded electromagnetic emission, the encoded electronic signal, and the encoded mechanical wave of the environment signaling.

10. The method of claim 1, wherein the processor further executes the environment interpretation software from the first non-transitory memory causing the processor to:

access a portion of the digital twin memory that includes an object knowledgebase based on a particular identified medical treatment device;

compare an attribute of detection of the particular identified medical treatment device to the portion of the digital twin memory that includes the object knowledgebase to produce the particular identified medical treatment device; and

access the portion of the digital twin memory that includes the object knowledgebase based on the particular identified medical treatment device to produce the object profile information.

11. The method of claim 1 further comprising:

executing, by the processor, ledger software from a seventh non-transitory memory to facilitate intercommunication between the object tracking software and the ledger software causing the processor to memorialize the patient care tracking information in an object distributed ledger by:

obtaining a portion of the object distributed ledger;

hashing a portion of the patient care tracking information utilizing a receiving public key associated with the object distributed ledger to produce a next transaction hash value;

encrypting the next transaction hash value utilizing a private key of the processor to produce a next transaction signature;

generating a next block of a blockchain of the object distributed ledger to include the portion of the patient care tracking information and the next transaction signature; and

causing inclusion of the next block in the object distributed ledger.

12. The method of claim **1** further comprising:

executing, by the processor, object control software from an eighth non-transitory memory to facilitate intercommunication between the object tracking software and the object control software causing the processor to manage the patient care provided by at least some of the plurality of medical treatment devices by:

obtaining a portion of the patient care tracking information from the digital twin memory;

identifying a historical operational trend for a first medical device of the plurality of medical devices based on the patient care tracking information;

detecting a patient care performance metric of the historical operational trend for the first medical device that is outside of an expected performance range;

identifying an optimization for the first medical device based on the patient care performance metric of the historical operational trend for the first medical device that is outside of the expected performance range;

generating the object command information based on the optimization for the first medical device; and

facilitating communication of the object command information to the first medical device.

13. The method of claim **1** further comprising:

executing, by the processor, AI optimization software from a nineth non-transitory memory to facilitate intercommunication between the object tracking software and the AI optimization software causing the processor to manage the patient care provided by at least some of the plurality of medical treatment devices by:

obtaining a portion of recovered prescriptive information associated with a first medical treatment device of the plurality of medical devices from the AI memory;

identifying a historical operational trend for the first medical device based on the portion of recovered prescriptive information;

detecting a patient care performance metric of the historical operational trend for the first medical device that is outside of an expected performance range;

identifying an optimization for the first medical device based on the patient care performance metric of the historical operational trend for the first medical device that is outside of the expected performance range and a historical remediation of the portion of recovered prescriptive information that is expected to produce a future patient care performance metric of a future historical operational trend for the first medical device that is inside of the expected performance range;

generating the object command information based on the optimization for the first medical device; and

facilitating communication of the object command information to the first medical device.

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