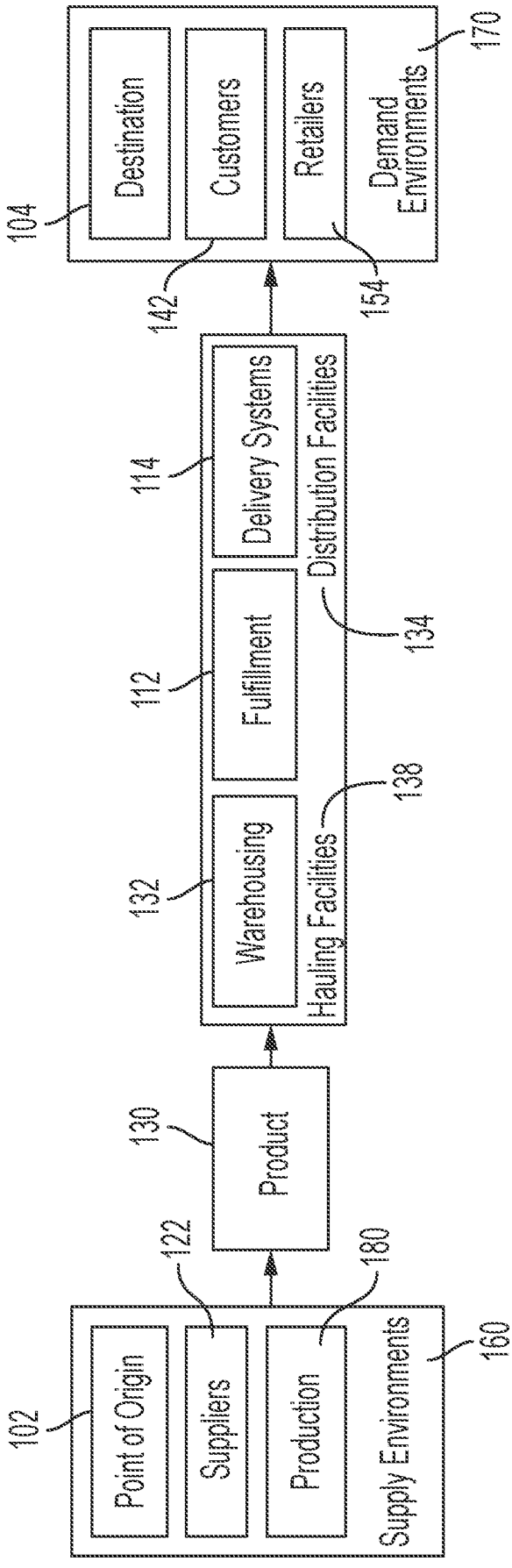

Point of Origin
Suppliers
Production
Supply Environments
102
122
180
160
Product
130
Warehousing
Fulfillment
Delivery Systems
Distribution Facilities
Hauling Facilities
132
112
114
134
138
Destination
Customers
Retailers
Demand Environments
104
142
154
170

FIG. 1

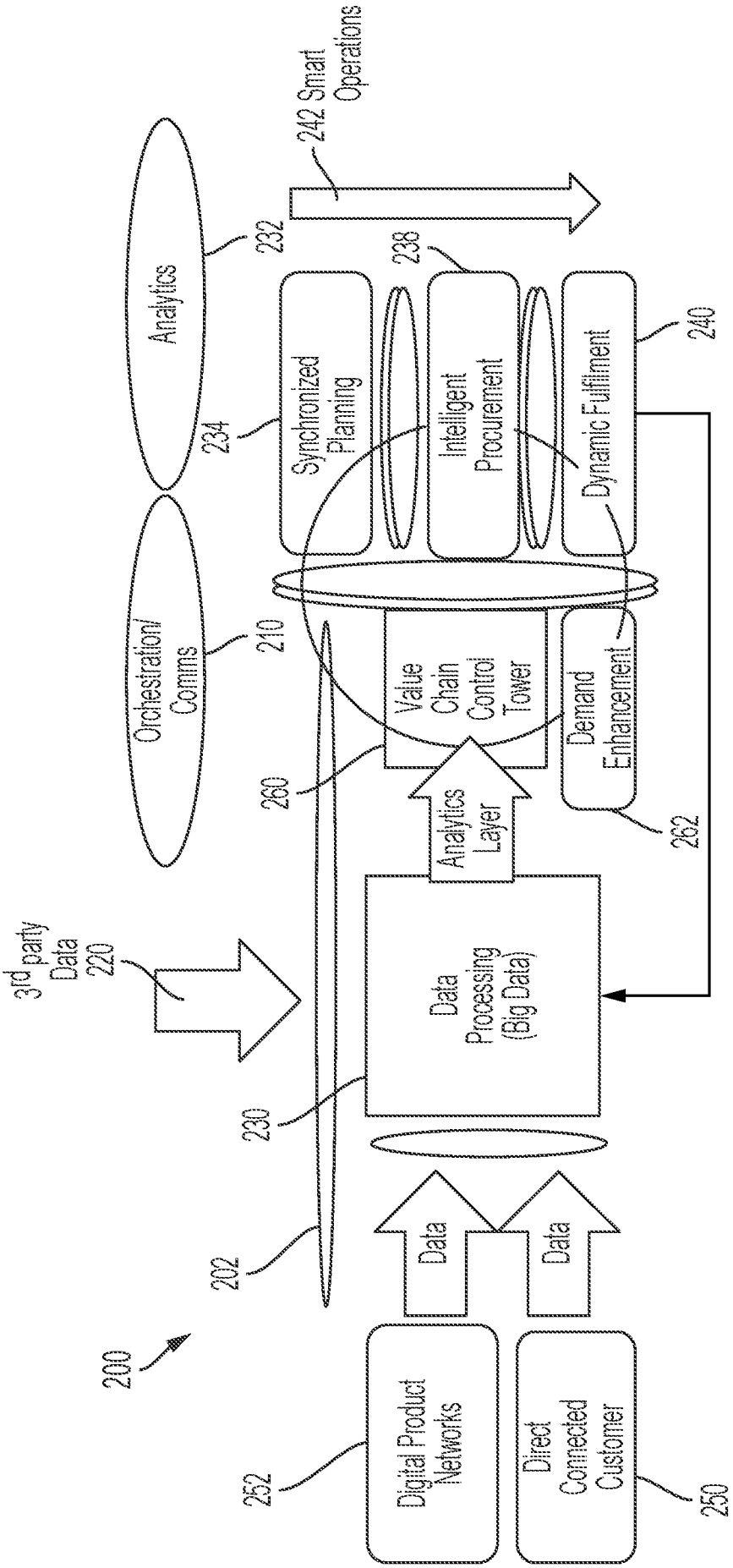

200
202
210
220
230
232
234
238
240
242 Smart Operations
252
260
262
Digital Product Networks
Direct Connected Customer
Data
Data
Data Processing (Big Data)
Analytics Layer
Value Chain Control Tower
Demand Enhancement
Dynamic Fulfilment
Intelligent Procurement
Synchronized Planning
Analytics
Orchestration/ Comms
3rd party Data

FIG. 2

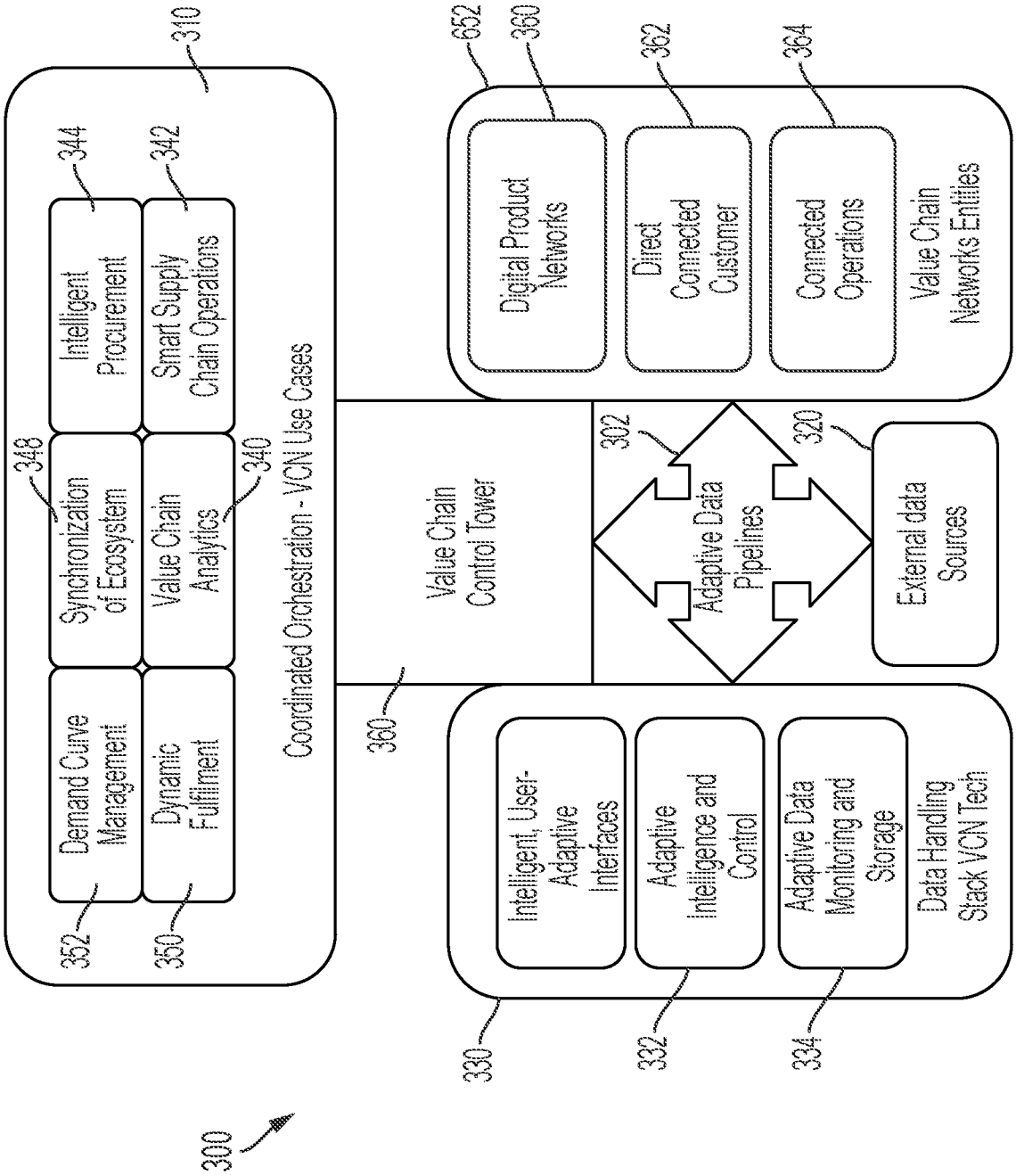

300
310
Coordinated Orchestration - VCN Use Cases
Demand Curve Management
352
Dynamic Fulfilment
350
Synchronization of Ecosystem
348
Value Chain Analytics
340
Intelligent Procurement
344
Smart Supply Chain Operations
342
360
Value Chain Control Tower
302
Adaptive Data Pipelines
320
External data Sources
652
360
Digital Product Networks
362
Direct Connected Customer
364
Connected Operations
Value Chain Networks Entities
330
Intelligent, User-Adaptive Interfaces
332
Adaptive Intelligence and Control
334
Adaptive Data Monitoring and Storage
Data Handling Stack VCN Tech

FIG. 3

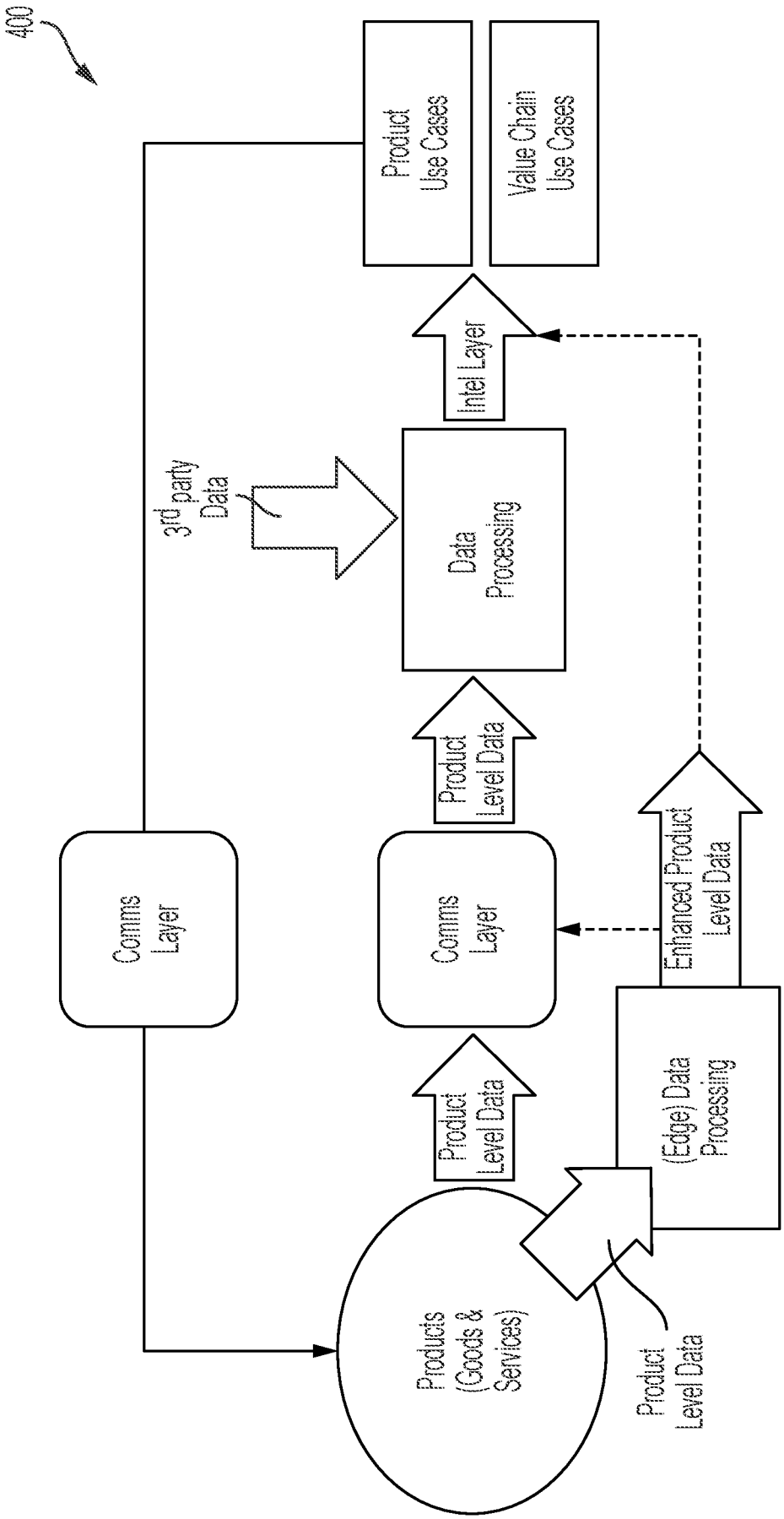

400
Product Use Cases
Value Chain Use Cases
Intel Layer
3rd party Data
Data Processing
Product Level Data
Comms Layer
Comms Layer
Enhanced Product Level Data
Product Level Data
(Edge) Data Processing
Products (Goods & Services)
Product Level Data

FIG. 4

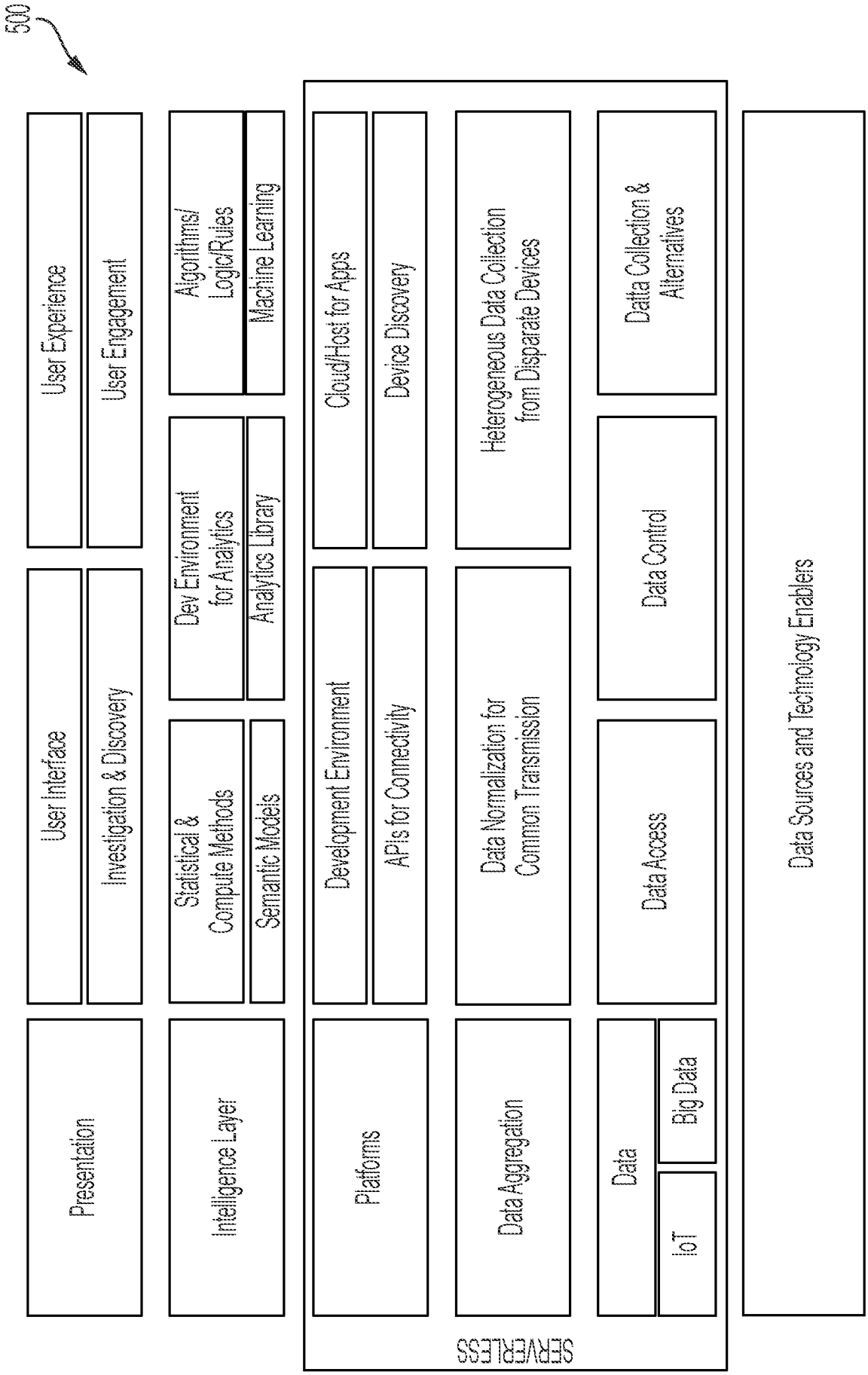

500
Presentation
User Interface
User Experience
Investigation & Discovery
User Engagement
Intelligence Layer
Statistical & Compute Methods
Semantic Models
Dev Environment for Analytics
Analytics Library
Algorithms/ Logic/Rules
Machine Learning
SERVERLESS
Platforms
Development Environment
APIs for Connectivity
Cloud/Host for Apps
Device Discovery
Data Aggregation
Data Normalization for Common Transmission
Heterogeneous Data Collection from Disparate Devices
Data
IoT
Big Data
Data Access
Data Control
Datta Collection & Alternatives
Data Sources and Technology Enablers

FIG. 5

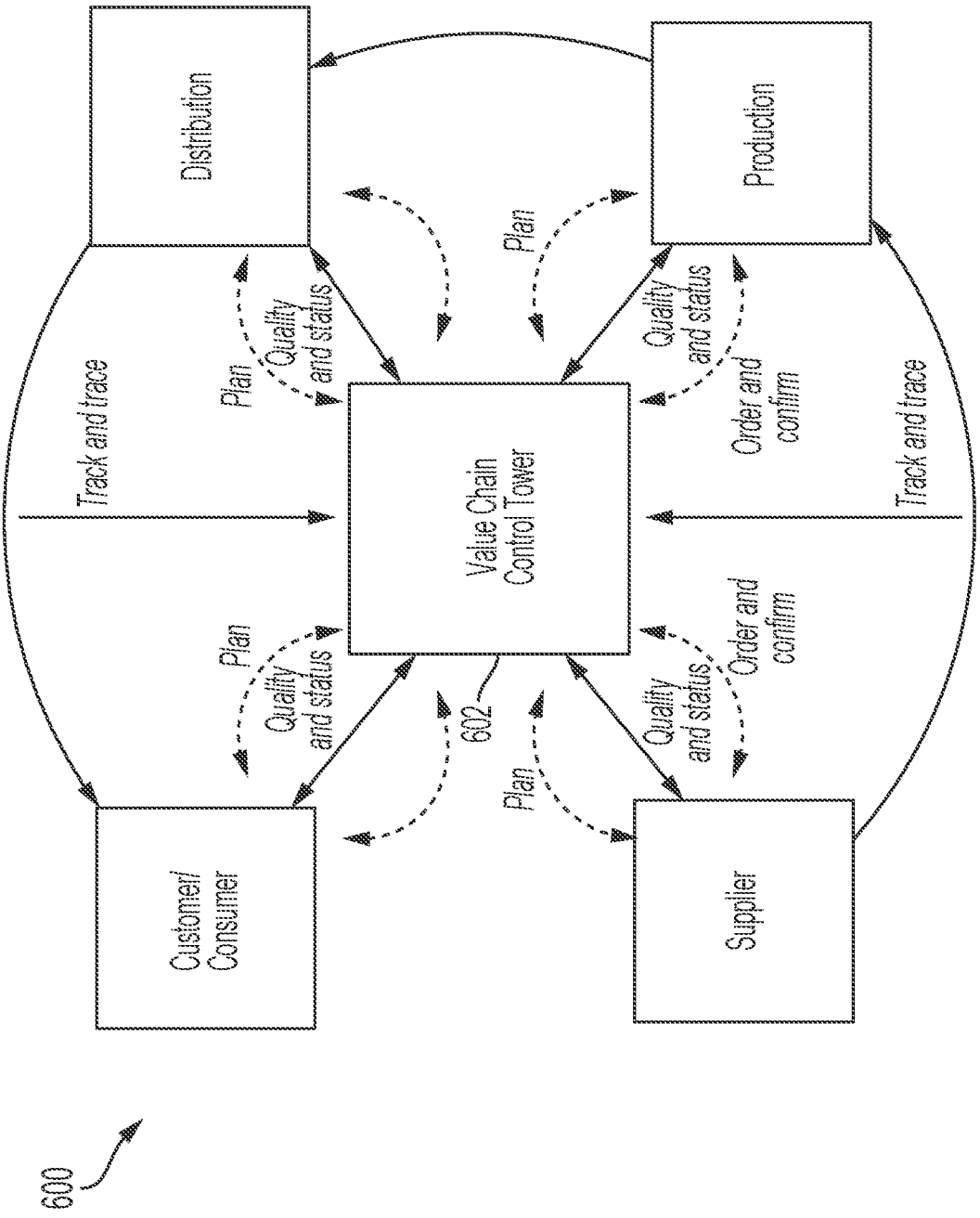

600
Distribution
Production
Customer/ Consumer
Supplier
Value Chain Control Tower
602
Track and trace
Plan
Quality and status
Plan
Quality and status
Plan
Quality and status
Order and confirm
Track and trace
Plan
Quality and status
Order and confirm
Quality and status
Plan

FIG. 6

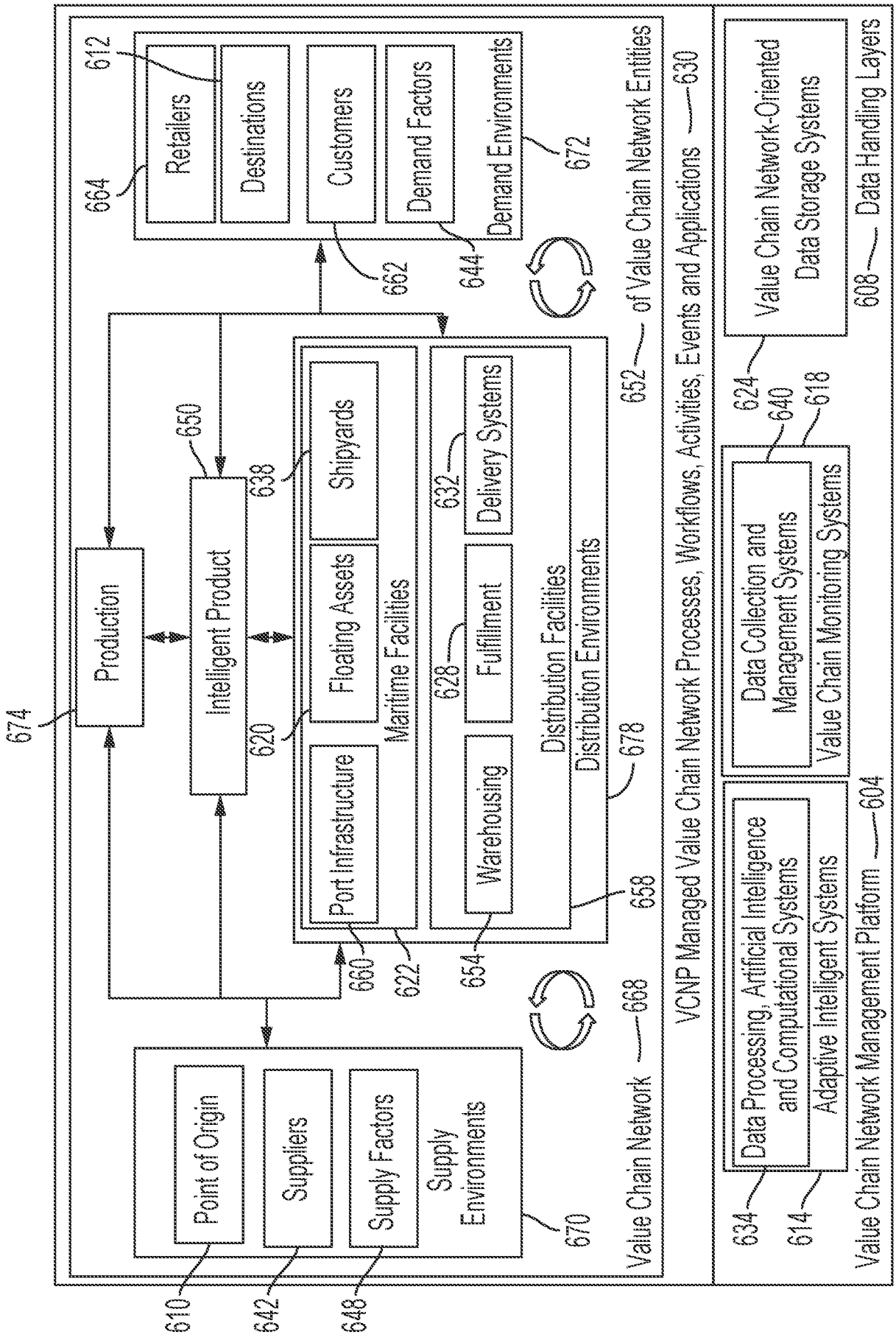

674
Production
Intelligent Product
650
620
638
Shipyards
Floating Assets
Port Infrastructure
Maritime Facilities
632
Delivery Systems
628
Fulfillment
Warehousing
Distribution Facilities
Distribution Environments
678
658
660
622
654
668
Value Chain Network
652
of Value Chain Network Entities
612
664
Retailers
Destinations
Customers
Demand Factors
Demand Environments
672
662
644
VCNP Managed Value Chain Network Processes, Workflows, Activities, Events and Applications
630
624
640
618
Data Collection and Management Systems
Value Chain Monitoring Systems
Value Chain Network-Oriented Data Storage Systems
608
Data Handling Layers
634
614
Data Processing, Artificial Intelligence and Computational Systems
Adaptive Intelligent Systems
Value Chain Network Management Platform
604
610
642
648
Point of Origin
Suppliers
Supply Factors
Supply Environments
670

FIG. 7

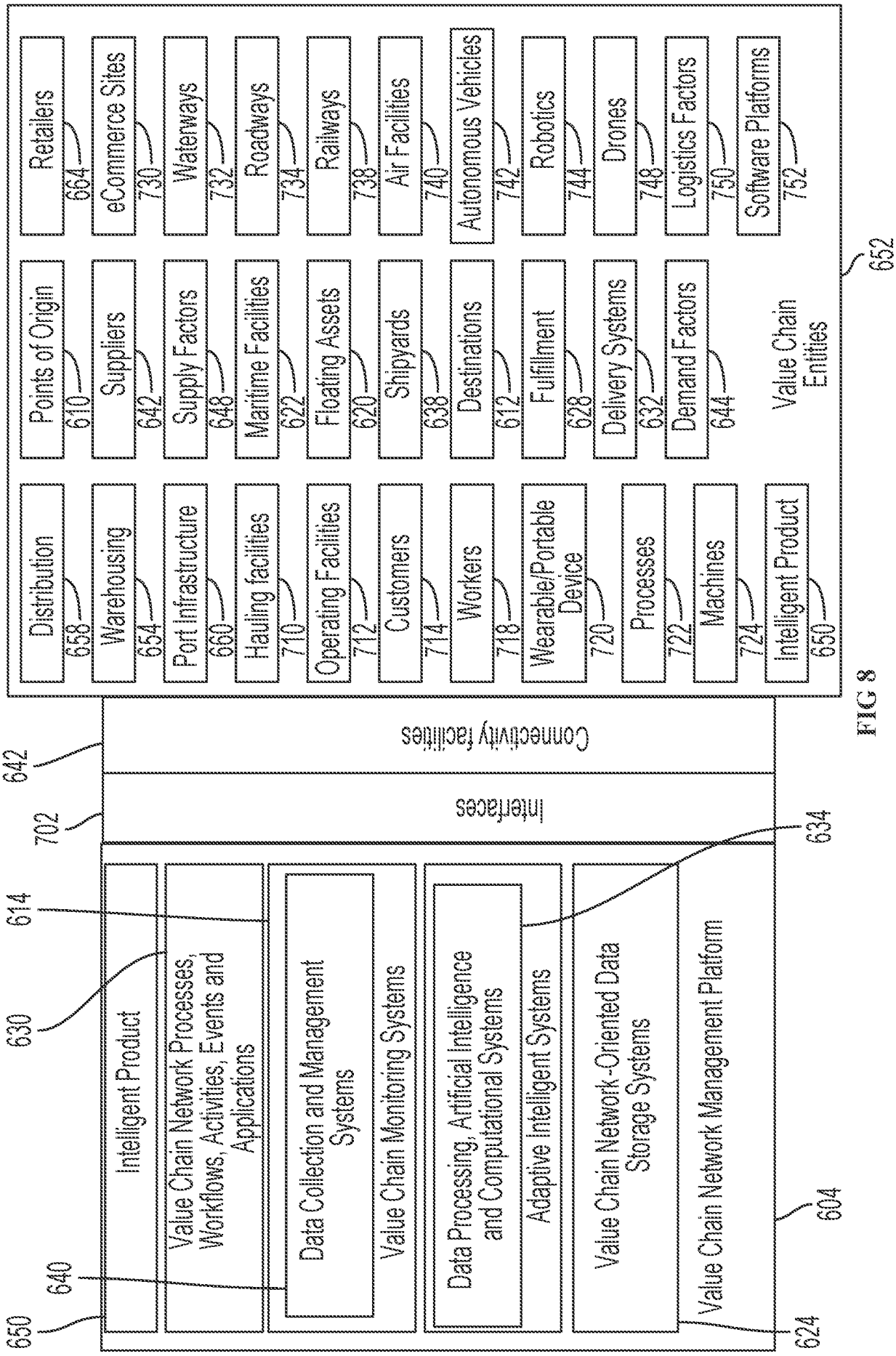

Value Chain Entities
652
Distribution
658
Warehousing
654
Port Infrastructure
660
Hauling facilities
710
Operating Facilities
712
Customers
714
Workers
718
Wearable/Portable Device
720
Processes
722
Machines
724
Intelligent Product
650
Points of Origin
610
Suppliers
642
Supply Factors
648
Maritime Facilities
622
Floating Assets
620
Shipyards
638
Destinations
612
Fulfillment
628
Delivery Systems
632
Demand Factors
644
Retailers
664
eCommerce Sites
730
Waterways
732
Roadways
734
Railways
738
Air Facilities
740
Autonomous Vehicles
742
Robotics
744
Drones
748
Logistics Factors
750
Software Platforms
752
Connectivity facilities
642
Interfaces
702
614
630
634
650
640
624
604
Intelligent Product
Value Chain Network Processes, Workflows, Activities, Events and Applications
Data Collection and Management Systems
Value Chain Monitoring Systems
Data Processing, Artificial Intelligence and Computational Systems
Adaptive Intelligent Systems
Value Chain Network-Oriented Data Storage Systems
Value Chain Network Management Platform

FIG 8

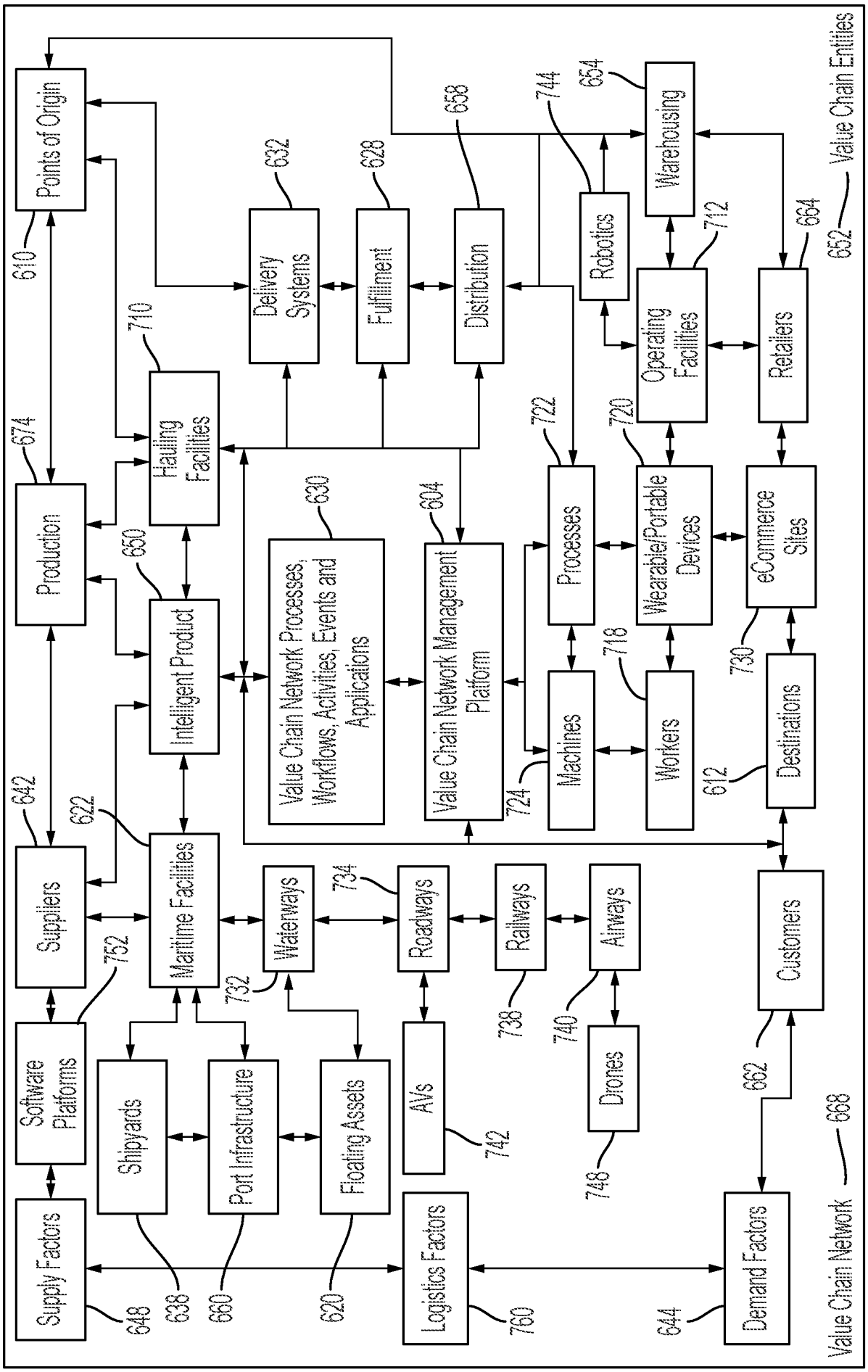

Value Chain Entities
652
Points of Origin
610
Delivery Systems
632
Fulfillment
628
Distribution
658
Robotics
744
Warehousing
654
Hauling Facilities
710
Operating Facilities
712
Retailers
664
Production
674
Processes
722
Wearable/Portable Devices
720
eCommerce Sites
730
Intelligent Product
650
Value Chain Network Processes, Workflows, Activities, Events and Applications
630
Value Chain Network Management Platform
604
Machines
724
Workers
718
Destinations
612
Suppliers
642
Maritime Facilities
622
Waterways
732
Roadways
734
Railways
738
Airways
740
Customers
662
Software Platforms
752
Shipyards
638
Port Infrastructure
660
Floating Assets
620
AVs
742
Drones
748
Supply Factors
648
Logistics Factors
760
Demand Factors
644
Value Chain Network
668

FIG. 9

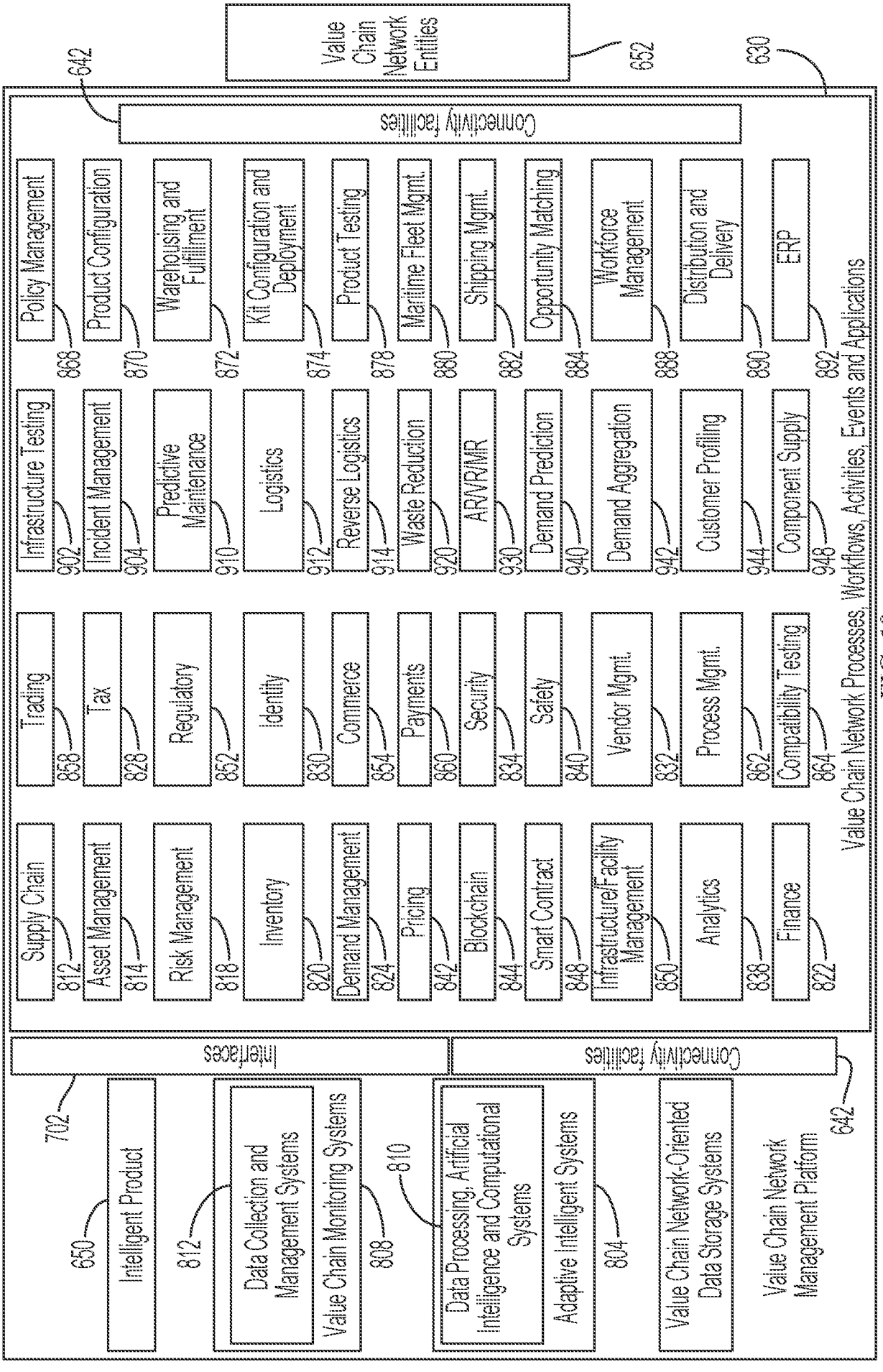

Value Chain Network Entities
652
630
642
Connectivity facilities
Policy Management
868
Product Configuration
870
Warehousing and Fulfillment
872
Kit Configuration and Deployment
874
Product Testing
878
Maritime Fleet Mgmt.
880
Shipping Mgmt.
882
Opportunity Matching
884
Workforce Management
888
Distribution and Delivery
890
ERP
892
Infrastructure Testing
902
Incident Management
904
Predictive Maintenance
910
Logistics
912
Reverse Logistics
914
Waste Reduction
920
ARVR/MR
930
Demand Prediction
940
Demand Aggregation
942
Customer Profiling
944
Component Supply
948
Trading
858
Tax
828
Regulatory
852
Identity
830
Commerce
854
Payments
860
Security
834
Safety
840
Vendor Mgmt.
832
Process Mgmt.
862
Compatibility Testing
864
Supply Chain
812
Asset Management
814
Risk Management
818
Inventory
820
Demand Management
824
Pricing
842
Blockchain
844
Smart Contract
846
Infrastructure/Facility Management
850
Analytics
838
Finance
822
Value Chain Network Processes, Workflows, Activities, Events and Applications
interfaces
Connectivity facilities
702
650
Intelligent Product
812
Data Collection and Management Systems
Value Chain Monitoring Systems
808
810
Data Processing, Artificial Intelligence and Computational Systems
Adaptive Intelligent Systems
804
Value Chain Network-Oriented Data Storage Systems
Value Chain Network Management Platform
642

FIG. 10

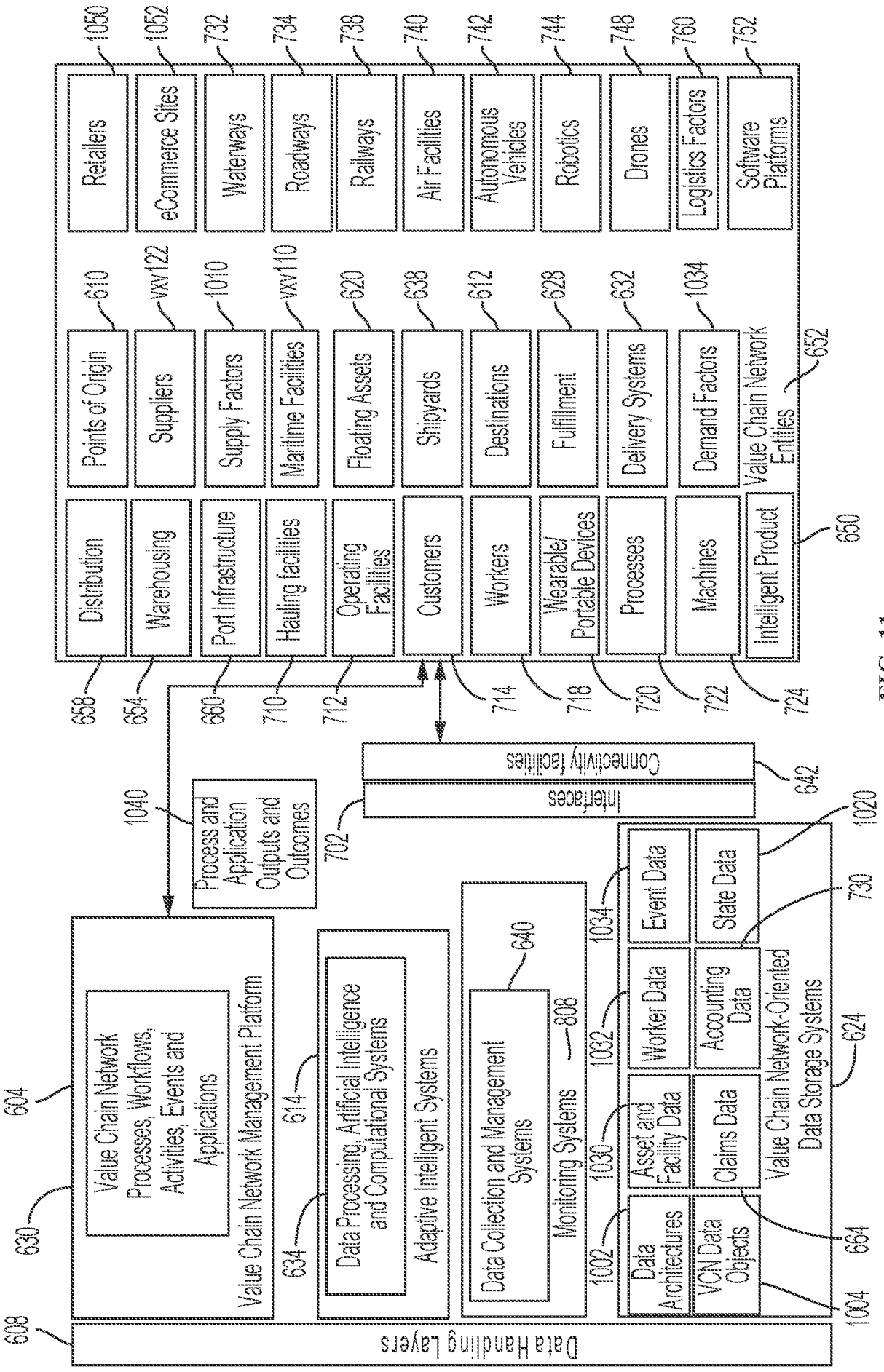

Data Handling Layers
608
Value Chain Network Management Platform
604
Value Chain Network Processes, Workflows, Activities, Events and Applications
630
Adaptive Intelligent Systems
614
Data Processing, Artificial Intelligence and Computational Systems
634
Monitoring Systems
808
Data Collection and Management Systems
640
Data Architectures
1002
VCN Data Objects
1004
Asset and Facility Data
1030
Claims Data
Worker Data
1032
Accounting Data
Event Data
1034
State Data
1020
Value Chain Network-Oriented Data Storage Systems
624
730
664
Process and Application Outputs and Outcomes
1040
Interfaces
702
Connectivity facilities
642
Distribution
Warehousing
Port Infrastructure
Hauling facilities
Operating Facilities
Customers
Workers
Wearable/ Portable Devices
Processes
Machines
Intelligent Product
650
Points of Origin
610
Suppliers
vxv122
Supply Factors
1010
Maritime Facilities
vxv110
Floating Assets
620
Shipyards
638
Destinations
612
Fulfillment
628
Delivery Systems
632
Demand Factors
1034
Value Chain Network Entities
652
Retailers
1050
eCommerce Sites
1052
Waterways
732
Roadways
734
Railways
738
Air Facilities
740
Autonomous Vehicles
742
Robotics
744
Drones
748
Logistics Factors
760
Software Platforms
752
658
654
660
710
712
714
718
720
722
724

FIG. 11

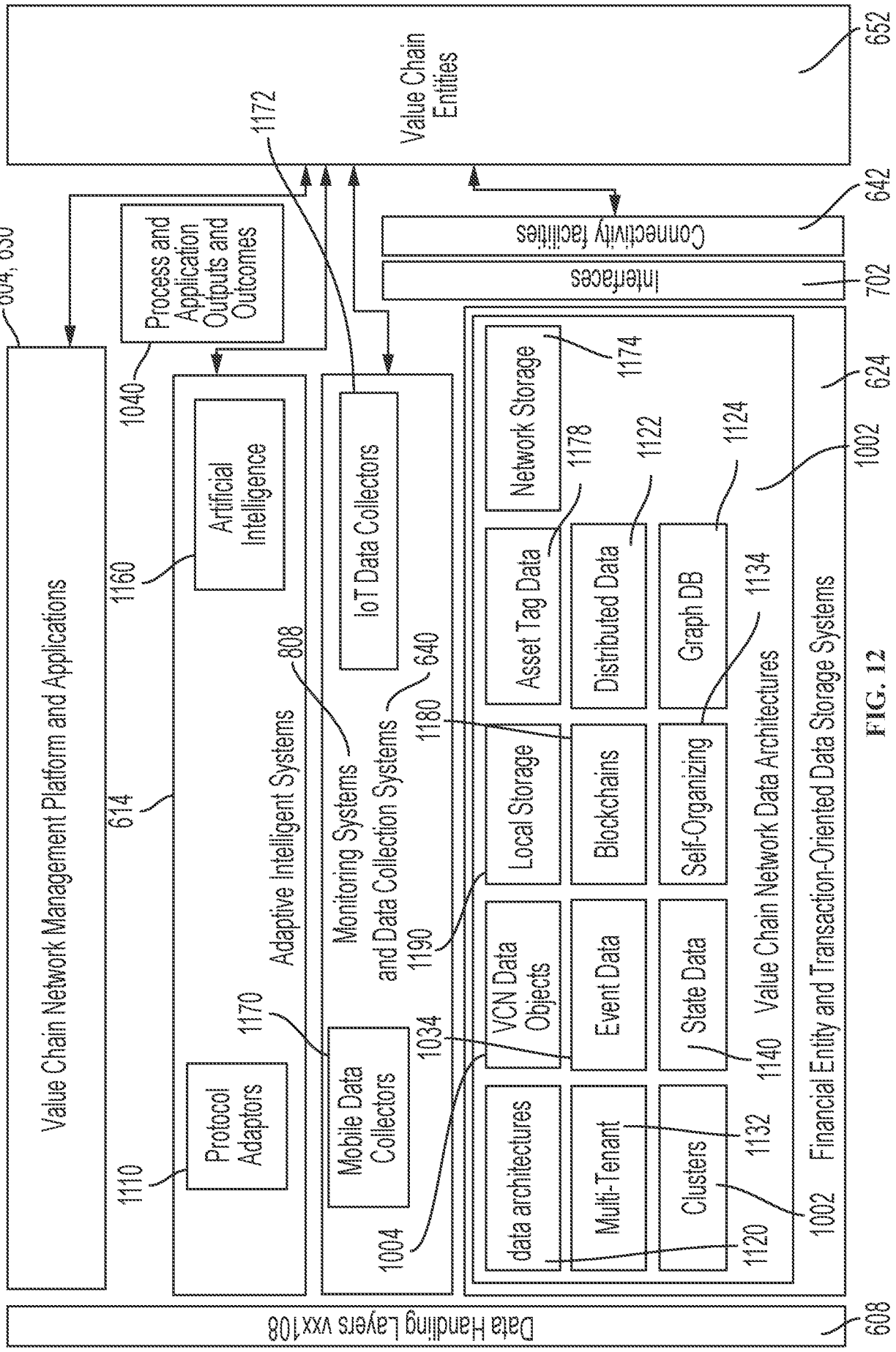

Value Chain Entities
652
1172
Process and Application Outputs and Outcomes
1040
Connectivity facilities
642
Interfaces
702
604, 630
Value Chain Network Management Platform and Applications
614
Artificial Intelligence
1160
Adaptive Intelligent Systems
808
IoT Data Collectors
640
Monitoring Systems and Data Collection Systems
1180
Network Storage
1174
Asset Tag Data
1178
Distributed Data
1122
Graph DB
1124
Local Storage
Blockchains
Self-Organizing
1134
1190
VCN Data Objects
Event Data
State Data
1140
Value Chain Network Data Architectures
1002
Financial Entity and Transaction-Oriented Data Storage Systems
1002
624
1034
1004
1170
Protocol Adaptors
Mobile Data Collectors
1110
data architectures
Multi-Tenant
Clusters
1132
1120
Data Handling Layers vxx108
608

FIG. 12

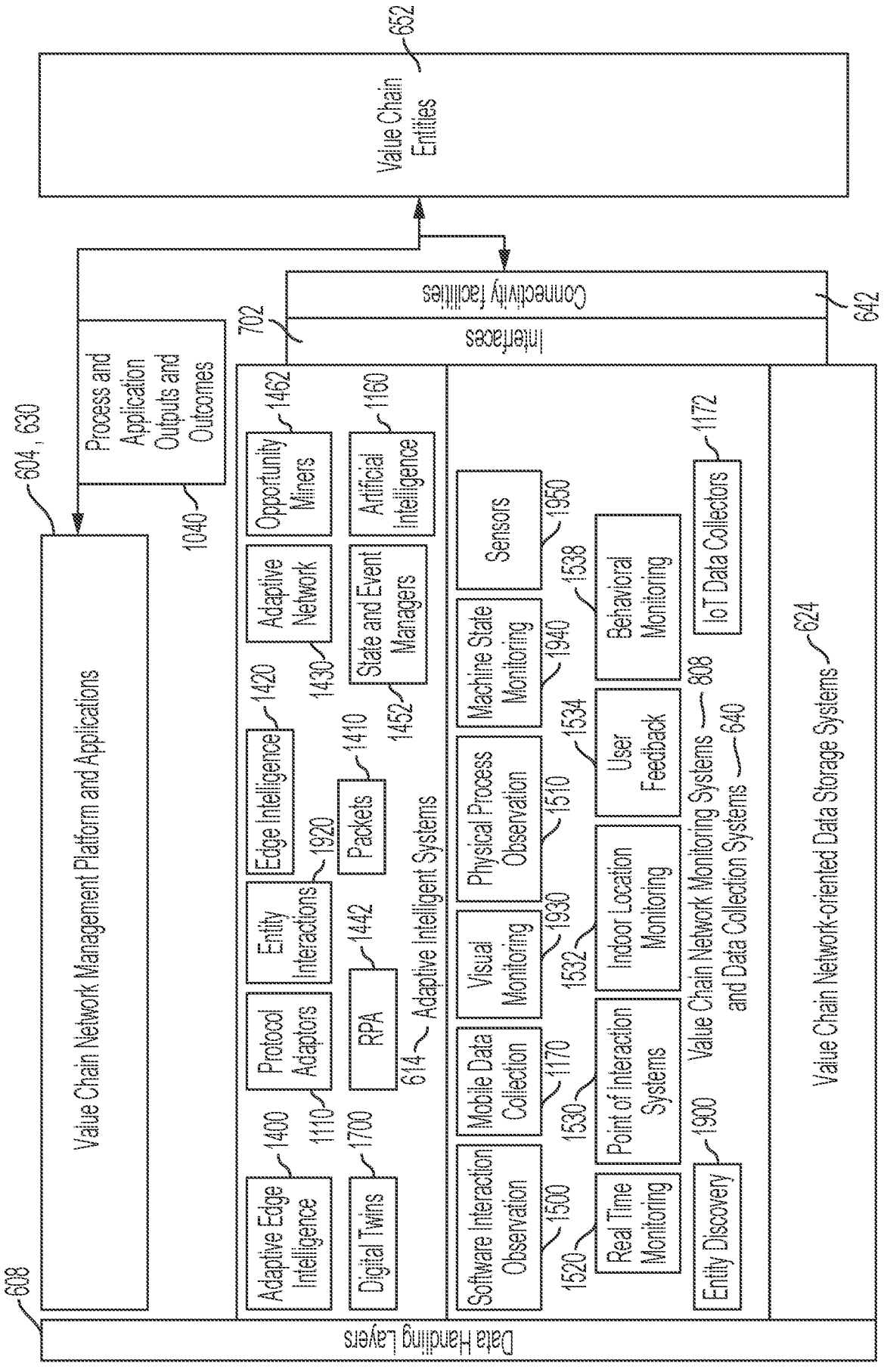

Value Chain Entities
652
Connectivity facilities
642
Interfaces
702
Process and Application Outputs and Outcomes
1040
604, 630
Value Chain Network Management Platform and Applications
608
Data Handling Layers
Adaptive Edge Intelligence
1400
Digital Twins
1700
Protocol Adaptors
1110
RPA
1442
614
Adaptive Intelligent Systems
Entity Interactions
1920
Edge Intelligence
1420
Packets
1410
Adaptive Network
1430
State and Event Managers
1452
Opportunity Miners
1462
Artificial Intelligence
1160
Software Interaction Observation
1500
Real Time Monitoring
1520
Mobile Data Collection
1170
Point of Interaction Systems
1530
Visual Monitoring
1930
Indoor Location Monitoring
1532
Physical Process Observation
1510
User Feedback
1534
Machine State Monitoring
1940
Behavioral Monitoring
1538
Sensors
1950
Entity Discovery
1900
Value Chain Network Monitoring Systems and Data Collection Systems
808
640
IoT Data Collectors
1172
Value Chain Network-oriented Data Storage Systems
624

FIG. 13

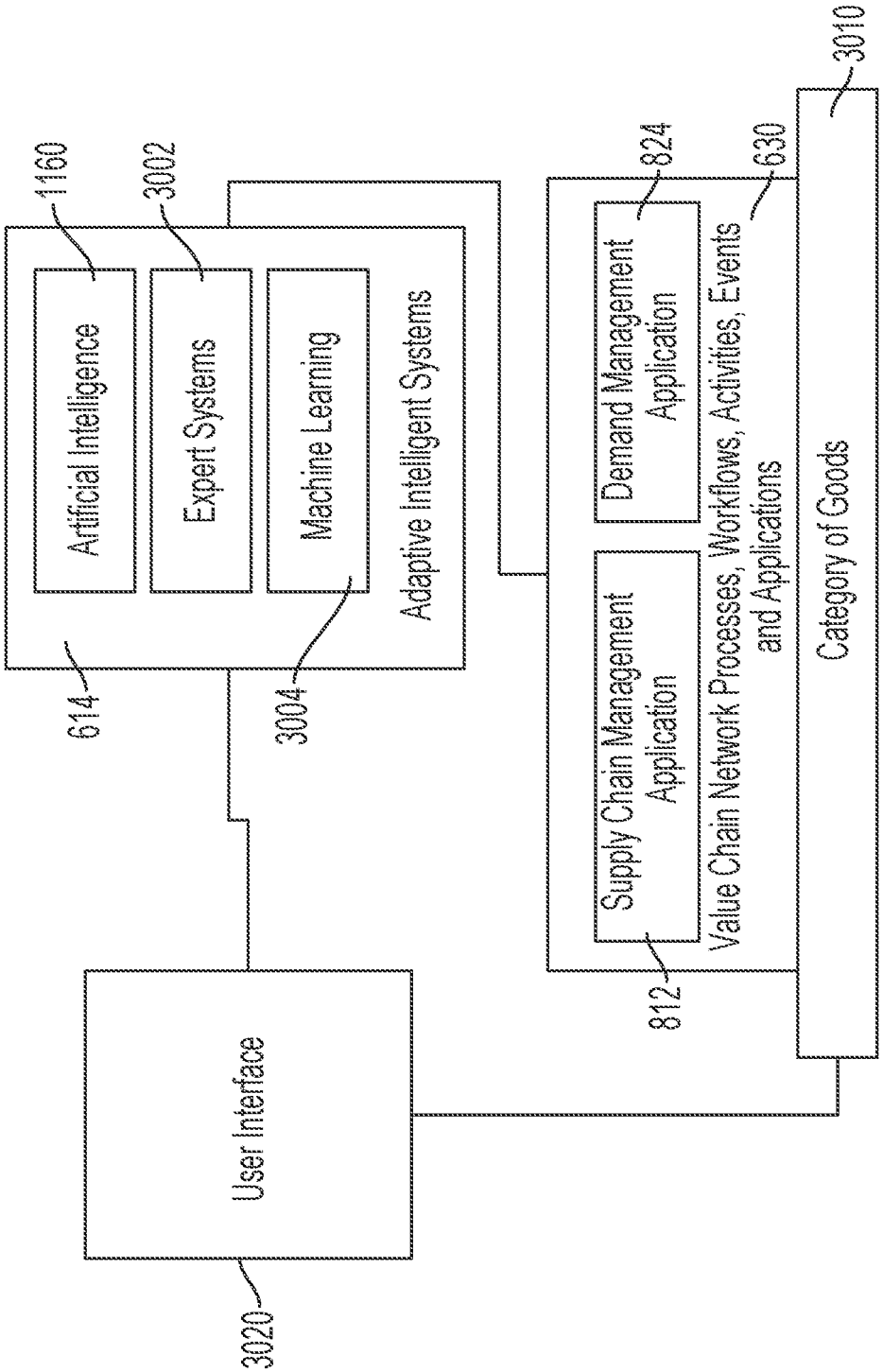

3010
1160
3002
824
630
Artificial Intelligence
Expert Systems
Machine Learning
Adaptive Intelligent Systems
Demand Management Application
Supply Chain Management Application
Value Chain Network Processes, Workflows, Activities, Events and Applications
Category of Goods
614
3004
812
User Interface
3020

FIG. 14

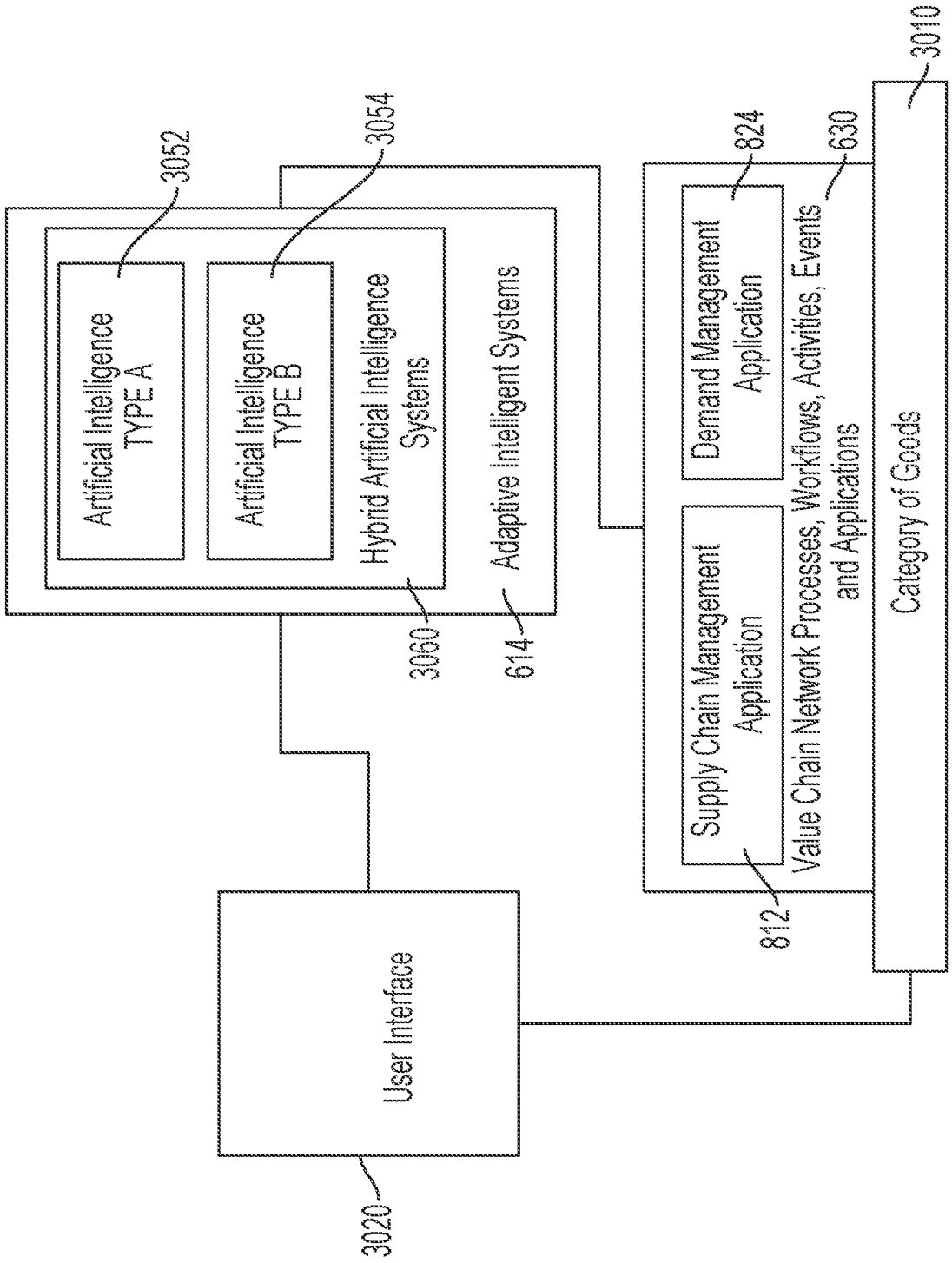

3010
Category of Goods
630
Value Chain Network Processes, Workflows, Activities, Events and Applications
824
Demand Management Application
812
Supply Chain Management Application
3020
User Interface
3060
Hybrid Artificial Intelligence Systems
3052
Artificial Intelligence TYPE A
3054
Artificial Intelligence TYPE B
614
Adaptive Intelligent Systems

FIG. 15

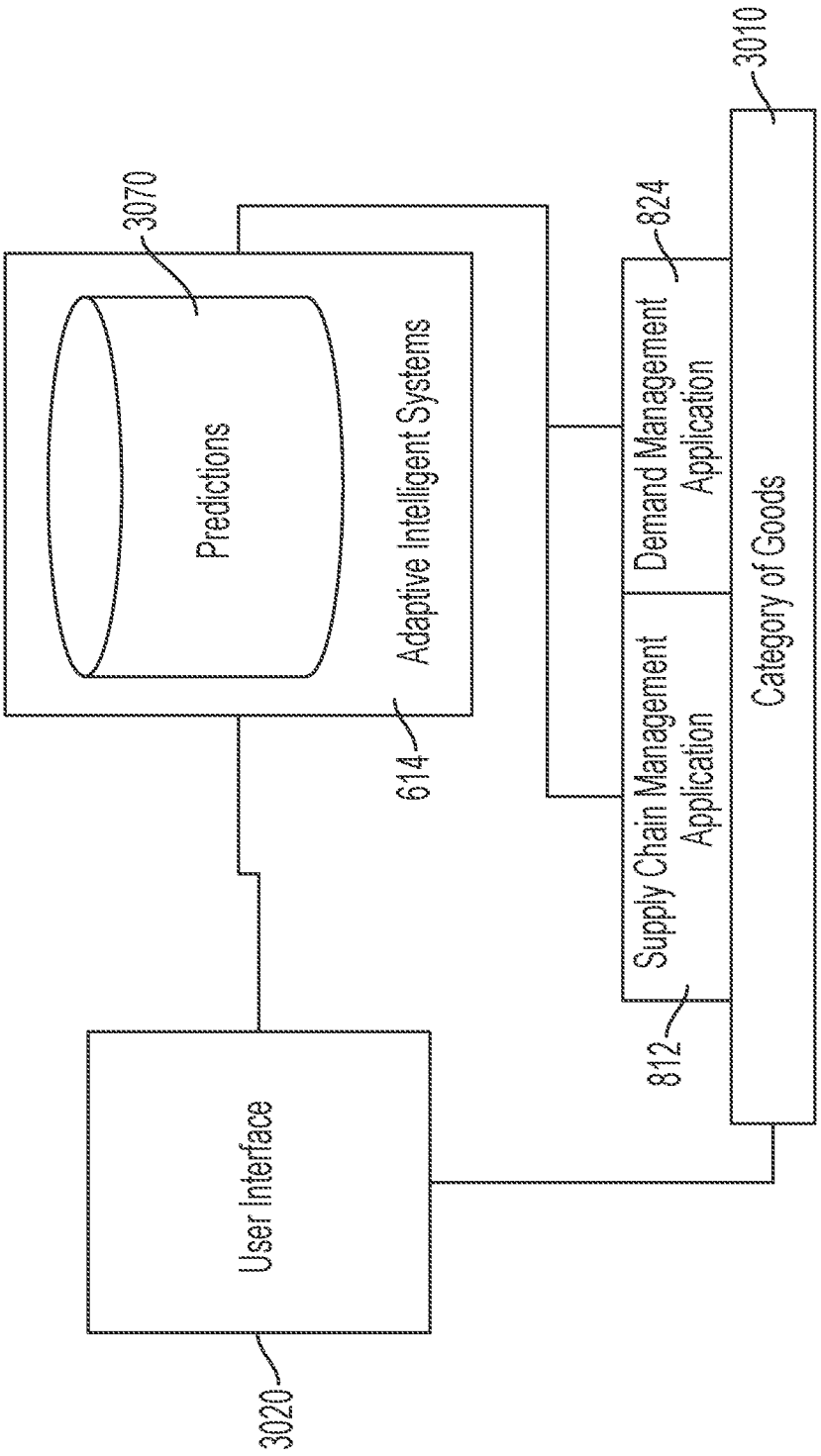

3010
Category of Goods
824
Demand Management Application
812
Supply Chain Management Application
3070
Predictions
Adaptive Intelligent Systems
614
User Interface
3020

FIG. 16

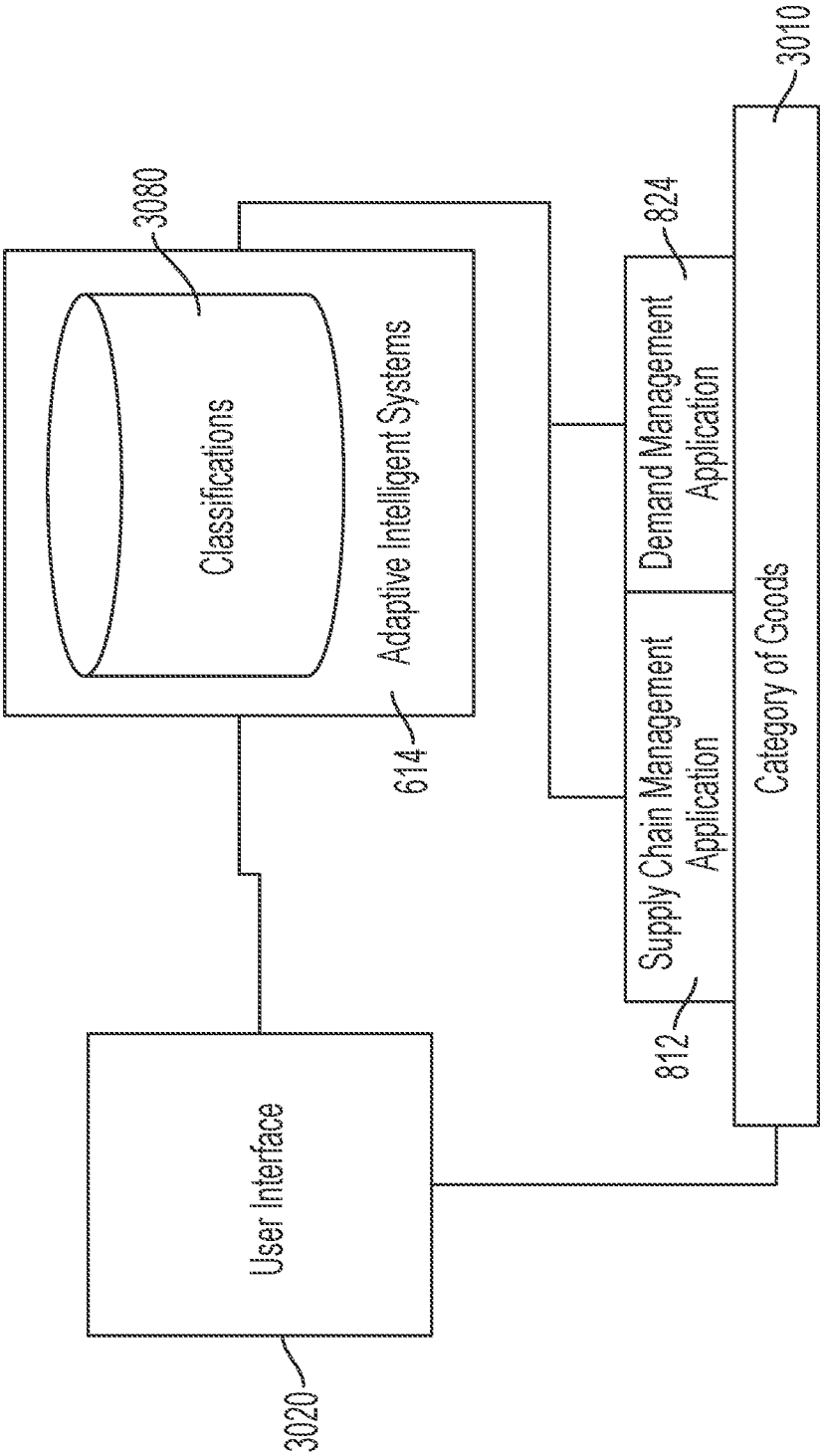

3010
3080
824
Classifications
Adaptive Intelligent Systems
Demand Management Application
Supply Chain Management Application
Category of Goods
614
812
User Interface
3020

FIG. 17

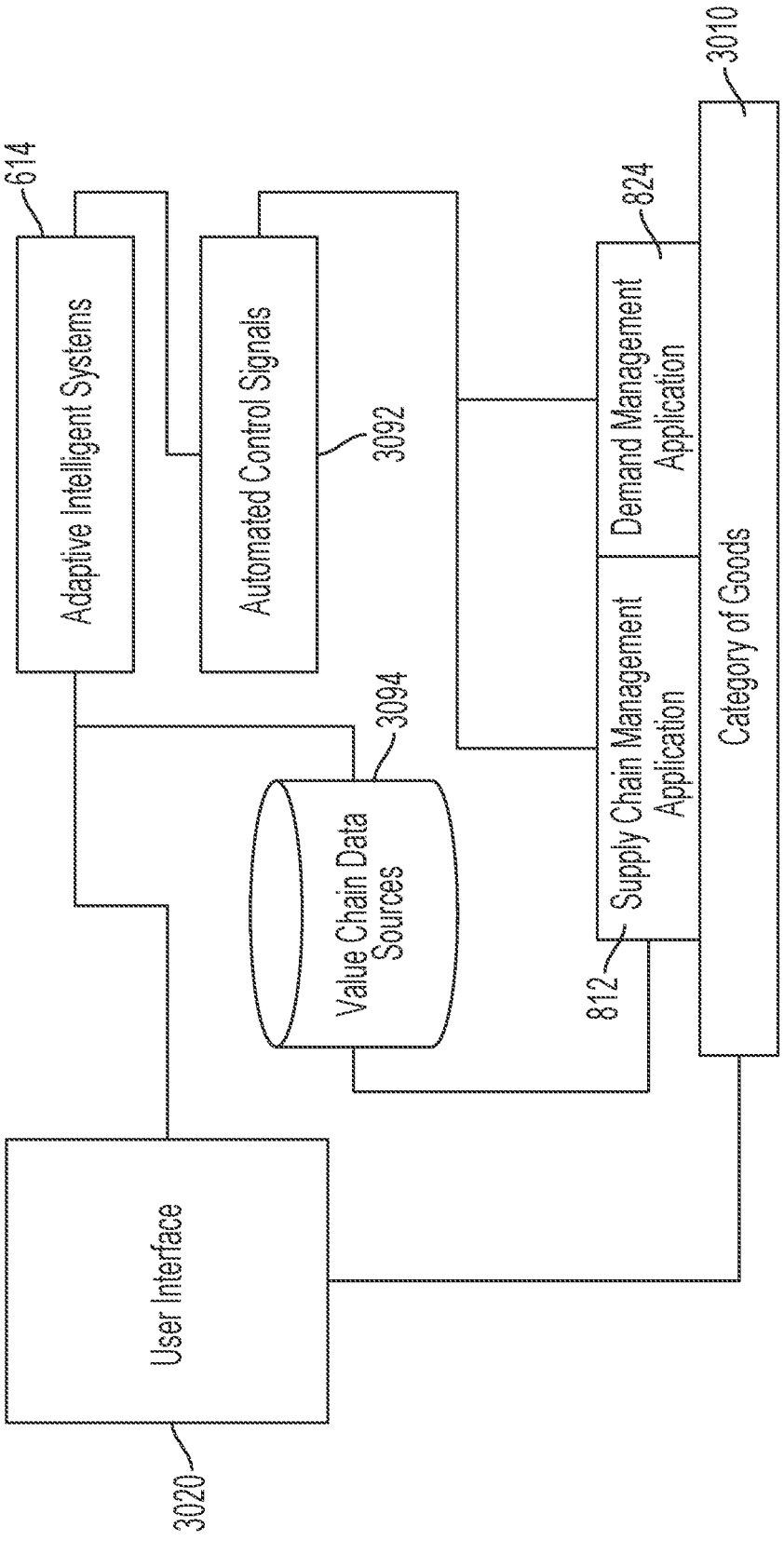

614
Adaptive Intelligent Systems
Automated Control Signals
3092
3094
Value Chain Data Sources
824
Demand Management Application
Supply Chain Management Application
812
3010
Category of Goods
User Interface
3020

FIG. 18

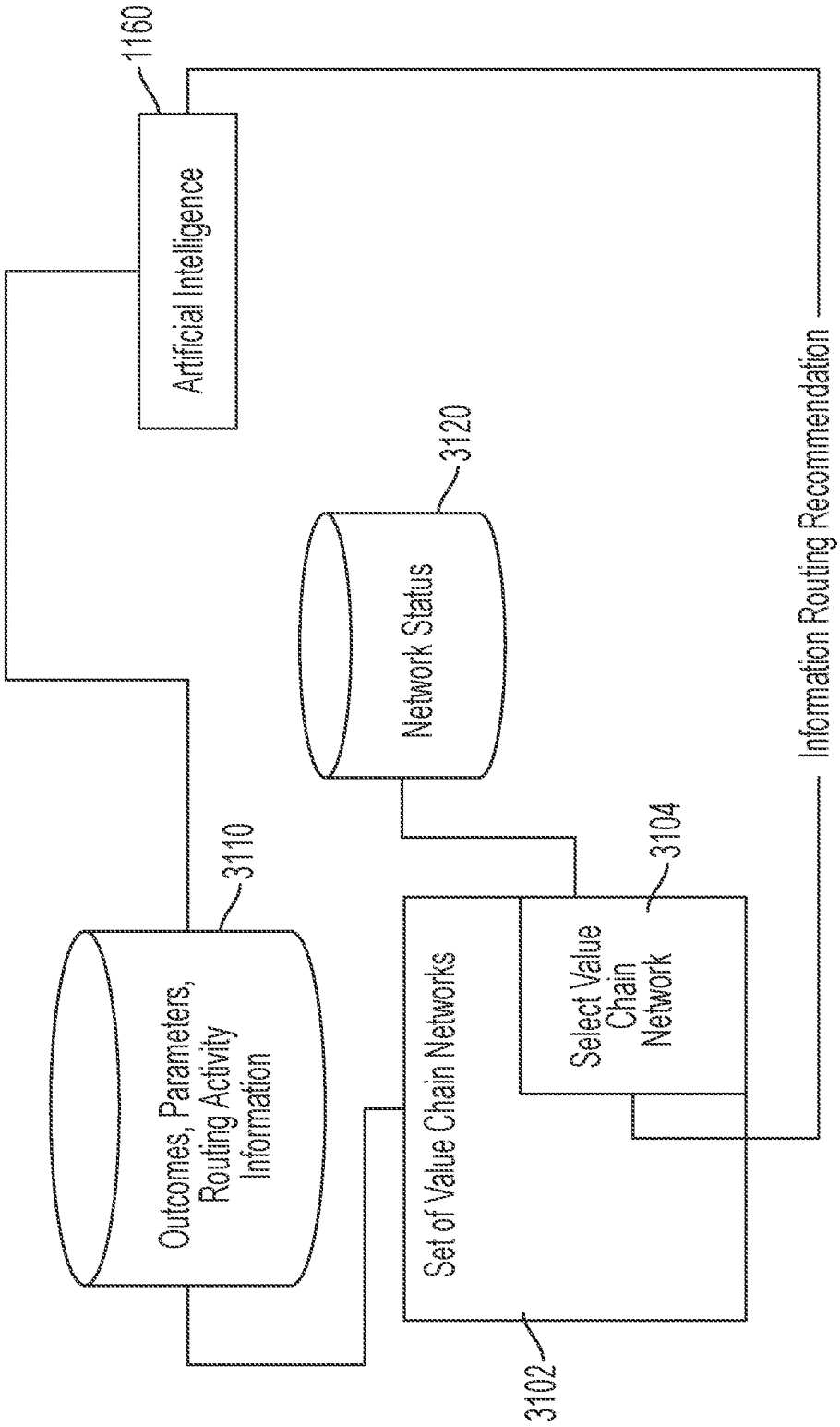

1160
Artificial Intelligence
3120
Network Status
3110
Outcomes, Parameters, Routing Activity Information
3104
Select Value Chain Network
Set of Value Chain Networks
3102
Information Routing Recommendation
3130

FIG. 19

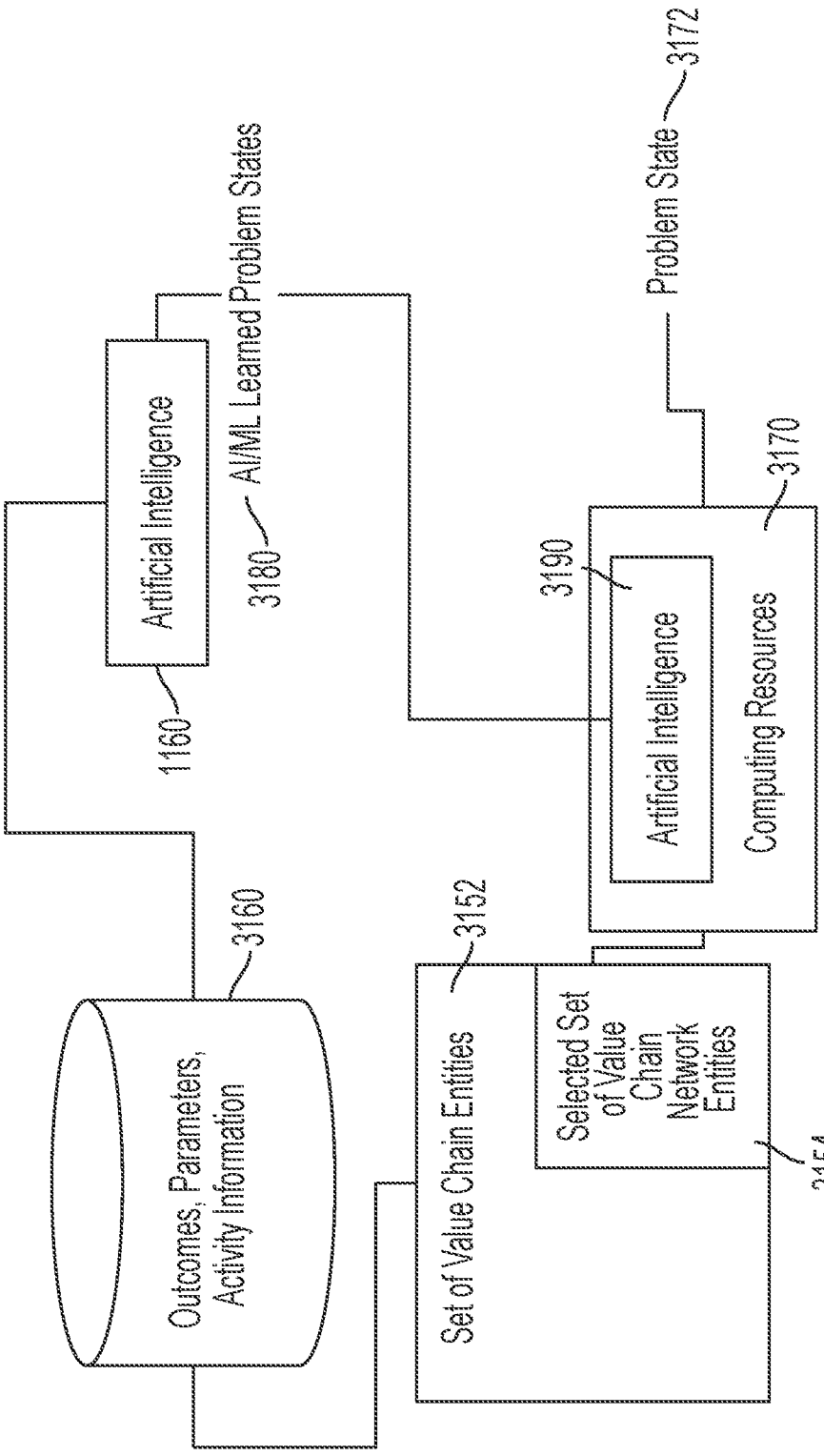

Artificial Intelligence
1160
AI/ML Learned Problem States
3180
Problem State
3172
3170
3190
Artificial Intelligence
Computing Resources
3160
Outcomes, Parameters, Activity Information
3152
Set of Value Chain Entities
Selected Set of Value Chain Network Entities
3154

FIG. 20

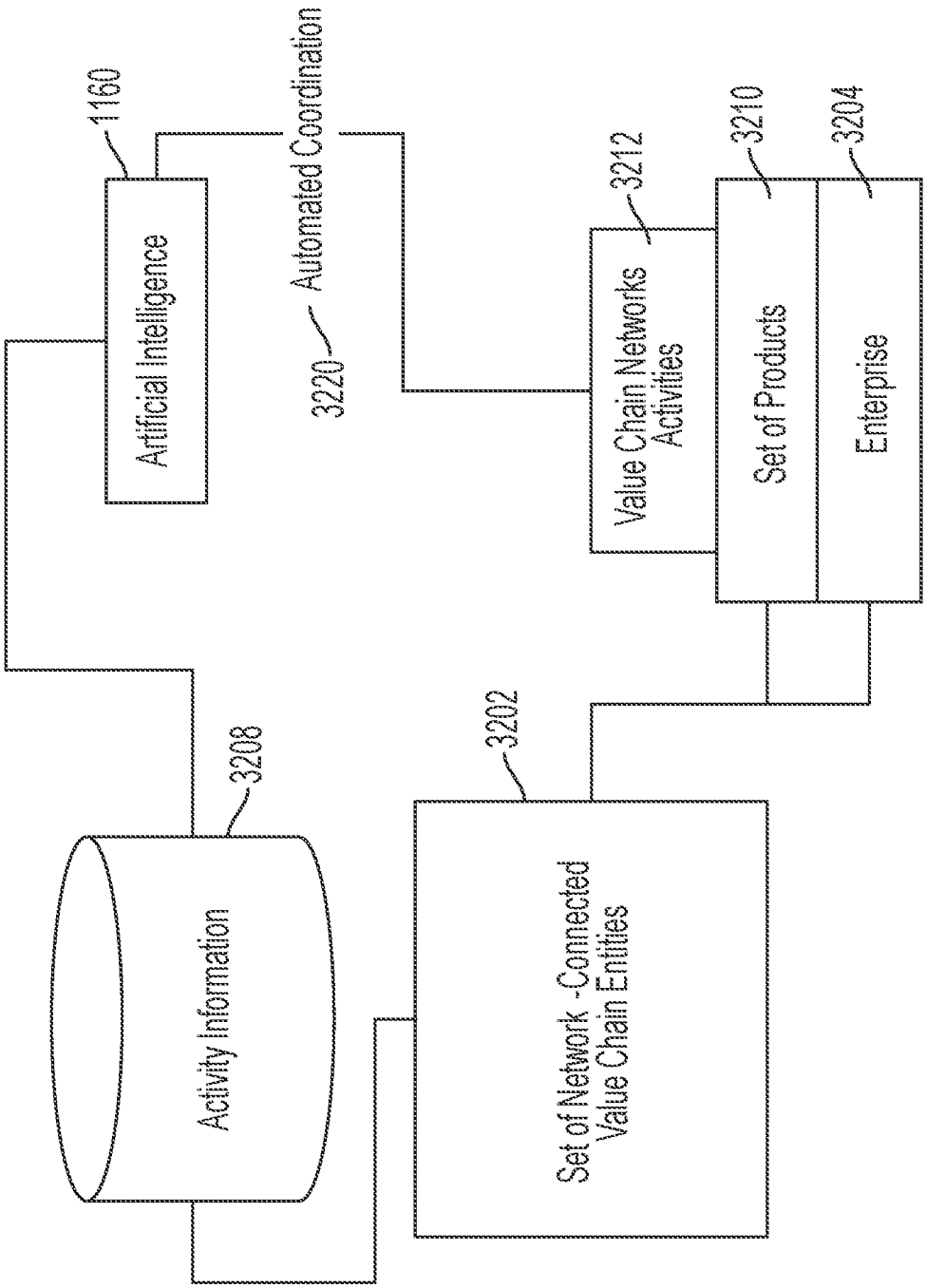

1160
Artificial Intelligence
Automated Coordination
3220
3212
Value Chain Networks Activities
3210
Set of Products
3204
Enterprise
3208
Activity Information
3202
Set of Network -Connected Value Chain Entities

FIG. 21

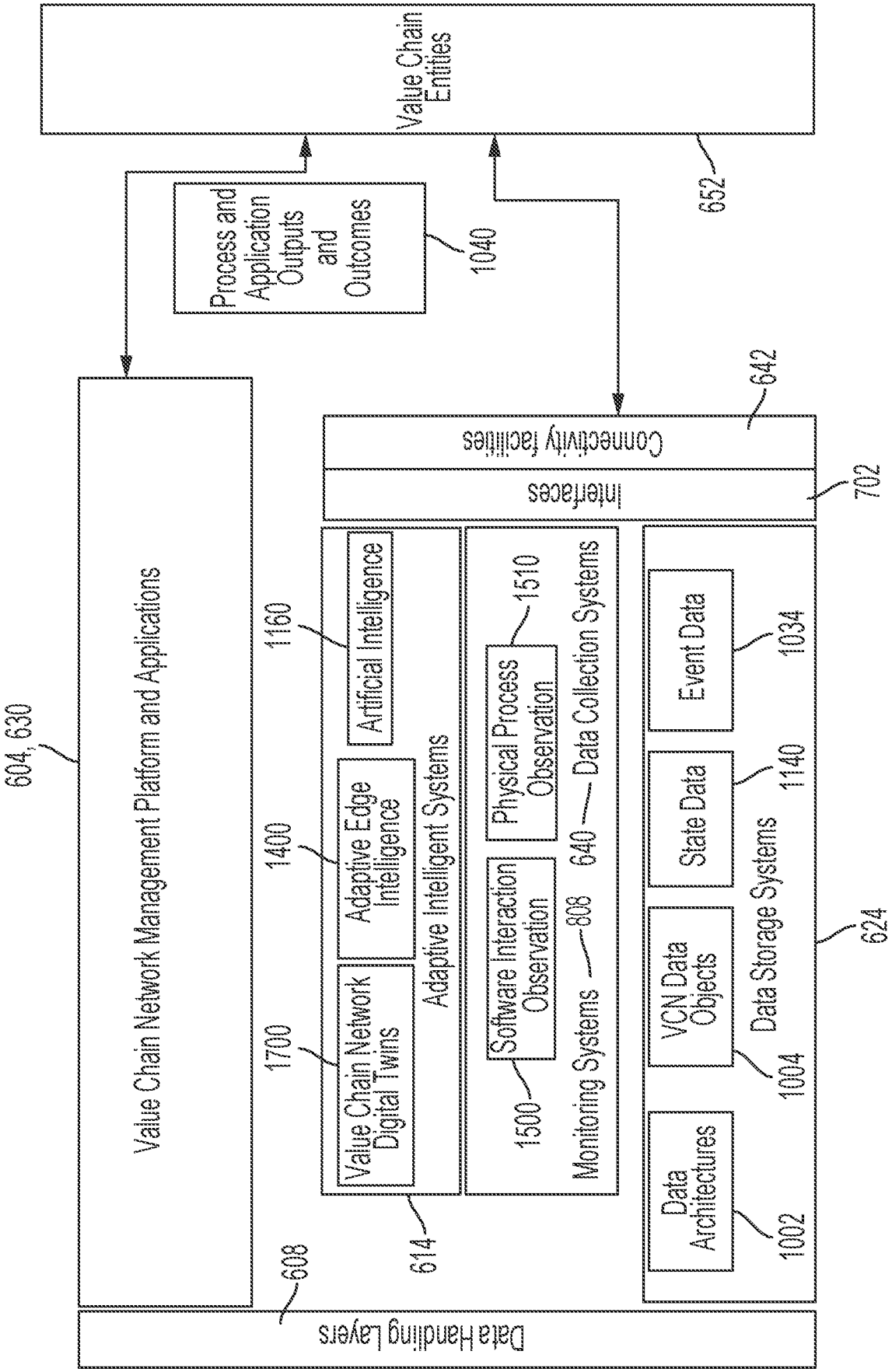

Value Chain Entities
652
Process and Application Outputs and Outcomes
1040
642
Connectivity facilities
Interfaces
702
604, 630
Value Chain Network Management Platform and Applications
1160
Artificial Intelligence
1400
Adaptive Edge Intelligence
Adaptive Intelligent Systems
1700
Value Chain Network Digital Twins
1510
Physical Process Observation
Software Interaction Observation
1500
640
Data Collection Systems
Monitoring Systems
808
Event Data
1034
State Data
1140
VCN Data Objects
1004
Data Storage Systems
624
Data Architectures
1002
614
608
Data Handling Layers

FIG. 22

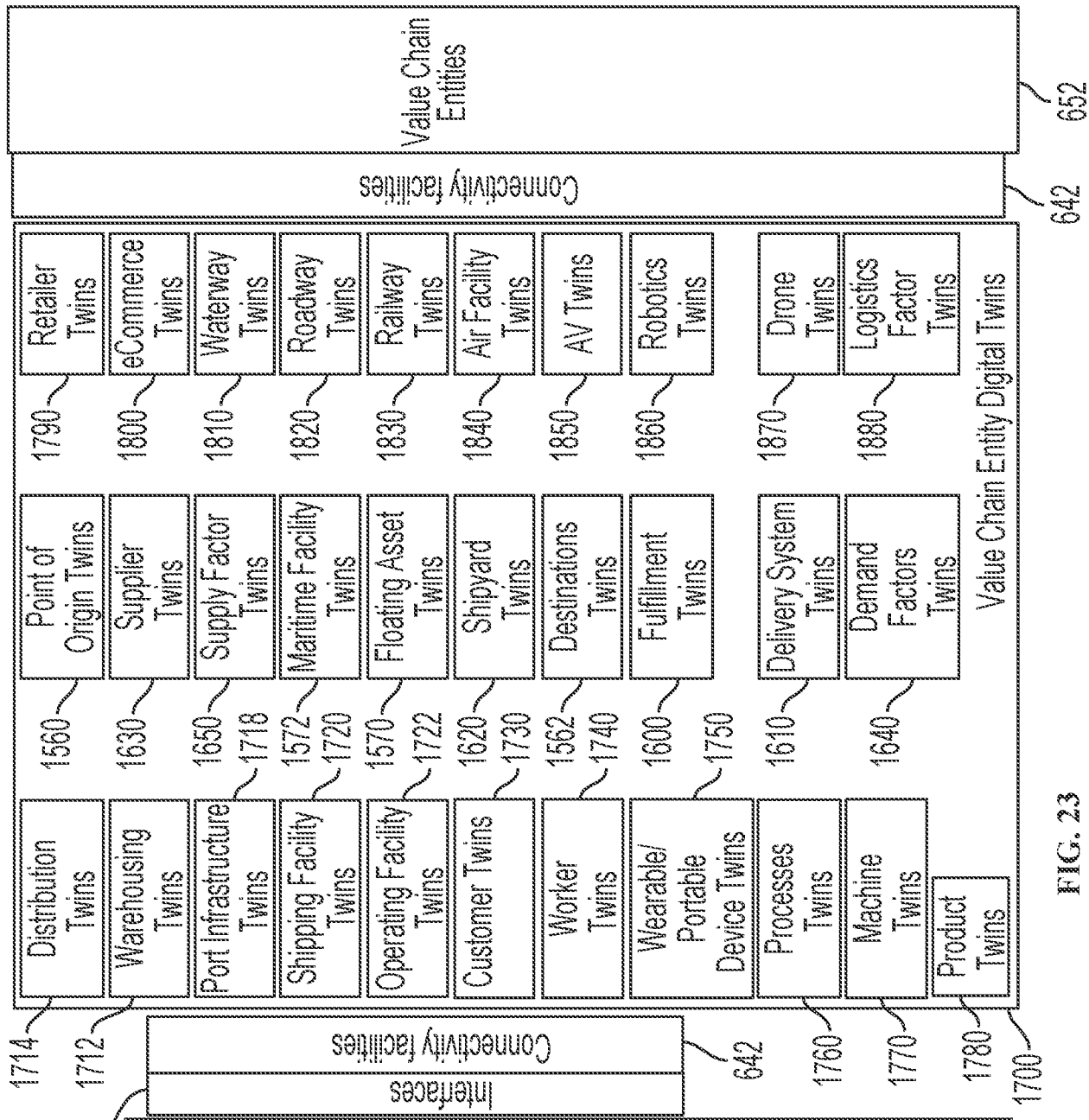

Value Chain Entities
652
Connectivity facilities
642
Retailer Twins
1790
eCommerce Twins
1800
Waterway Twins
1810
Roadway Twins
1820
Railway Twins
1830
Air Facility Twins
1840
AV Twins
1850
Robotics Twins
1860
Drone Twins
1870
Logistics Factor Twins
1880
Point of Origin Twins
1560
Supplier Twins
1630
Supply Factor Twins
1650
Maritime Facility Twins
1572
Floating Asset Twins
1570
Shipyard Twins
1620
Destinations Twins
1562
Fulfillment Twins
1600
Delivery System Twins
1610
Demand Factors Twins
1640
Value Chain Entity Digital Twins
Distribution Twins
1714
Warehousing Twins
1712
Port Infrastructure Twins
1718
Shipping Facility Twins
1720
Operating Facility Twins
1722
Customer Twins
1730
Worker Twins
1740
Wearable/ Portable Device Twins
1750
Processes Twins
1760
Machine Twins
1770
Product Twins
1780
1700
Interfaces
702
Connectivity facilities
642
650
630
640
808
Intelligent Product
Value Chain Network Processes, Workflows, Activities, Events and Applications
Data Collection and Management Systems
Value Chain Monitoring Systems
Data Processing, Artificial Intelligence and Computational Systems
Adaptive Intelligent Systems
634
Event Data
1034
State Data
1140
VCN Data Objects
1004
614
Value Chain Network-Oriented Data Storage Systems
VCNP
624
604

FIG. 23

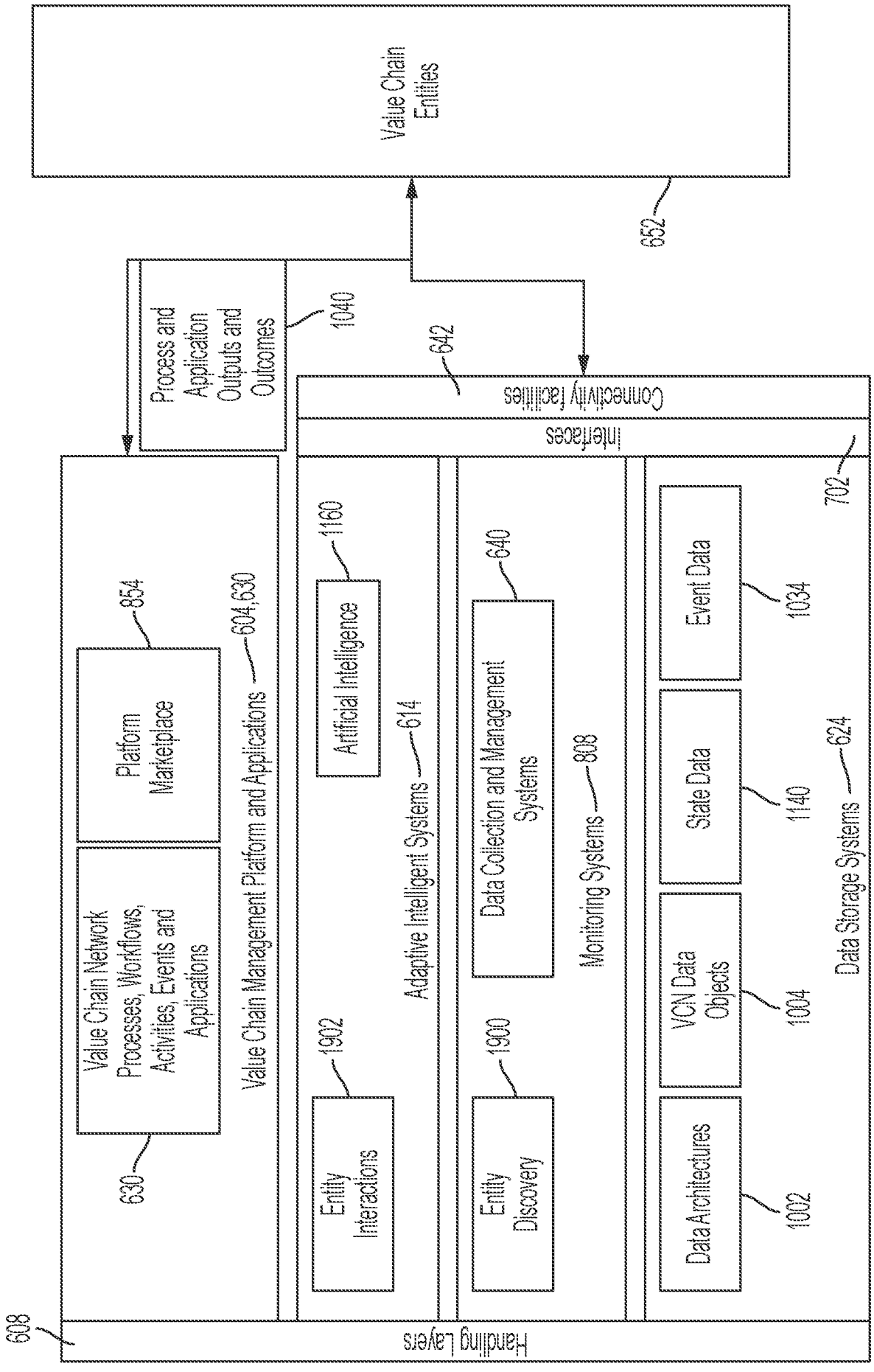

Value Chain Entities
652
Process and Application Outputs and Outcomes
1040
642
Connectivity facilities
Interfaces
702
Value Chain Management Platform and Applications
604,630
854
Platform Marketplace
Value Chain Network Processes, Workflows, Activities, Events and Applications
630
Artificial Intelligence
1160
Adaptive Intelligent Systems
614
Entity Interactions
1902
Entity Discovery
1900
Data Collection and Management Systems
640
Monitoring Systems
808
Event Data
1034
State Data
1140
VCN Data Objects
1004
Data Architectures
1002
Data Storage Systems
624
Handling Layers
608

FIG. 24

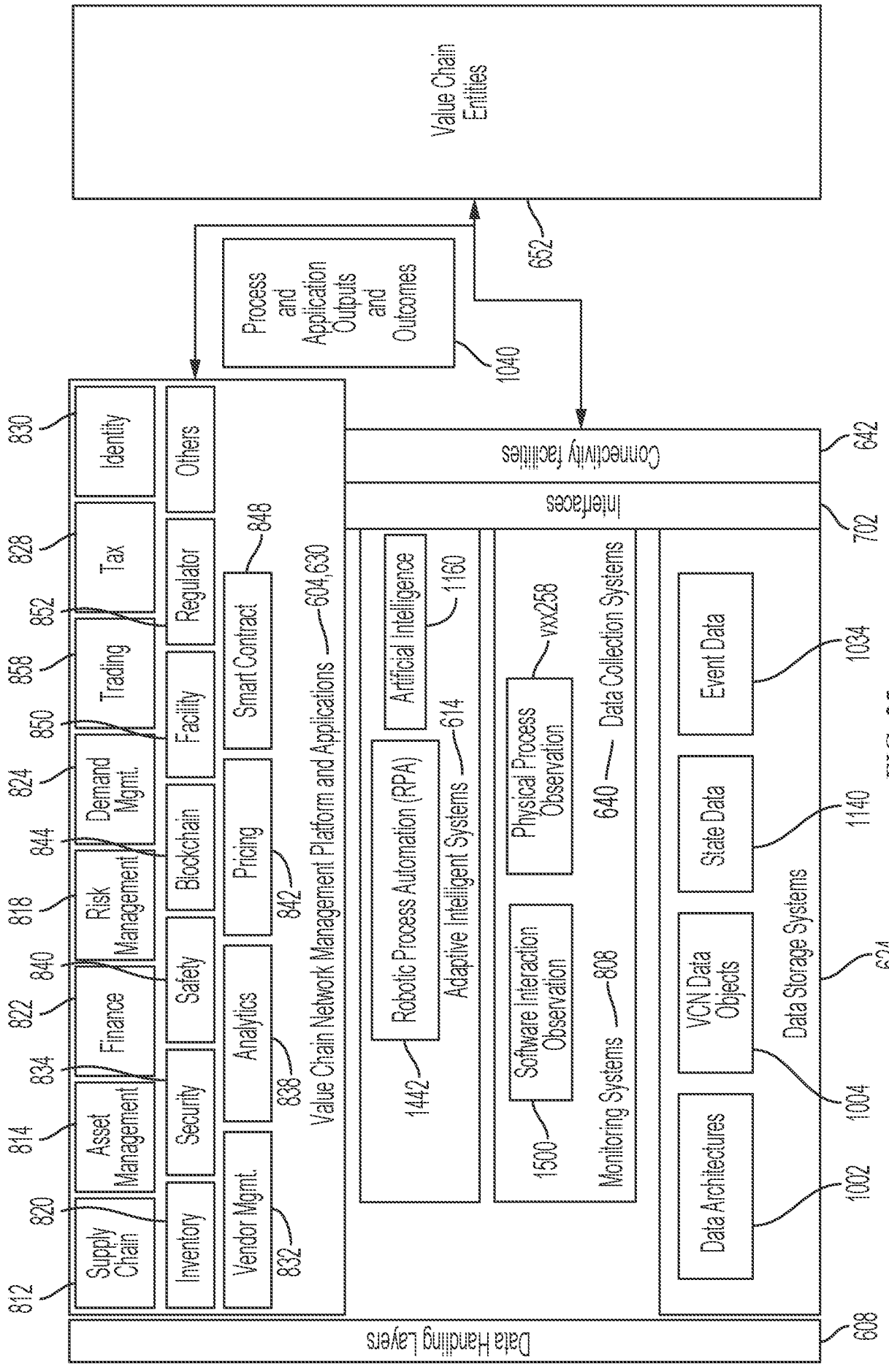

Value Chain Entities
652
Process and Application Outputs and Outcomes
1040
Connectivity facilities
642
Interfaces
702
Data Handling Layers
608
Value Chain Network Management Platform and Applications
604,630
Identity
830
Others
Tax
828
Regulator
852
Trading
858
Facility
850
Demand Mgmt.
824
Smart Contract
848
Blockchain
844
Pricing
842
Risk Management
818
Safety
840
Analytics
838
Finance
822
Security
834
Asset Management
814
Vendor Mgmt.
832
Supply Chain
820
Inventory
812
Artificial Intelligence
1160
614
Adaptive Intelligent Systems
Robotic Process Automation (RPA)
1442
Physical Process Observation
vxx258
Software Interaction Observation
1500
Monitoring Systems
808
640
Data Collection Systems
Event Data
1034
State Data
1140
VCN Data Objects
1004
Data Architectures
1002
Data Storage Systems
624

FIG. 25

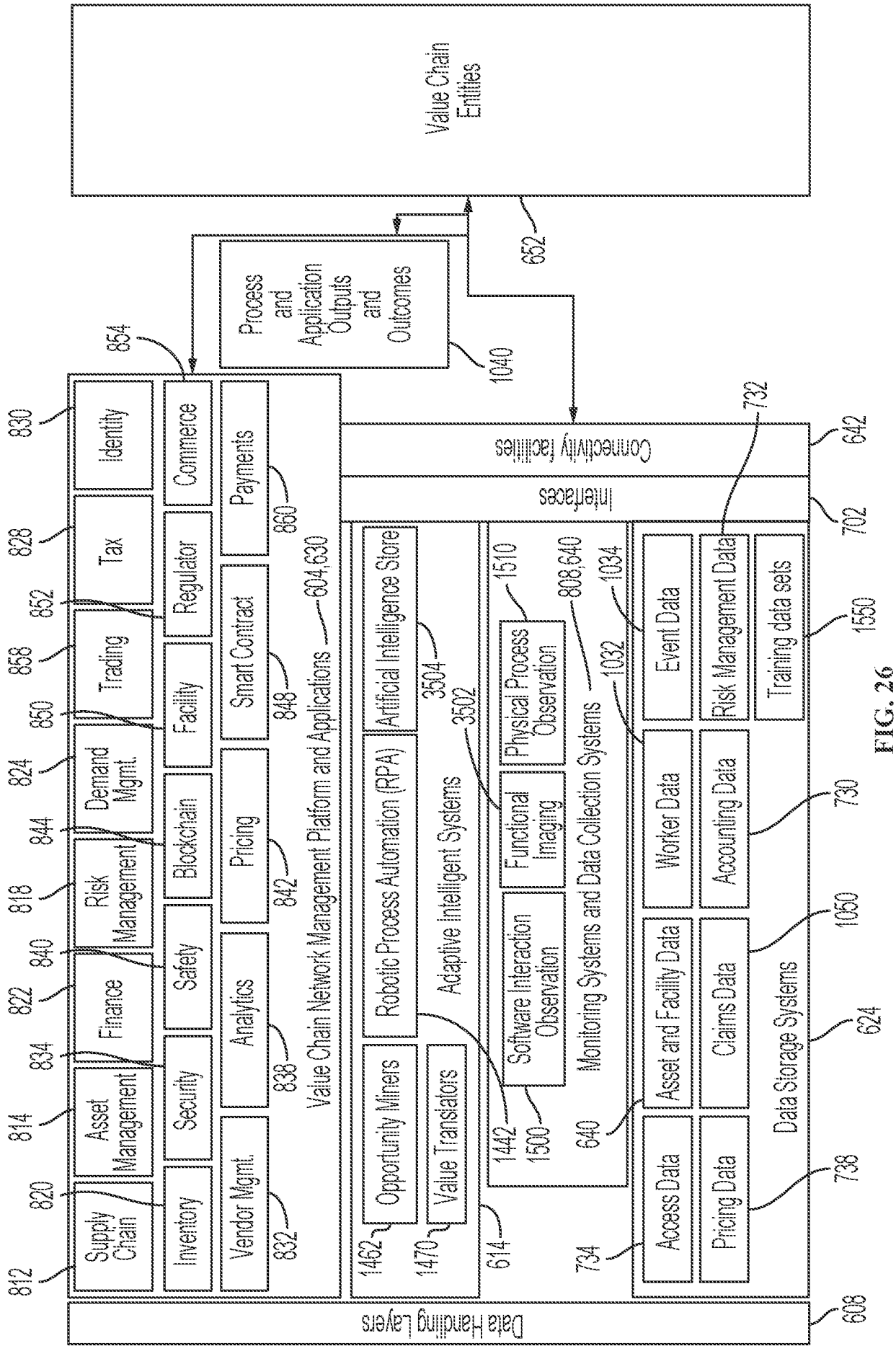

Value Chain Entities
652
Process and Application Outputs and Outcomes
1040
854
Identity
Commerce
Tax
Payments
Regulator
Trading
Smart Contract
Facility
Demand Mgmt.
Pricing
Blockchain
Risk Management
Safety
Analytics
Finance
Security
Asset Management
Vendor Mgmt.
Inventory
Supply Chain
830
828
852
858
850
824
844
818
840
822
834
814
820
812
832
838
842
848
860
Value Chain Network Management Platform and Applications
604,630
Connectivity facilities
732
642
Interfaces
702
Artificial Intelligence Store
3504
Robotic Process Automation (RPA)
3502
Adaptive Intelligent Systems
Opportunity Miners
Value Translators
1462
1470
614
1510
Physical Process Observation
Functional Imaging
Software Interaction Observation
1442
1500
808,640
1034
1032
640
Monitoring Systems and Data Collection Systems
Event Data
Risk Management Data
Training data sets
1550
Worker Data
Accounting Data
730
Asset and Facility Data
Claims Data
Data Storage Systems
1060
624
Access Data
Pricing Data
738
734
Data Handling Layers
608

FIG. 26

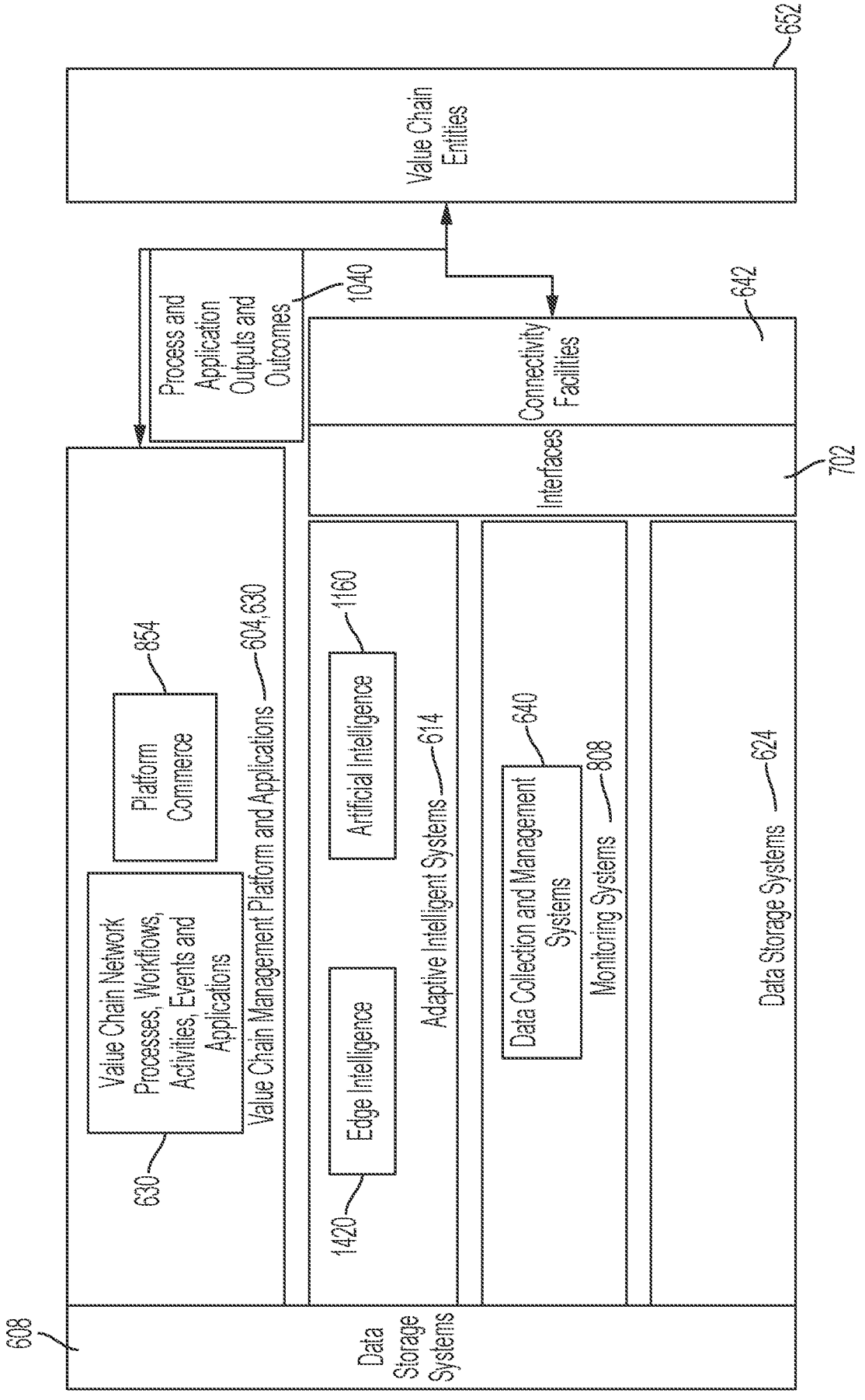

652
Value Chain Entities
1040
Process and Application Outputs and Outcomes
642
Connectivity Facilities
Interfaces
702
854
Platform Commerce
604, 630
Value Chain Management Platform and Applications
1160
Artificial Intelligence
614
Adaptive Intelligent Systems
640
Data Collection and Management Systems
808
Monitoring Systems
624
Data Storage Systems
630
Value Chain Network Processes, Workflows, Activities, Events and Applications
1420
Edge Intelligence
608
Data Storage Systems

FIG. 27

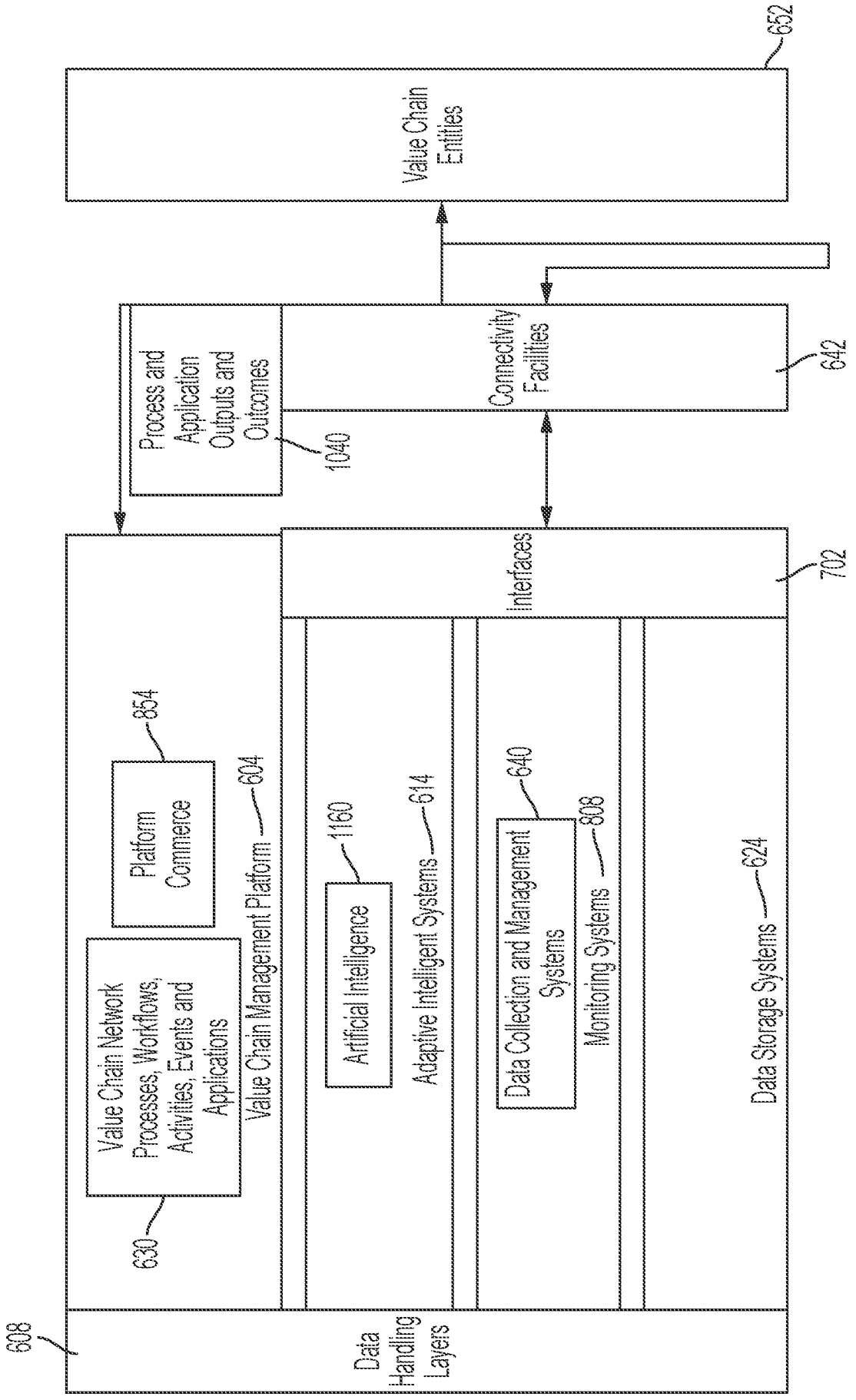

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Value Chain Entities
Process and Application Outputs and Outcomes
1040
Connectivity Facilities
642
Interfaces
702
854
Platform Commerce
604
Value Chain Management Platform
630
Value Chain Network Processes, Workflows, Activities, Events and Applications
1160
Artificial Intelligence
614
Adaptive Intelligent Systems
640
Data Collection and Management Systems
808
Monitoring Systems
624
Data Storage Systems
608
Data Handling Layers

FIG. 28

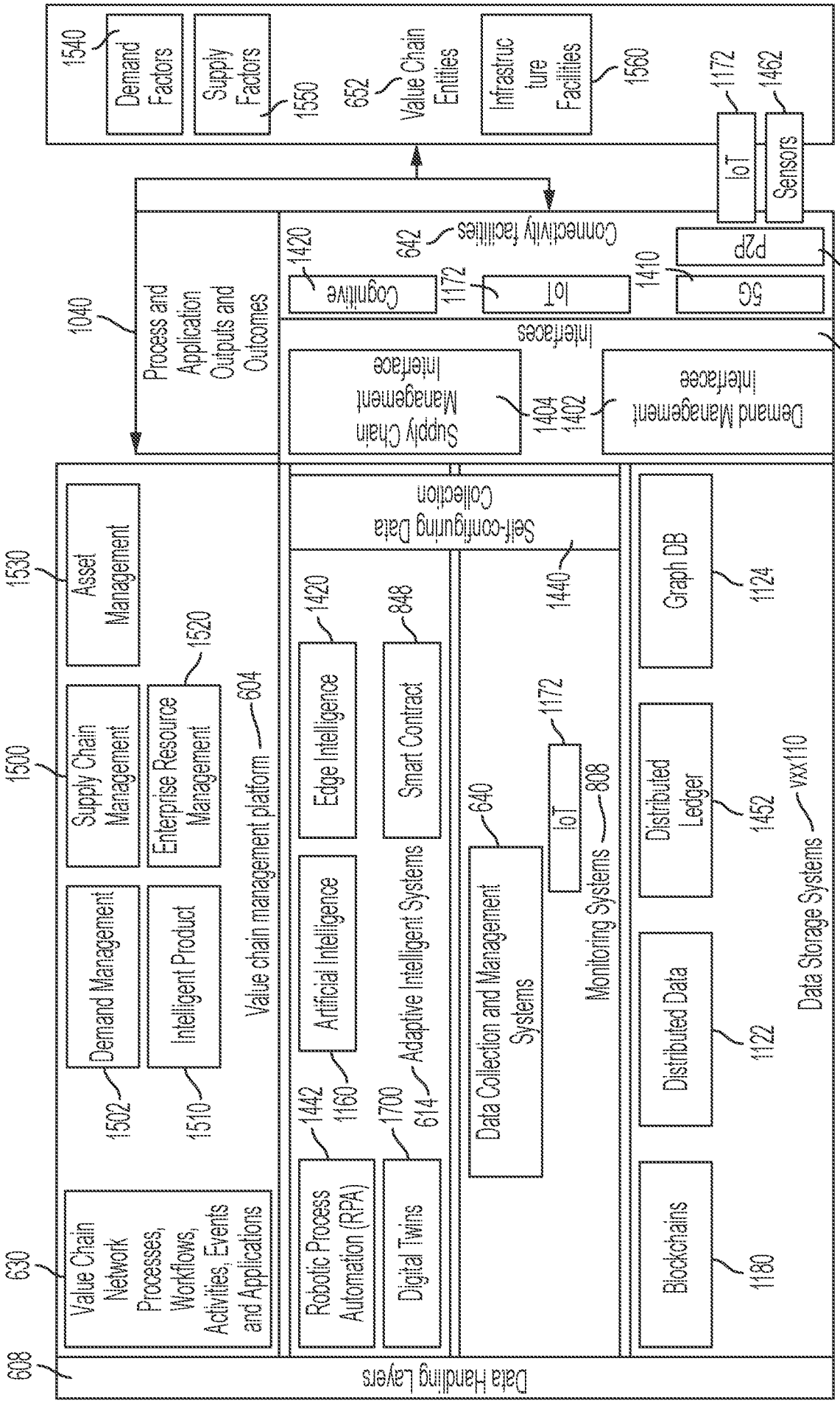

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Demand Factors
Supply Factors
1550
652
Value Chain Entities
Infrastructure Facilities
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1172
IoT
1462
Sensors
1040
Process and Application Outputs and Outcomes
Connectivity facilities
642
1420
Cognitive
1172
IoT
1410
5G
P2P
1430
Interfaces
Supply Chain Management Interface
1404
1402
Demand Management Interface
702
1530
Asset Management
1500
Supply Chain Management
Enterprise Resource Management
1520
604
Value chain management platform
Self-configuring Data Collection
1420
Edge Intelligence
848
Smart Contract
1440
Graph DB
1124
1502
Demand Management
1510
Intelligent Product
1442
1160
Artificial Intelligence
1700
614
Adaptive Intelligent Systems
640
Data Collection and Management Systems
1172
IoT
808
Monitoring Systems
Distributed Ledger
1452
vxx110
Data Storage Systems
630
Value Chain Network Processes, Workflows, Activities, Events and Applications
Robotic Process Automation (RPA)
Digital Twins
Distributed Data
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Blockchains
1180
608
Data Handling Layers

FIG. 29

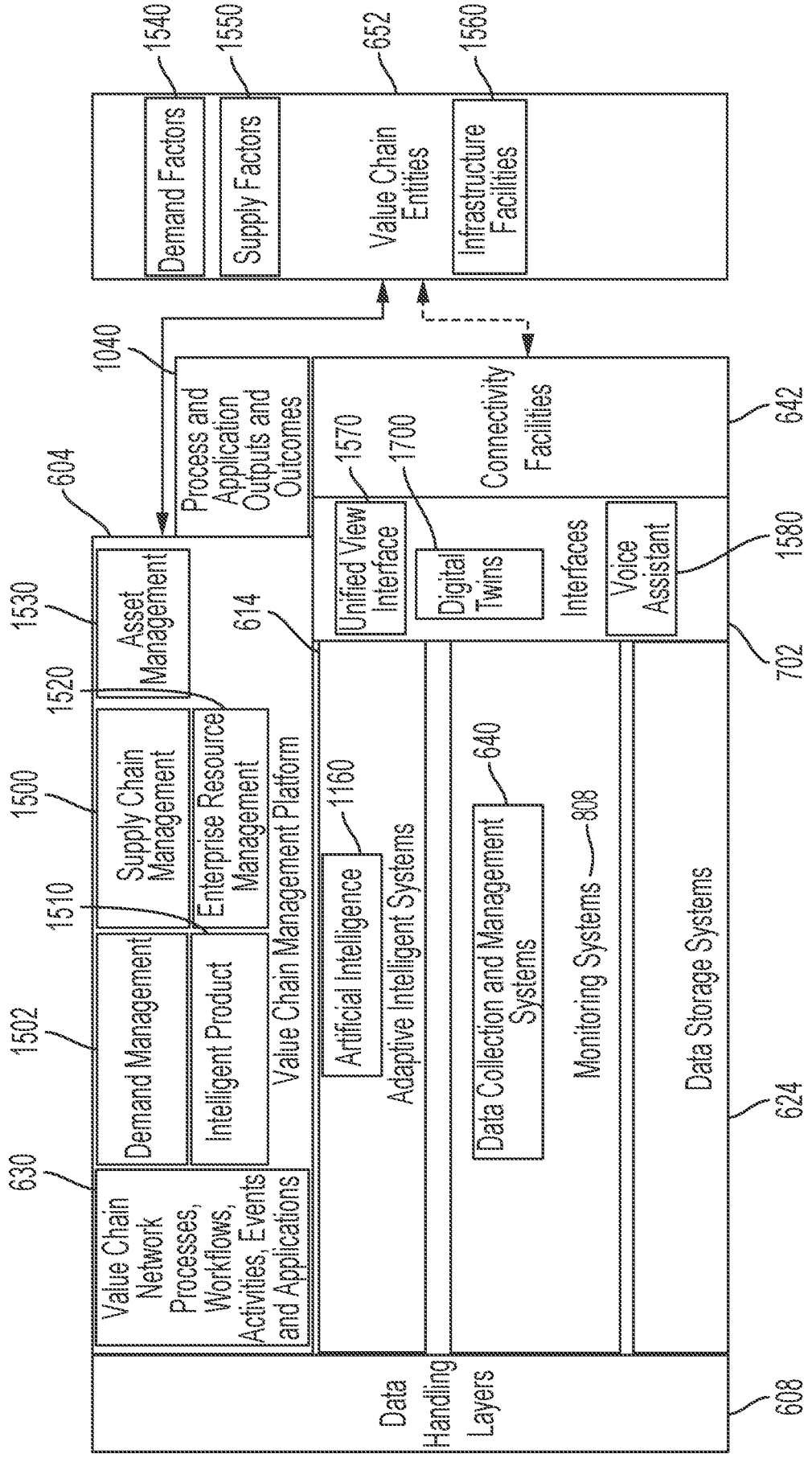

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Demand Factors
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Value Chain Entities
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Process and Application Outputs and Outcomes
604
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1700
Unified View Interface
Digital Twins
Connectivity Facilities
642
Interfaces
1580
Voice Assistant
1530
Asset Management
614
1520
Supply Chain Management
Enterprise Resource Management
1500
1510
Demand Management
Intelligent Product
Value Chain Management Platform
1502
630
Value Chain Network Processes, Workflows, Activities, Events and Applications
1160
Artificial Intelligence
Adaptive Intelligent Systems
640
Data Collection and Management Systems
808
Monitoring Systems
Data Storage Systems
624
702
Data Handling Layers
608

FIG. 30

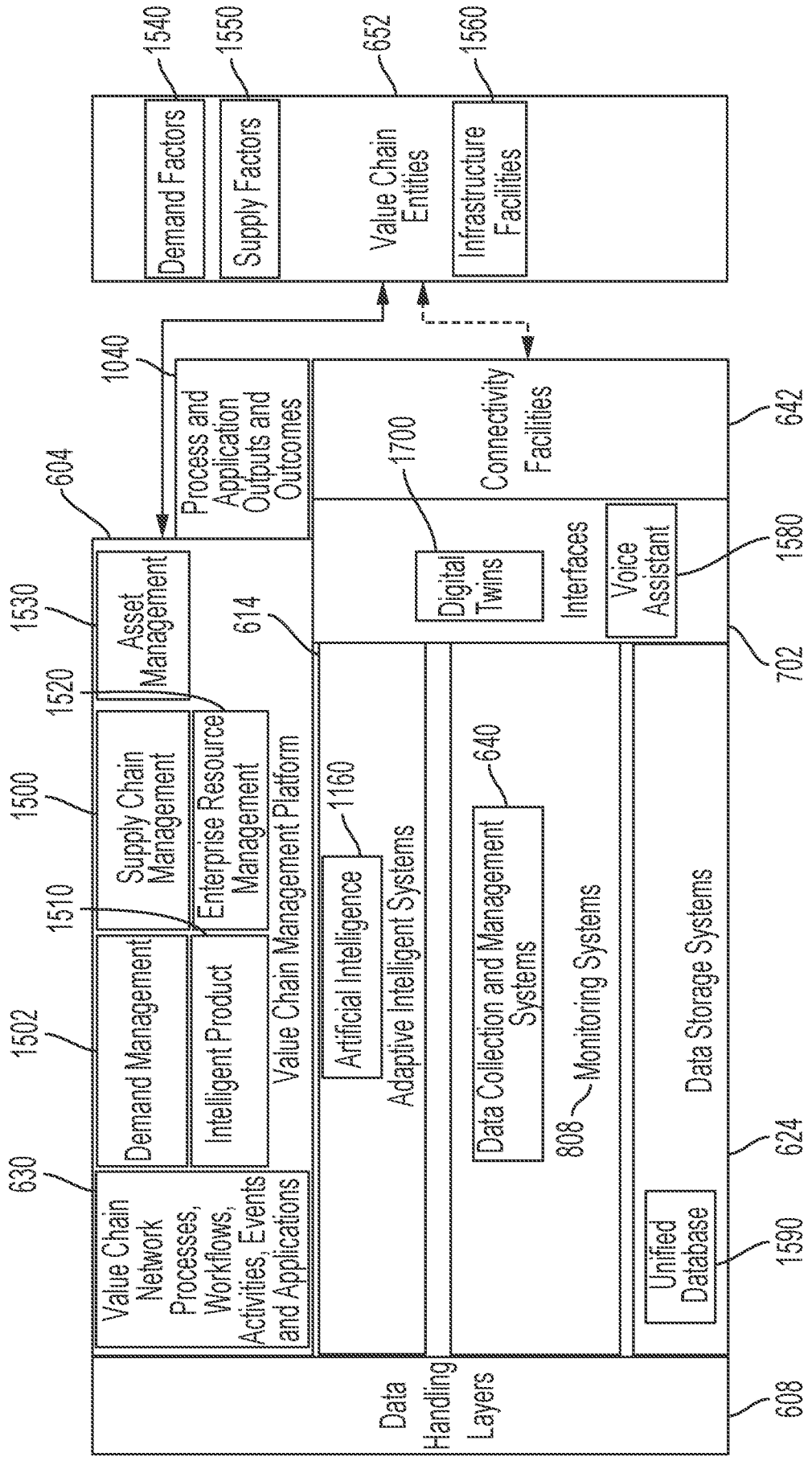

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Demand Factors
Supply Factors
Value Chain Entities
Infrastructure Facilities
1040
Process and Application Outputs and Outcomes
604
1530
Asset Management
1520
Supply Chain Management
1500
Enterprise Resource Management
1510
Value Chain Management Platform
614
1700
Connectivity Facilities
642
Digital Twins
Interfaces
Voice Assistant
1580
702
1502
Demand Management
1160
Artificial Intelligence
Adaptive Intelligent Systems
640
Data Collection and Management Systems
808
Monitoring Systems
630
Intelligent Product
Value Chain Network Processes, Workflows, Activities, Events and Applications
624
Data Storage Systems
1590
Unified Database
608
Data Handling Layers

FIG. 31

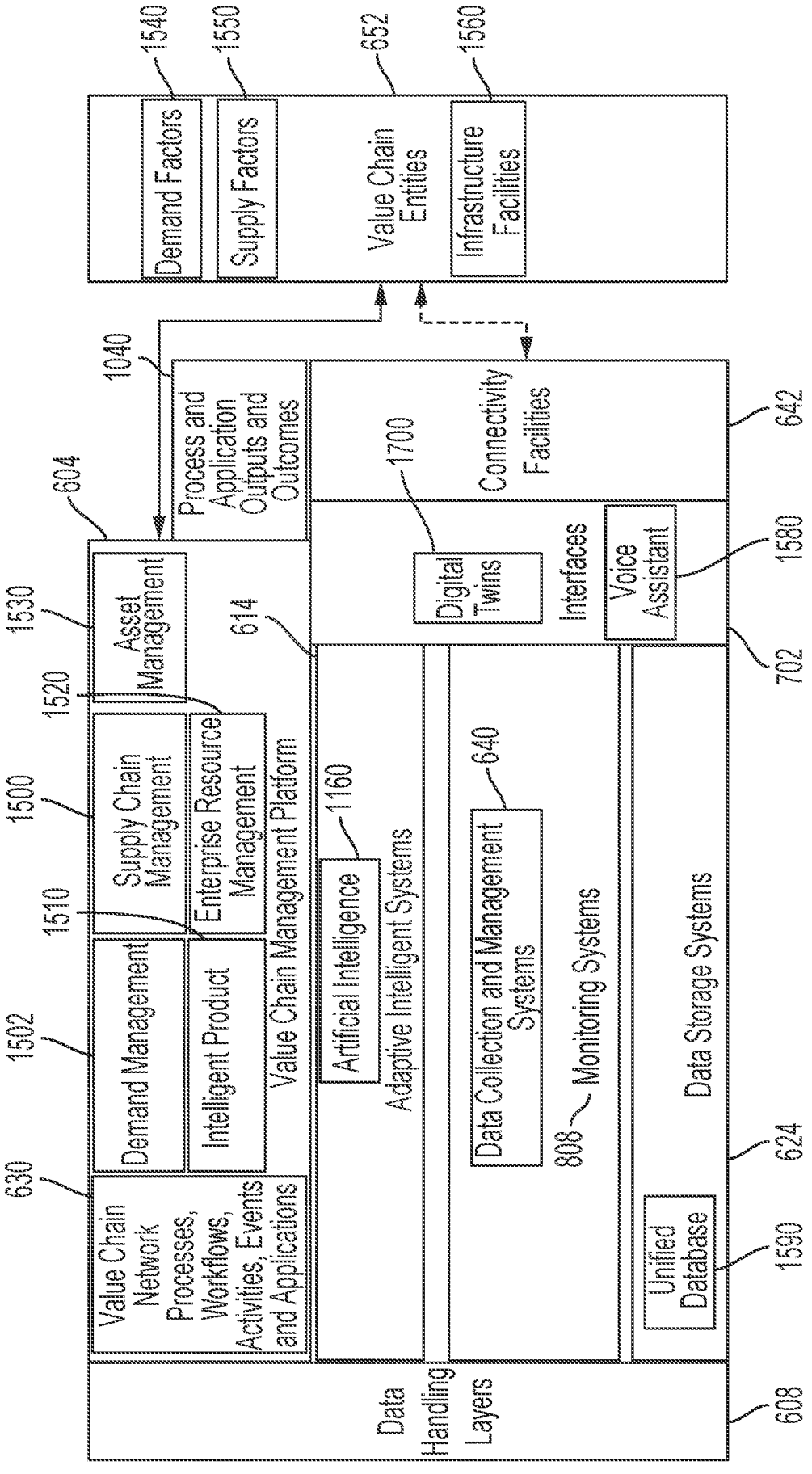

Demand Factors
Supply Factors
Value Chain Entities
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1040
Process and Application Outputs and Outcomes
604
Asset Management
1530
Supply Chain Management
1520
Enterprise Resource Management
1500
Demand Management
1510
Intelligent Product
1502
Value Chain Management Platform
614
Value Chain Network Processes, Workflows, Activities, Events and Applications
630
Artificial Intelligence
1160
Adaptive Intelligent Systems
Data Collection and Management Systems
640
808
Monitoring Systems
Data Storage Systems
Unified Database
1590
624
Data Handling Layers
608
1700
Digital Twins
Interfaces
Voice Assistant
1580
Connectivity Facilities
642
702

FIG. 32

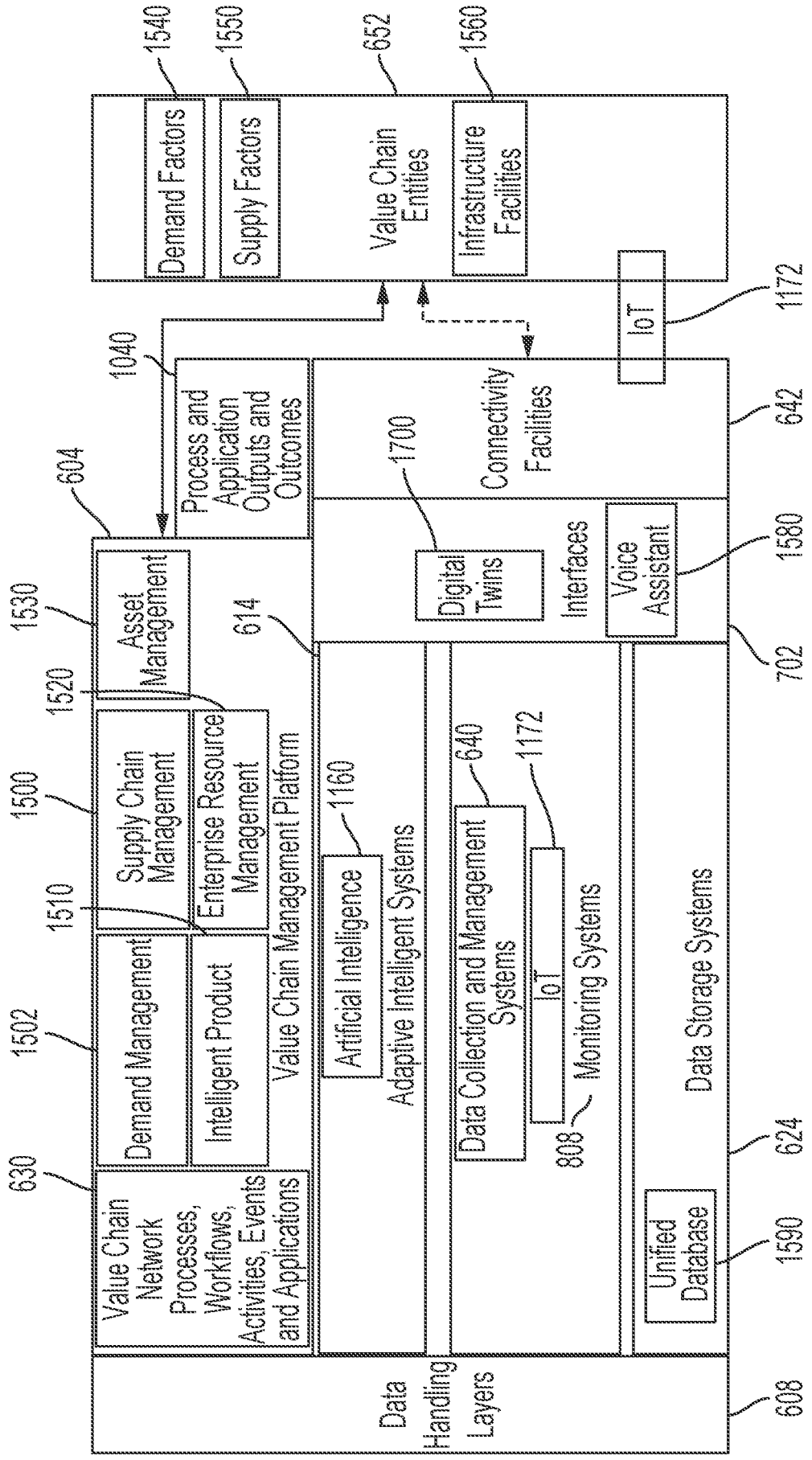

Data Handling Layers
608
Unified Database
1590
624
Data Storage Systems
Value Chain Network Processes, Workflows, Activities, Events and Applications
630
Demand Management
1502
Intelligent Product
1510
Supply Chain Management
1500
Enterprise Resource Management
1520
Value Chain Management Platform
614
Asset Management
1530
604
Artificial Intelligence
1160
Adaptive Intelligent Systems
Data Collection and Management Systems
640
IoT
1172
808
Monitoring Systems
Process and Application Outputs and Outcomes
1040
Digital Twins
1700
Interfaces
Voice Assistant
1580
702
Connectivity Facilities
642
IoT
1172
Demand Factors
1540
Supply Factors
1550
Value Chain Entities
652
Infrastructure Facilities
1560

FIG. 33

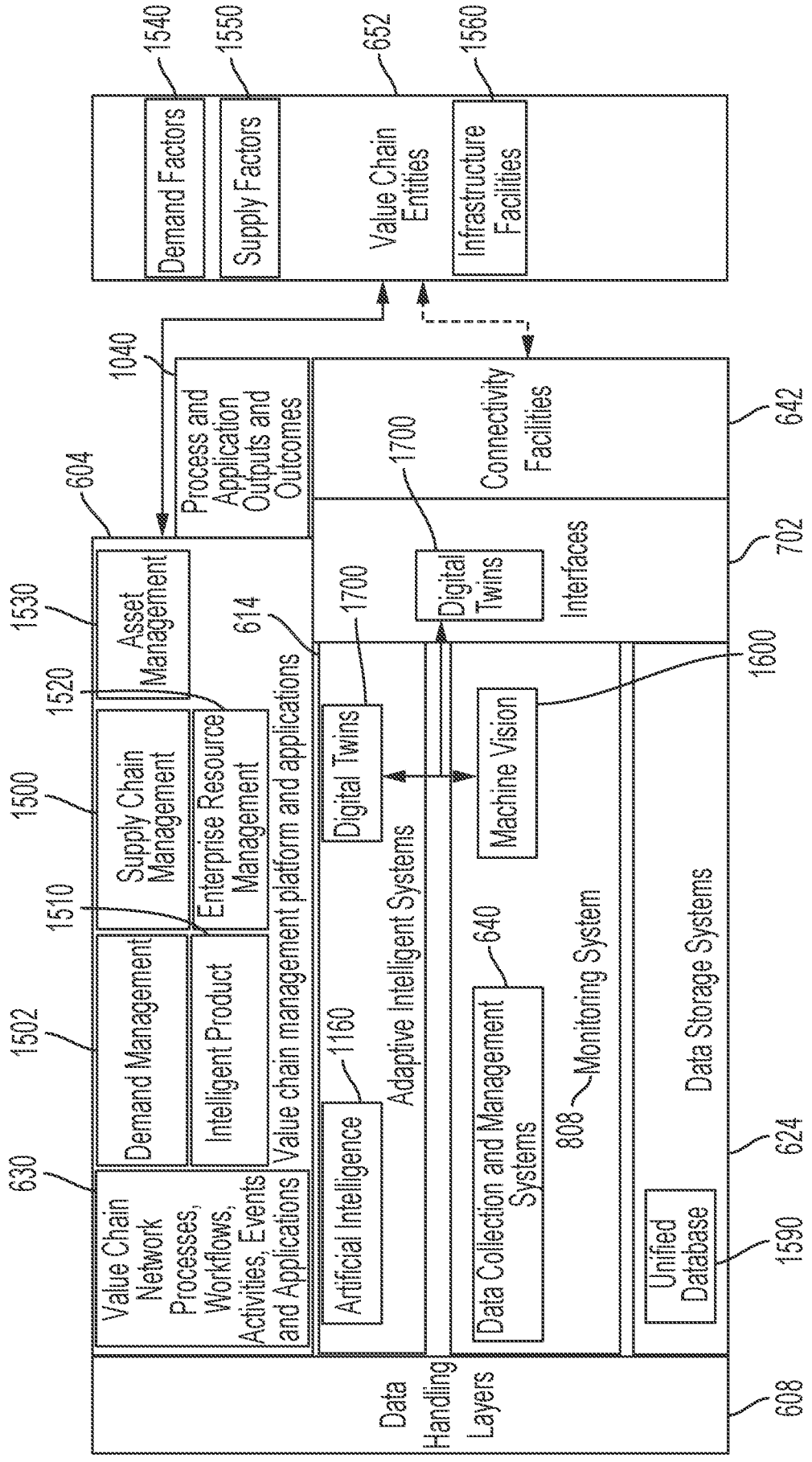

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1560
Demand Factors
Supply Factors
Value Chain Entities
Infrastructure Facilities
1040
604
Process and Application Outputs and Outcomes
1700
Connectivity Facilities
642
1530
Asset Management
1520
Supply Chain Management
1500
Enterprise Resource Management
614
1700
Digital Twins
Interfaces
702
1510
Demand Management
1502
Intelligent Product
Value chain management platform and applications
1600
Digital Twins
Machine Vision
1160
Artificial Intelligence
Adaptive Intelligent Systems
640
Data Collection and Management Systems
808
Monitoring System
630
Value Chain Network Processes, Workflows, Activities, Events and Applications
Unified Database
1590
624
Data Storage Systems
Data Handling Layers
608

FIG. 34

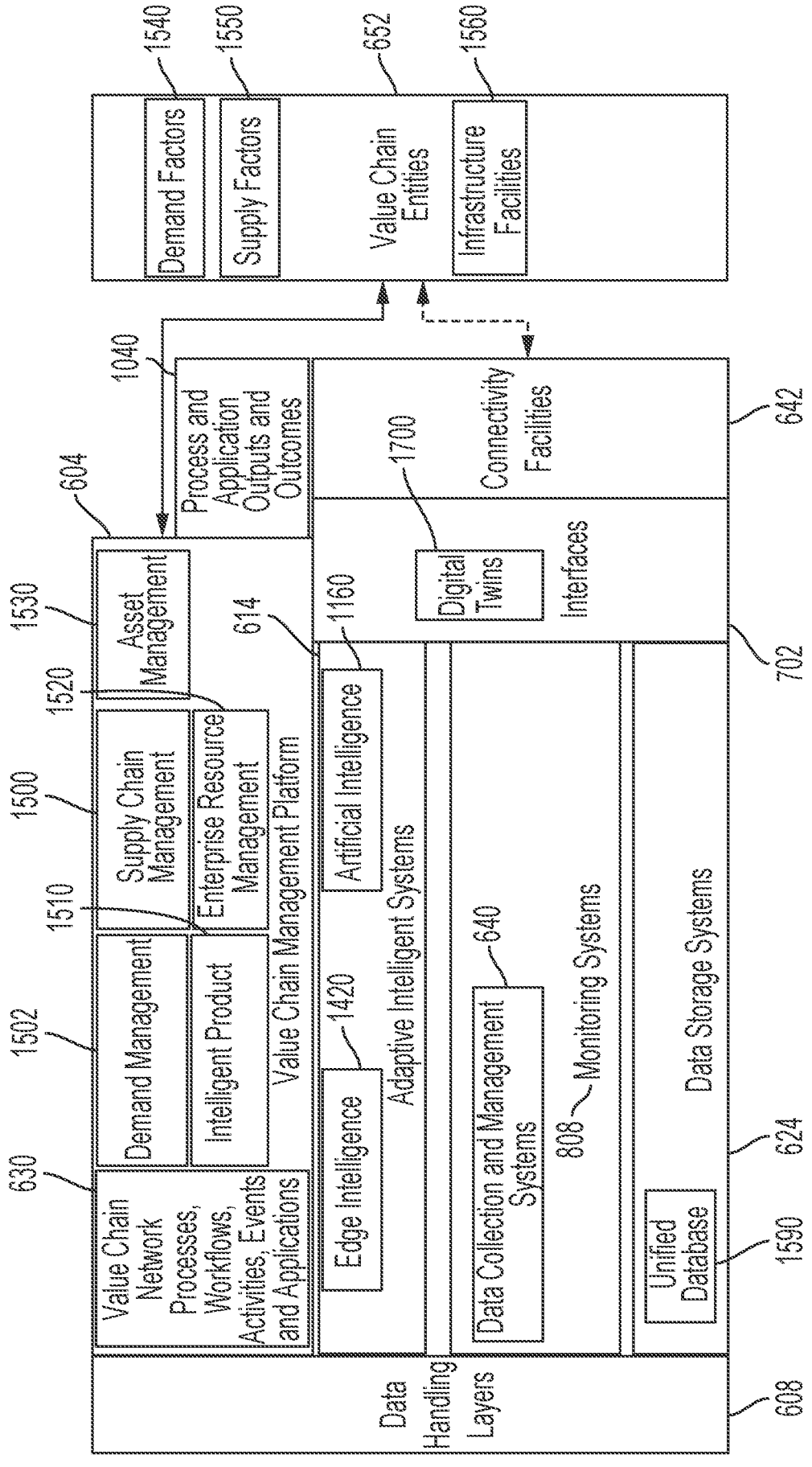

Data Handling Layers
608
Unified Database
1590
Data Storage Systems
624
Data Collection and Management Systems
640
Monitoring Systems
808
Edge Intelligence
1420
Artificial Intelligence
1160
Adaptive Intelligent Systems
Value Chain Network Processes, Workflows, Activities, Events and Applications
630
Demand Management
1502
Intelligent Product
1510
Supply Chain Management
1500
Enterprise Resource Management
1520
Asset Management
1530
Value Chain Management Platform
614
604
Process and Application Outputs and Outcomes
1040
Digital Twins
1700
Interfaces
Connectivity Facilities
642
702
Demand Factors
1540
Supply Factors
1550
Value Chain Entities
652
Infrastructure Facilities
1560

FIG. 35

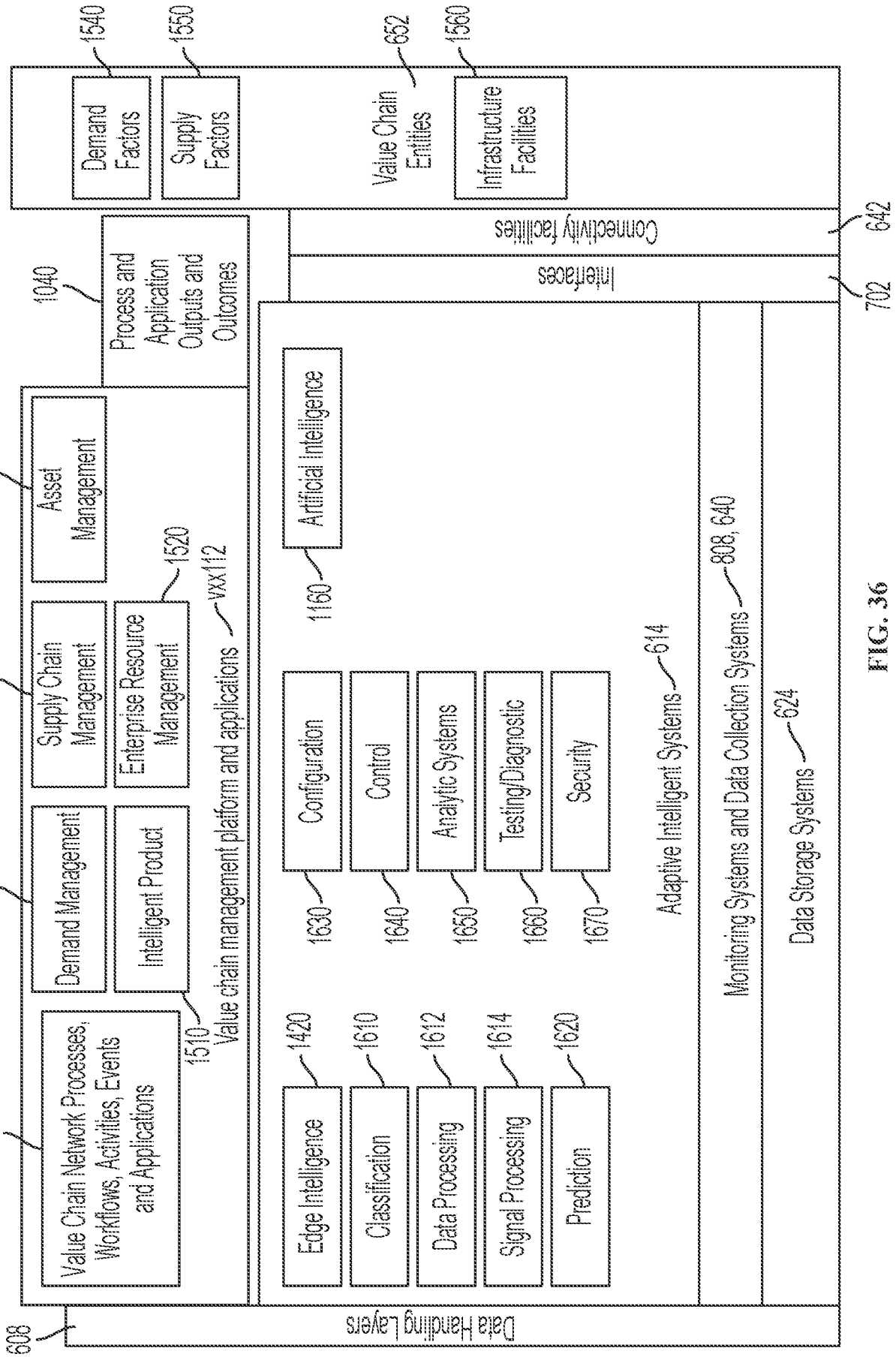

608
Data Handling Layers
630
Value Chain Network Processes, Workflows, Activities, Events and Applications
1502
Demand Management
1500
Supply Chain Management
1530
Asset Management
1510
Intelligent Product
1520
Enterprise Resource Management
vxx112
Value chain management platform and applications
1040
Process and Application Outputs and Outcomes
1420
Edge Intelligence
1610
Classification
1612
Data Processing
1614
Signal Processing
1620
Prediction
1630
Configuration
1640
Control
1650
Analytic Systems
1660
Testing/Diagnostic
1670
Security
1160
Artificial Intelligence
614
Adaptive Intelligent Systems
808, 640
Monitoring Systems and Data Collection Systems
624
Data Storage Systems
702
Interfaces
642
Connectivity facilities
1540
Demand Factors
1550
Supply Factors
652
Value Chain Entities
1560
Infrastructure Facilities

FIG. 36

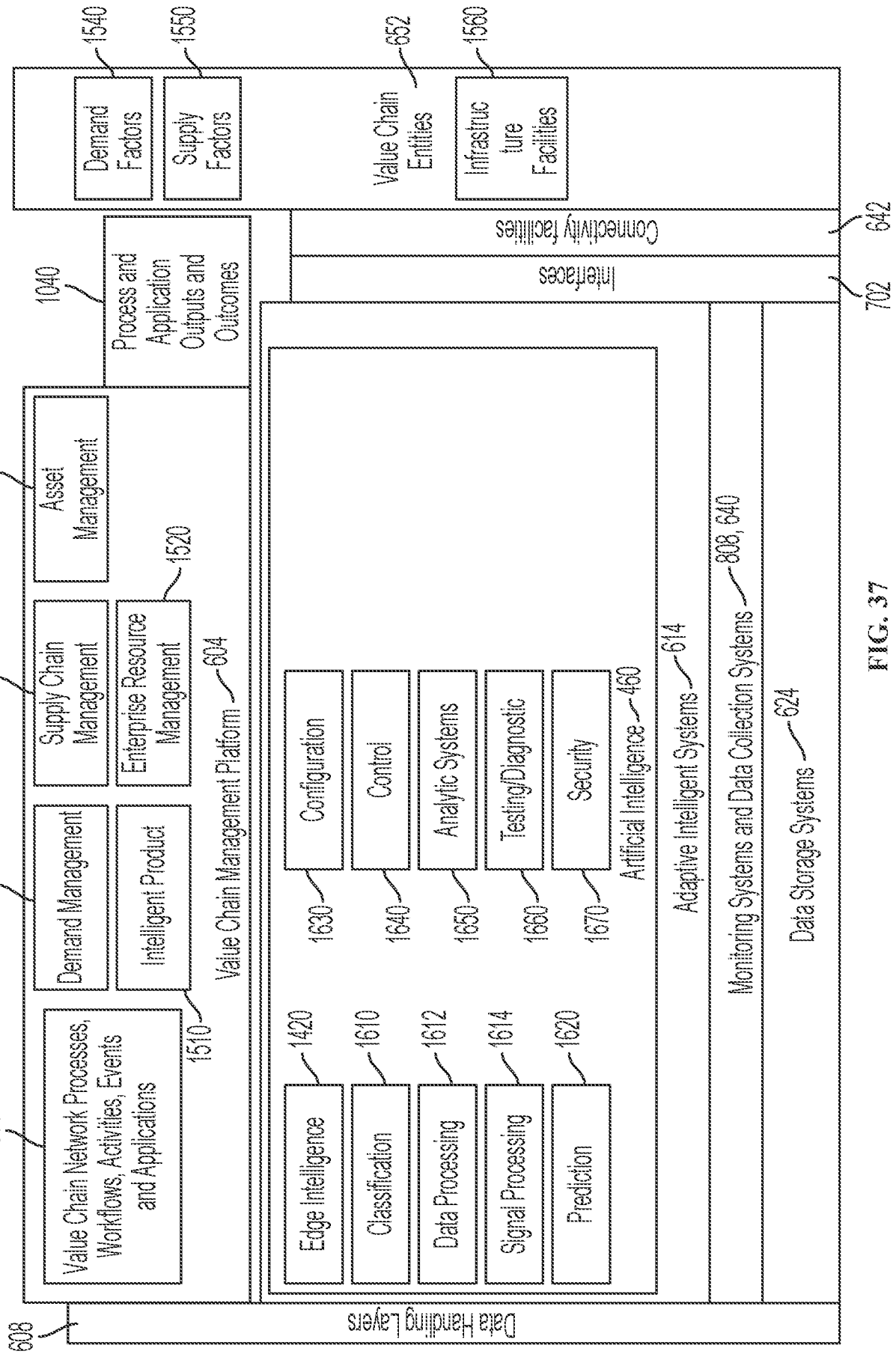

Data Handling Layers
608
Value Chain Network Processes, Workflows, Activities, Events and Applications
614
Demand Management
1502
Intelligent Product
1510
Supply Chain Management
1500
Enterprise Resource Management
1520
Asset Management
1530
Value Chain Management Platform
604
Process and Application Outputs and Outcomes
1040
Edge Intelligence
1420
Classification
1610
Data Processing
1612
Signal Processing
1614
Prediction
1620
Configuration
1630
Control
1640
Analytic Systems
1650
Testing/Diagnostic
1660
Security
1670
Artificial Intelligence
460
Adaptive Intelligent Systems
614
Monitoring Systems and Data Collection Systems
808, 640
Data Storage Systems
624
Interfaces
702
Connectivity facilities
642
Demand Factors
1540
Supply Factors
1550
Value Chain Entities
652
Infrastructure Facilities
1560

FIG. 37

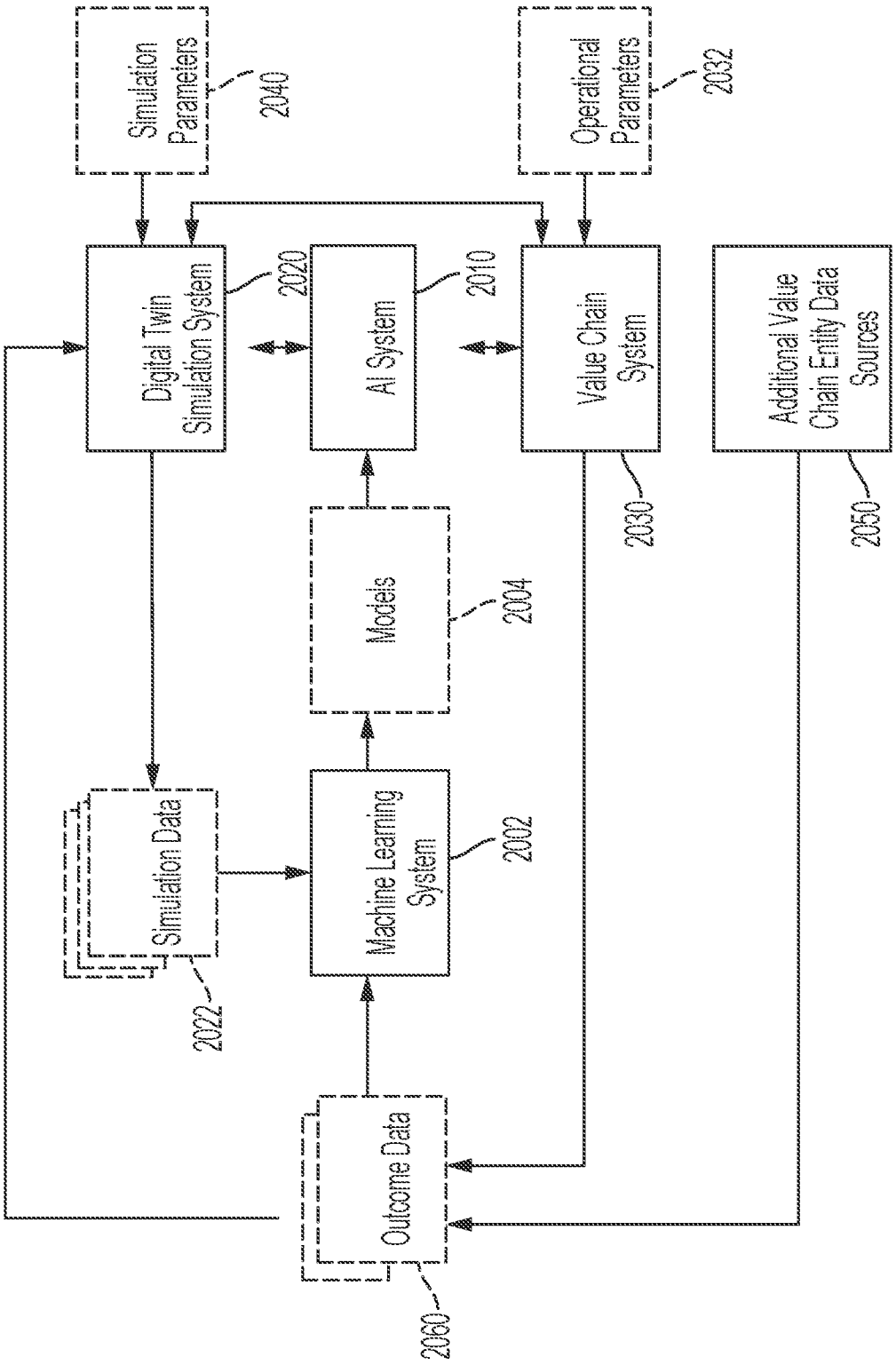

Simulation Parameters
2040
Operational Parameters
2032
Digital Twin Simulation System
2020
AI System
2010
Value Chain System
2030
Additional Value Chain Entity Data Sources
2050
Models
2004
Simulation Data
2022
Machine Learning System
2002
Outcome Data
2060

FIG. 38

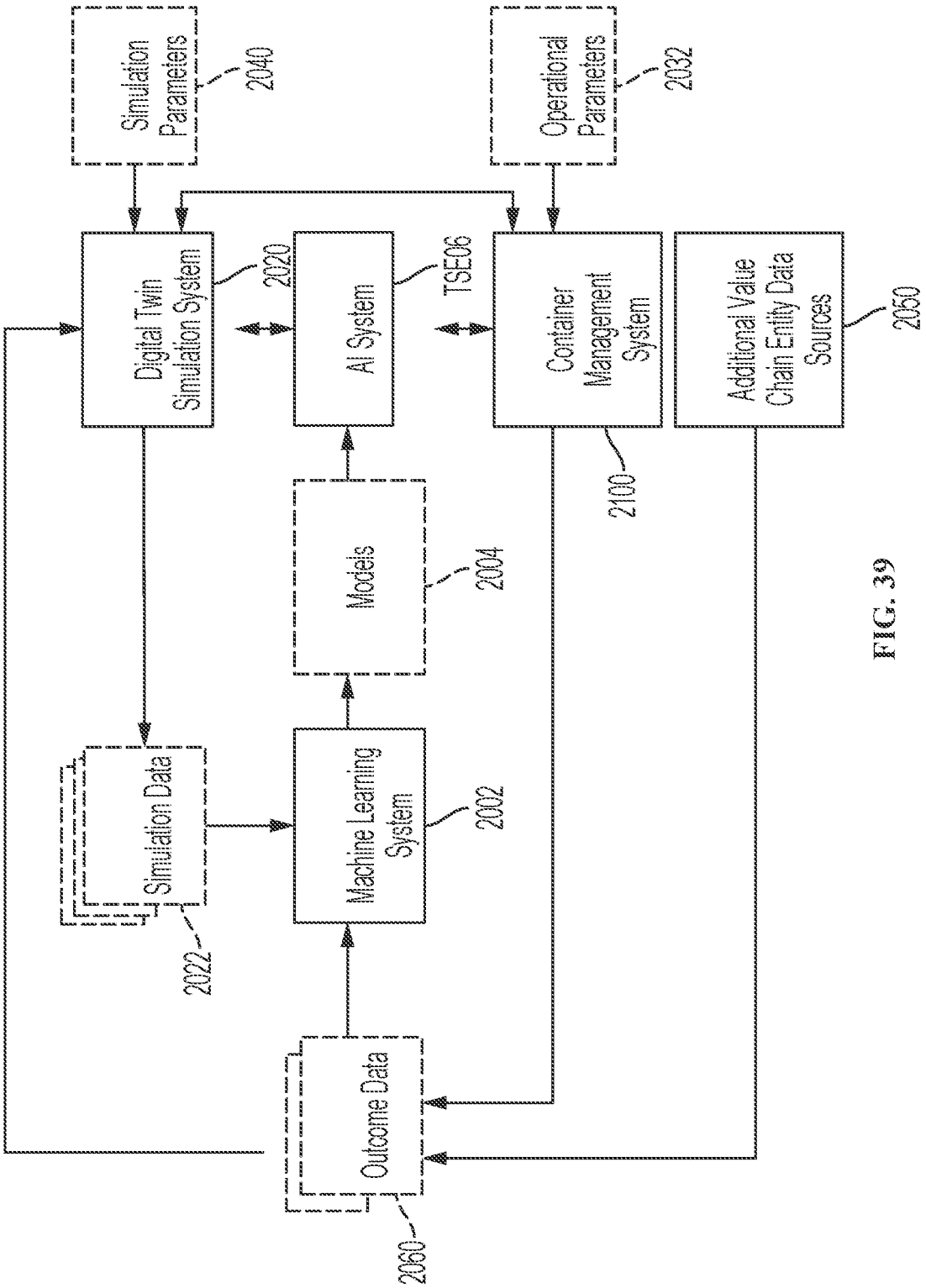

Simulation Parameters
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Operational Parameters
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Digital Twin Simulation System
2020
AI System
TSE06
Container Management System
Additional Value Chain Entity Data Sources
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Models
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Simulation Data
2022
Machine Learning System
2002
Outcome Data
2060

FIG. 39

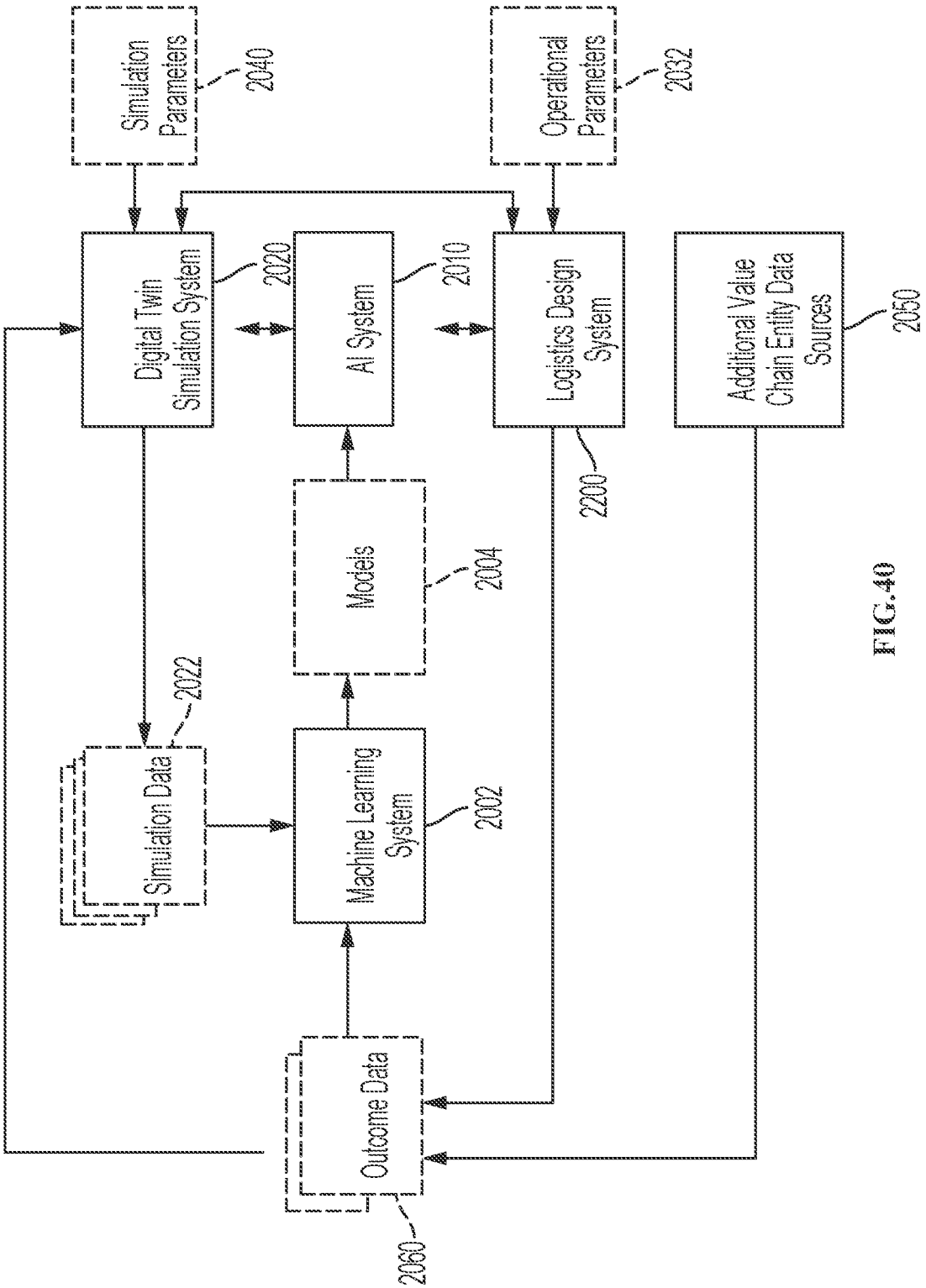

Simulation Parameters
2040
Operational Parameters
2032
Digital Twin Simulation System
2020
AI System
2010
Logistics Design System
2200
Additional Value Chain Entity Data Sources
2050
Models
2004
Simulation Data
2022
Machine Learning System
2002
Outcome Data
2060

FIG. 40

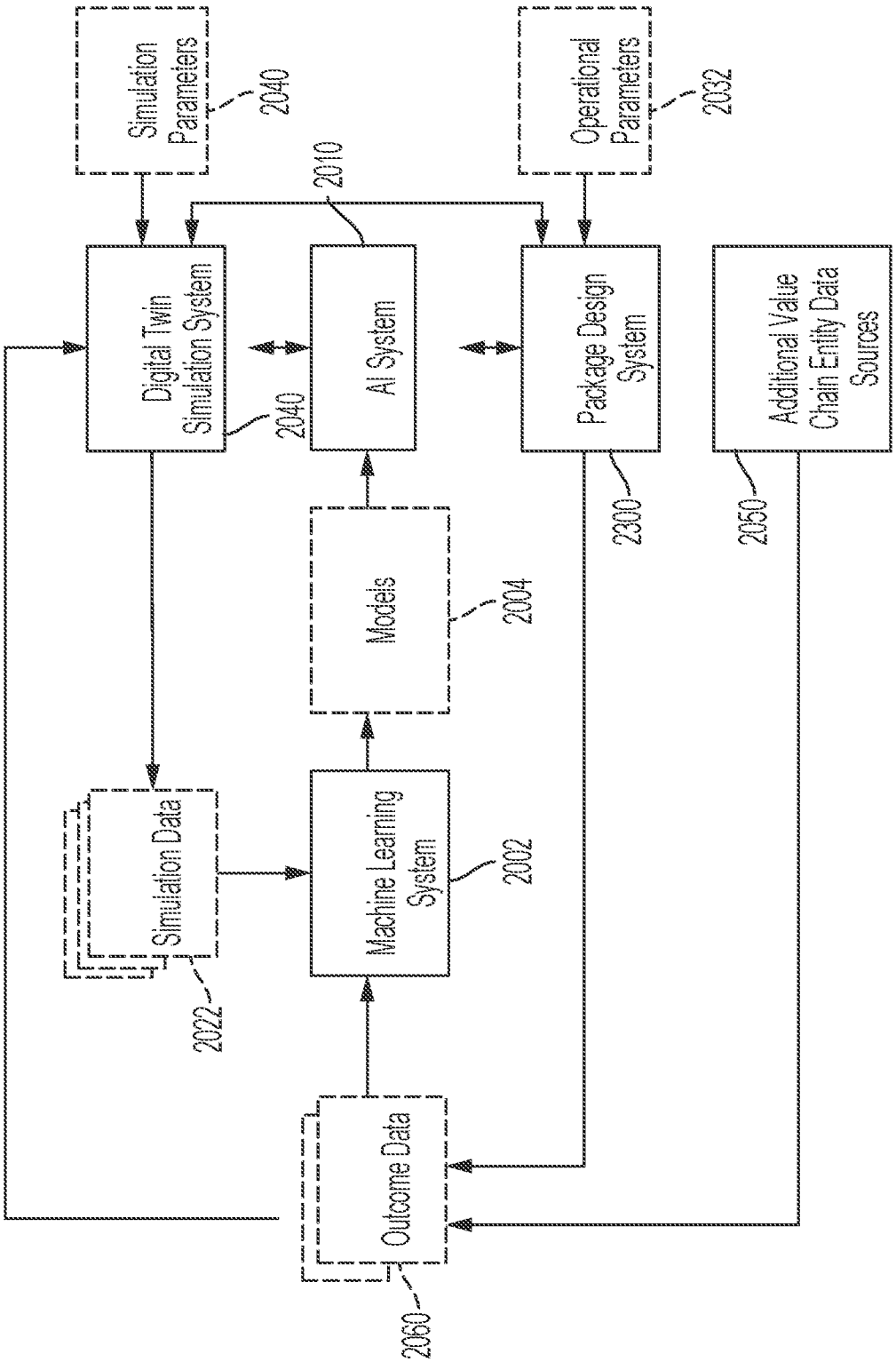

Simulation Parameters
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Operational Parameters
2032
2010
Digital Twin Simulation System
2040
AI System
Package Design System
Additional Value Chain Entity Data Sources
2300
2050
Models
2004
Simulation Data
2022
Machine Learning System
2002
Outcome Data
2060

FIG. 41

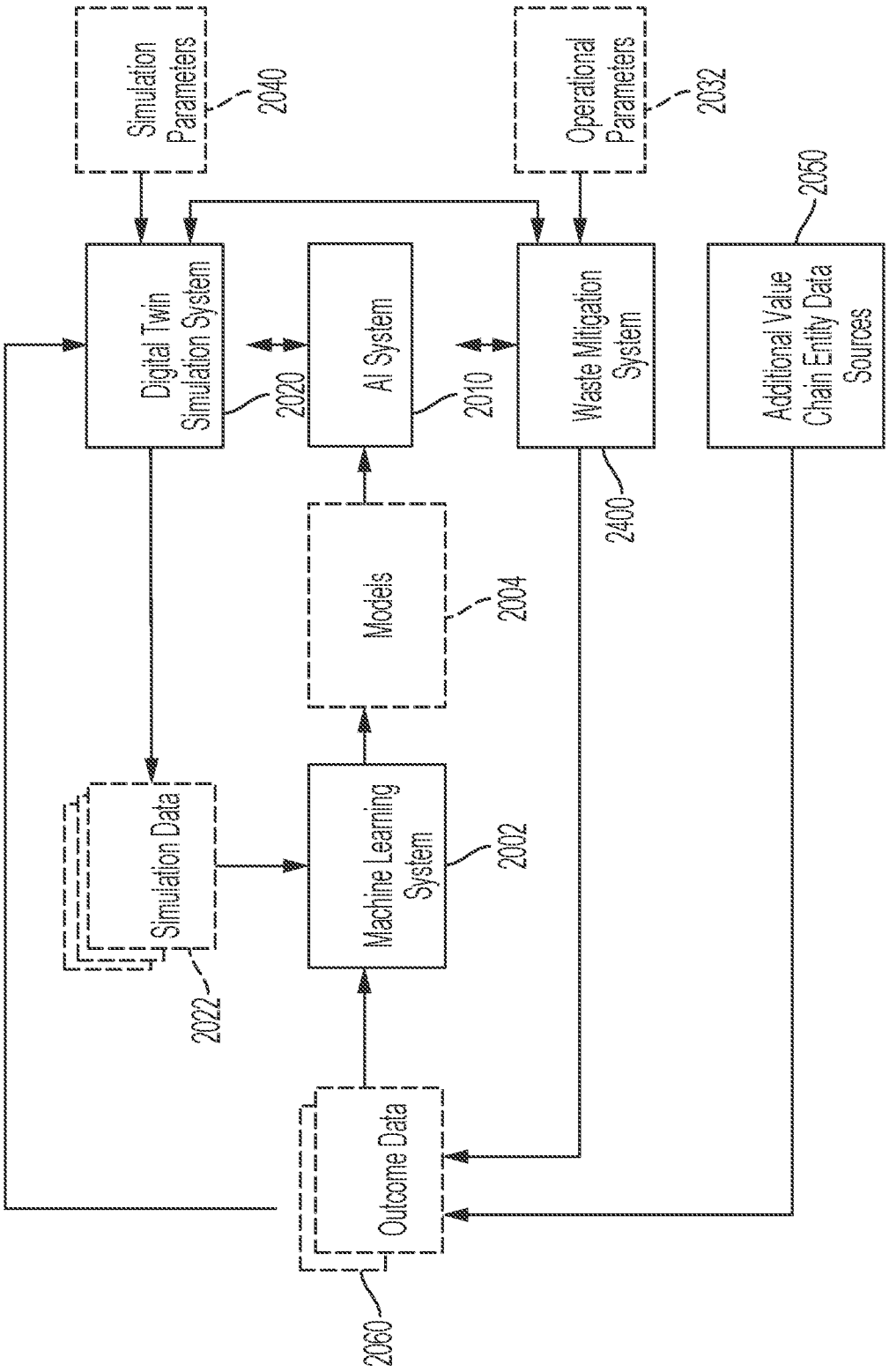

Simulation Parameters
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Operational Parameters
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Digital Twin Simulation System
2020
AI System
2010
Waste Mitigation System
2400
Additional Value Chain Entity Data Sources
Models
2004
Simulation Data
2022
Machine Learning System
2002
Outcome Data
2060

FIG. 42

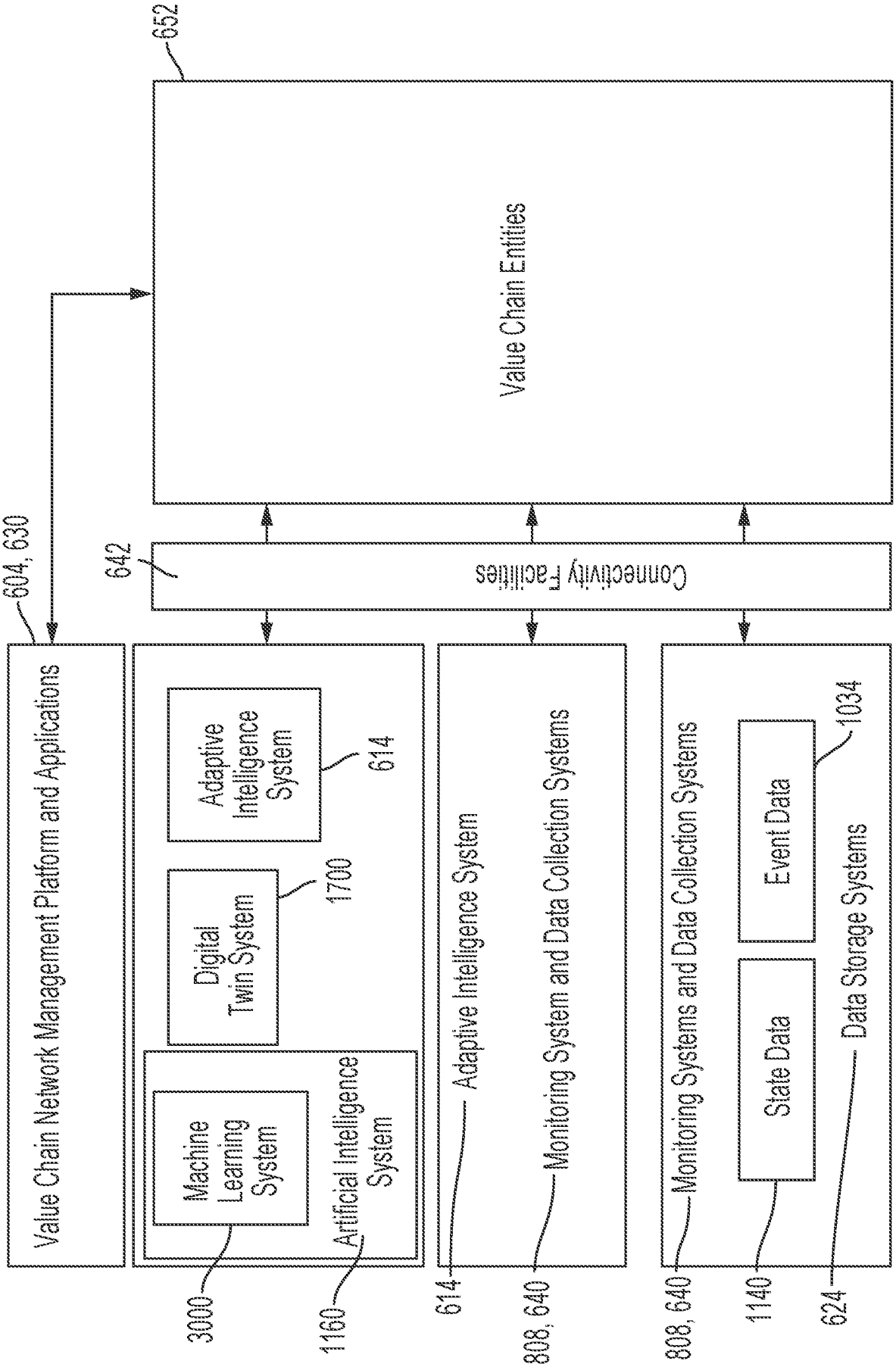

652
Value Chain Entities
642
Connectivity Facilities
604, 630
Value Chain Network Management Platform and Applications
Adaptive Intelligence System
614
Digital Twin System
1700
Machine Learning System
Artificial Intelligence System
3000
1160
Adaptive Intelligence System
Monitoring System and Data Collection Systems
614
808, 640
Monitoring Systems and Data Collection Systems
Event Data
1034
State Data
Data Storage Systems
808, 640
1140
624

FIG. 43

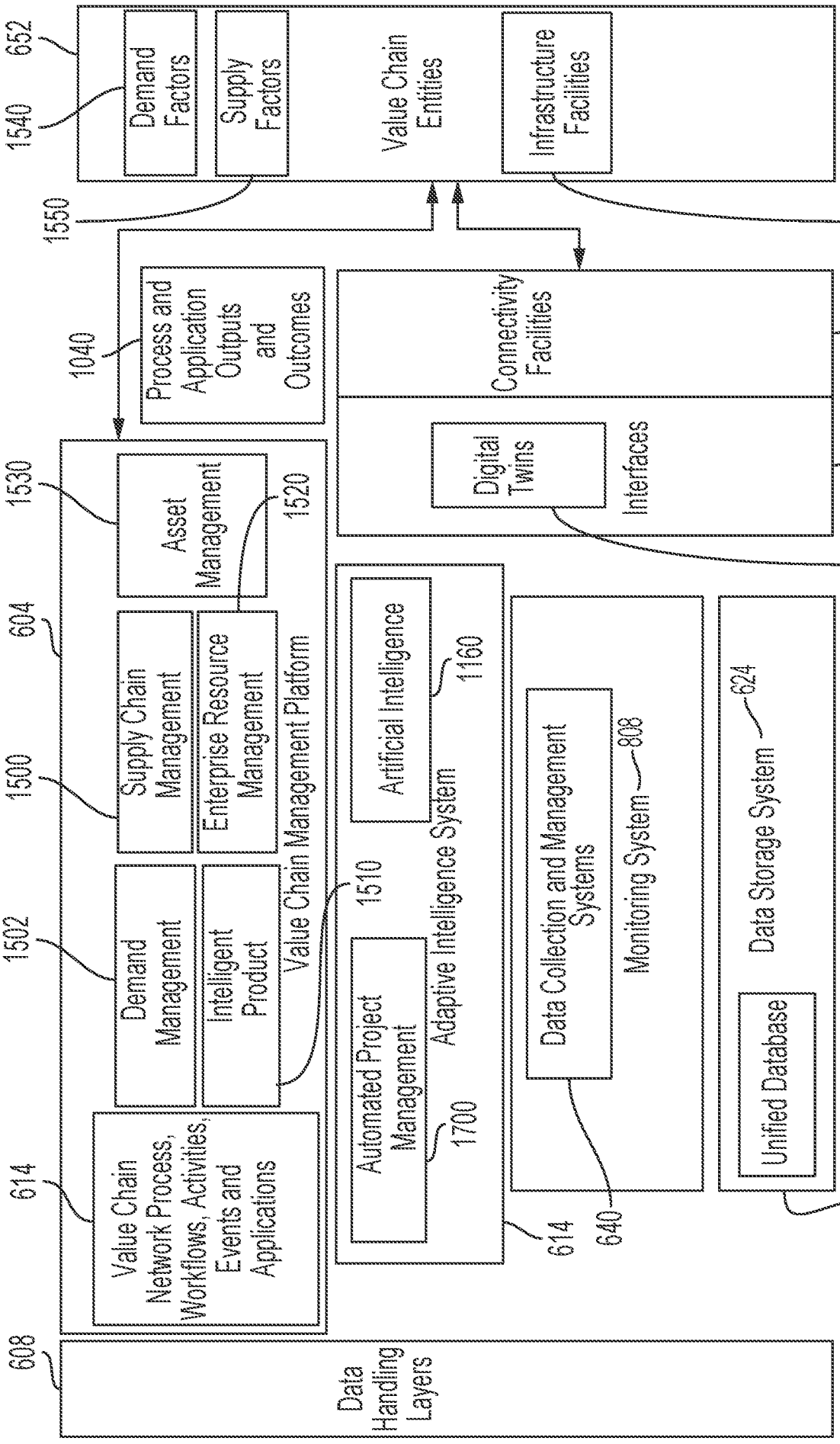

652
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Demand Factors
Supply Factors
Value Chain Entities
Infrastructure Facilities
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1560
1040
Process and Application Outputs and Outcomes
Connectivity Facilities
642
Digital Twins
Interfaces
702
1700
1530
Asset Management
1520
604
1500
Supply Chain Management
Enterprise Resource Management
Value Chain Management Platform
1502
Demand Management
Intelligent Product
1510
Artificial Intelligence
1160
Automated Project Management
1700
Adaptive Intelligence System
Data Collection and Management Systems
Monitoring System
808
624
Data Storage System
Unified Database
614
Value Chain Network Process, Workflows, Activities, Events and Applications
614
640
1590
608
Data Handling Layers

FIG. 44

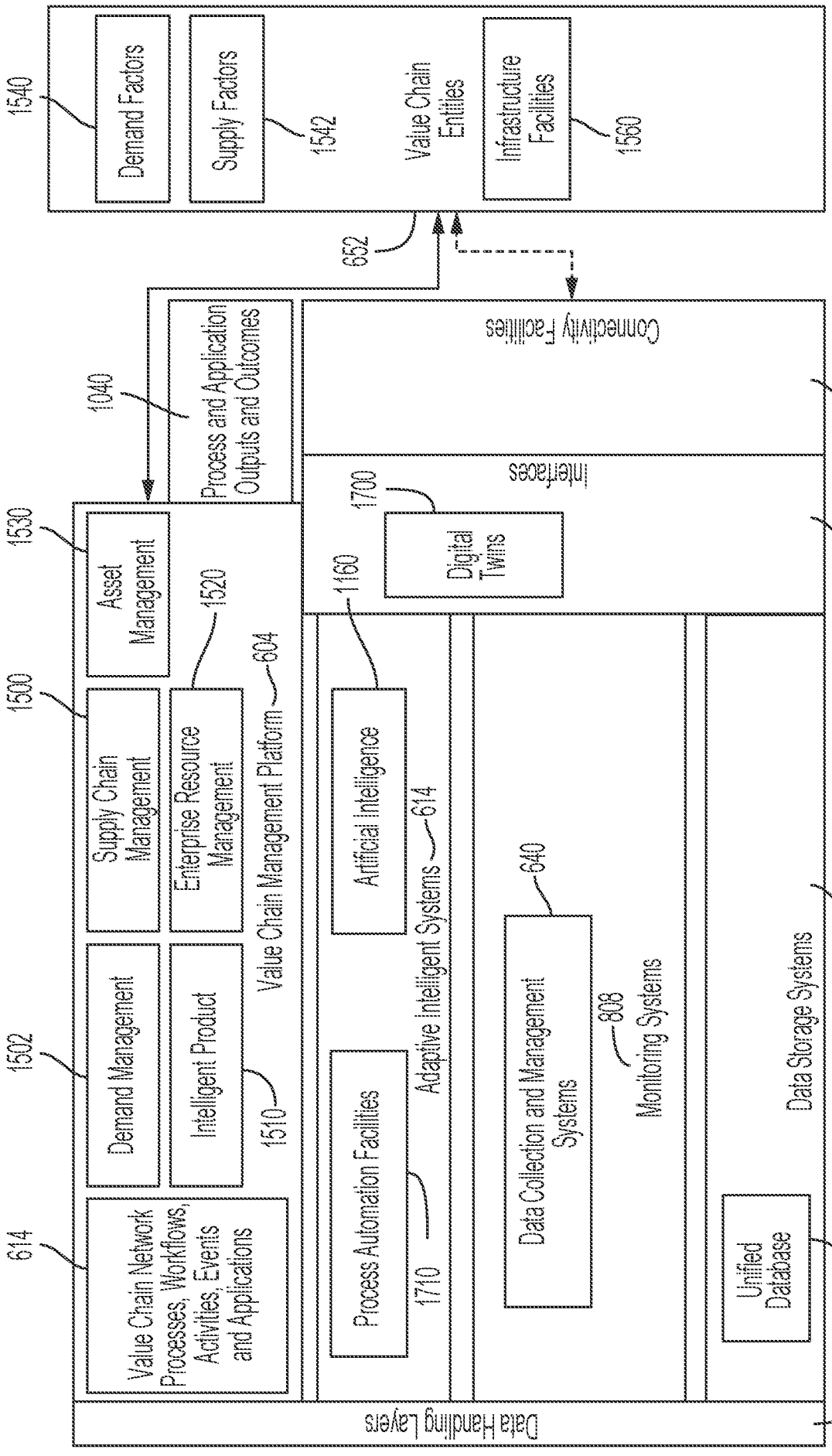

1540
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Supply Factors
1542
Value Chain Entities
Infrastructure Facilities
1560
652
1040
Process and Application Outputs and Outcomes
Connectivity Facilities
642
Interfaces
1700
Digital Twins
702
1530
Asset Management
1500
Supply Chain Management
1520
Enterprise Resource Management
604
Value Chain Management Platform
1160
Artificial Intelligence
614
Adaptive Intelligent Systems
1502
Demand Management
Intelligent Product
1510
640
Data Collection and Management Systems
808
Monitoring Systems
624
Data Storage Systems
614
Value Chain Network Processes, Workflows, Activities, Events and Applications
Process Automation Facilities
1710
Unified Database
1590
Data Handling Layers
608

FIG. 45

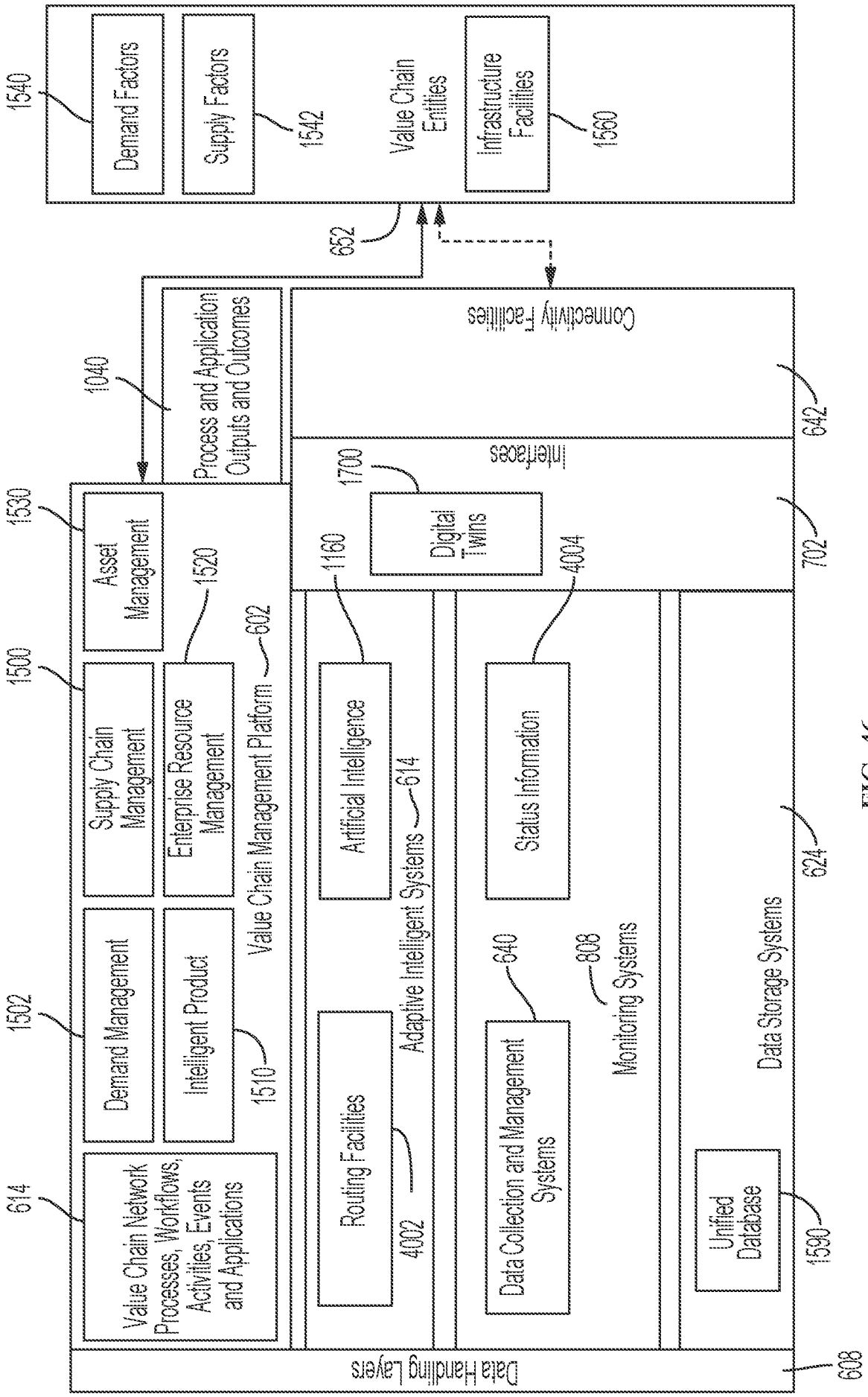

1540
Demand Factors
Supply Factors
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Value Chain Entities
Infrastructure Facilities
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652
1040
Process and Application Outputs and Outcomes
Connectivity Facilities
642
Interfaces
1700
Digital Twins
702
1530
Asset Management
1500
Supply Chain Management
1520
Enterprise Resource Management
602
Value Chain Management Platform
1160
Artificial Intelligence
4004
Status Information
1502
Demand Management
Intelligent Product
1510
614
Value Chain Network Processes, Workflows, Activities, Events and Applications
Routing Facilities
4002
Adaptive Intelligent Systems
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640
Data Collection and Management Systems
808
Monitoring Systems
624
Data Storage Systems
Unified Database
1590
Data Handling Layers
608

FIG. 46

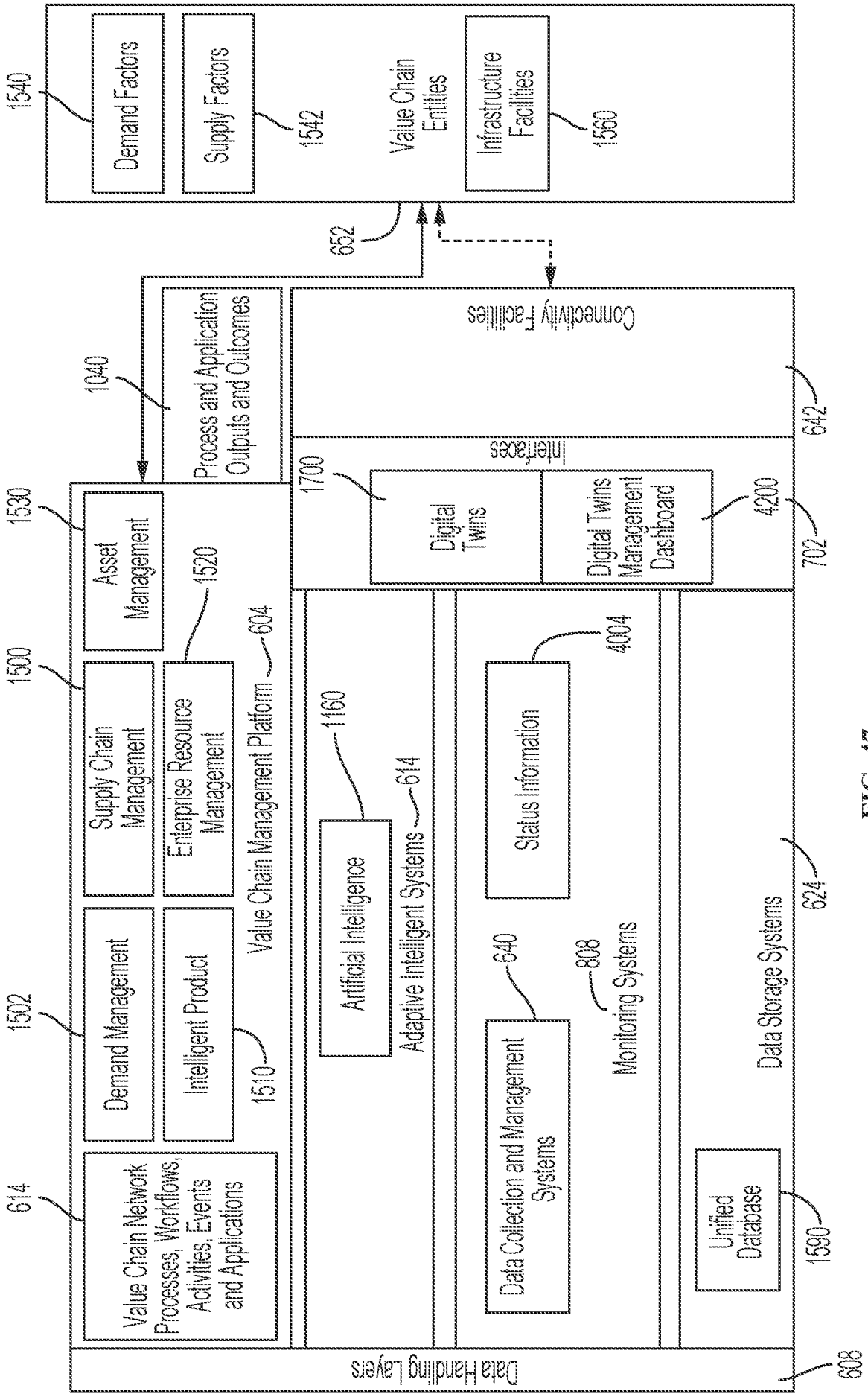

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Demand Factors
Supply Factors
1542
Value Chain Entities
Infrastructure Facilities
1560
652
1040
Process and Application Outputs and Outcomes
Connectivity Facilities
642
Interfaces
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Digital Twins
Digital Twins Management Dashboard
4200
702
1530
Asset Management
1500
Supply Chain Management
1520
Enterprise Resource Management
604
Value Chain Management Platform
1502
Demand Management
Intelligent Product
1510
614
Value Chain Network Processes, Workflows, Activities, Events and Applications
1160
Artificial Intelligence
614
Adaptive Intelligent Systems
4004
Status Information
640
Data Collection and Management Systems
808
Monitoring Systems
624
Data Storage Systems
1690
Unified Database
Data Handling Layers
608

FIG. 47

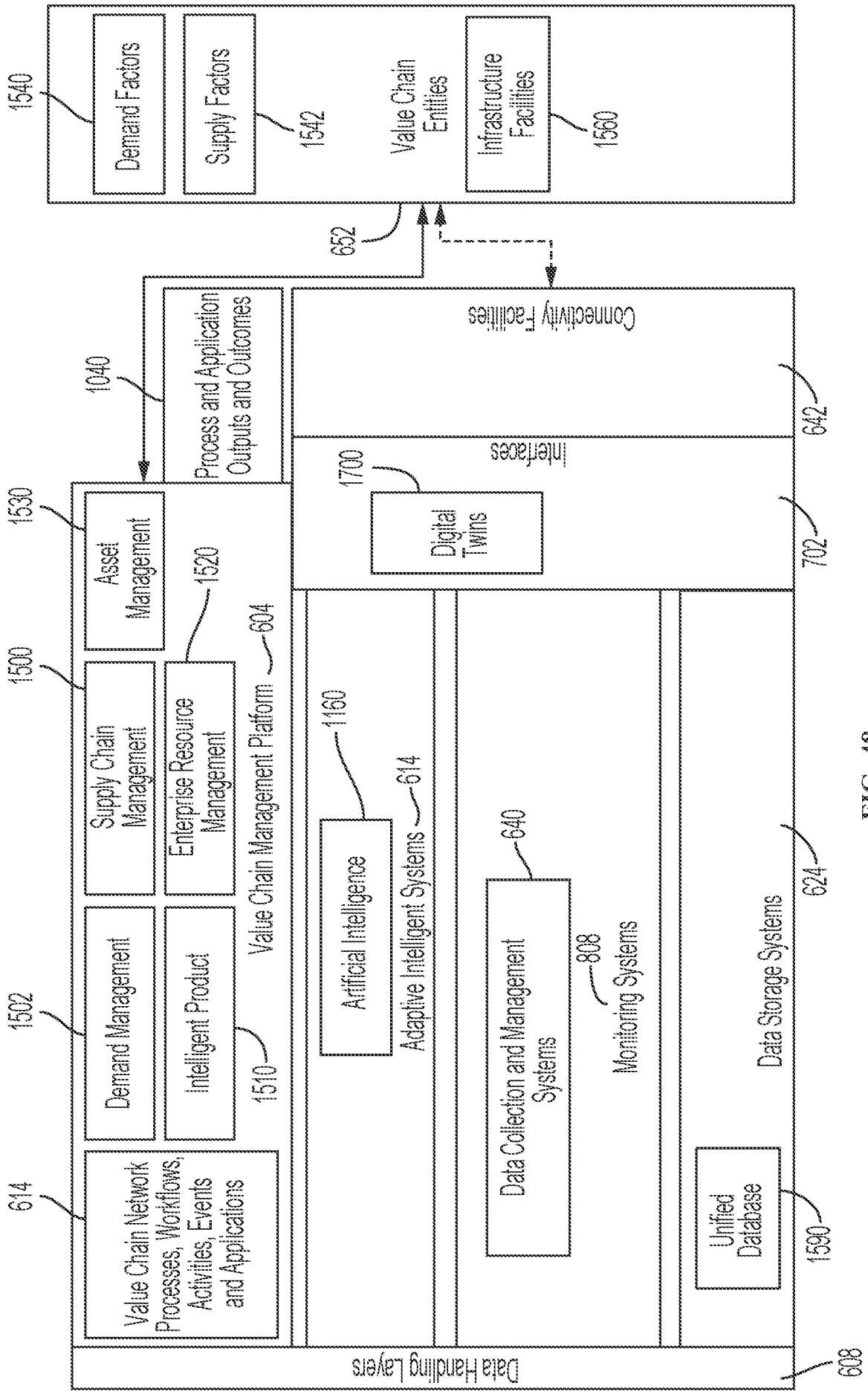

1540
Demand Factors
Supply Factors
1542
Value Chain Entities
Infrastructure Facilities
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652
1040
Process and Application Outputs and Outcomes
Connectivity Facilities
642
Interfaces
1700
Digital Twins
702
1530
Asset Management
1500
Supply Chain Management
1520
Enterprise Resource Management
604
Value Chain Management Platform
1160
Artificial Intelligence
614
Adaptive Intelligent Systems
640
Data Collection and Management Systems
808
Monitoring Systems
624
Data Storage Systems
1502
Demand Management
1510
Intelligent Product
614
Value Chain Network Processes, Workflows, Activities, Events and Applications
1590
Unified Database
Data Handling Layers
608

FIG. 48

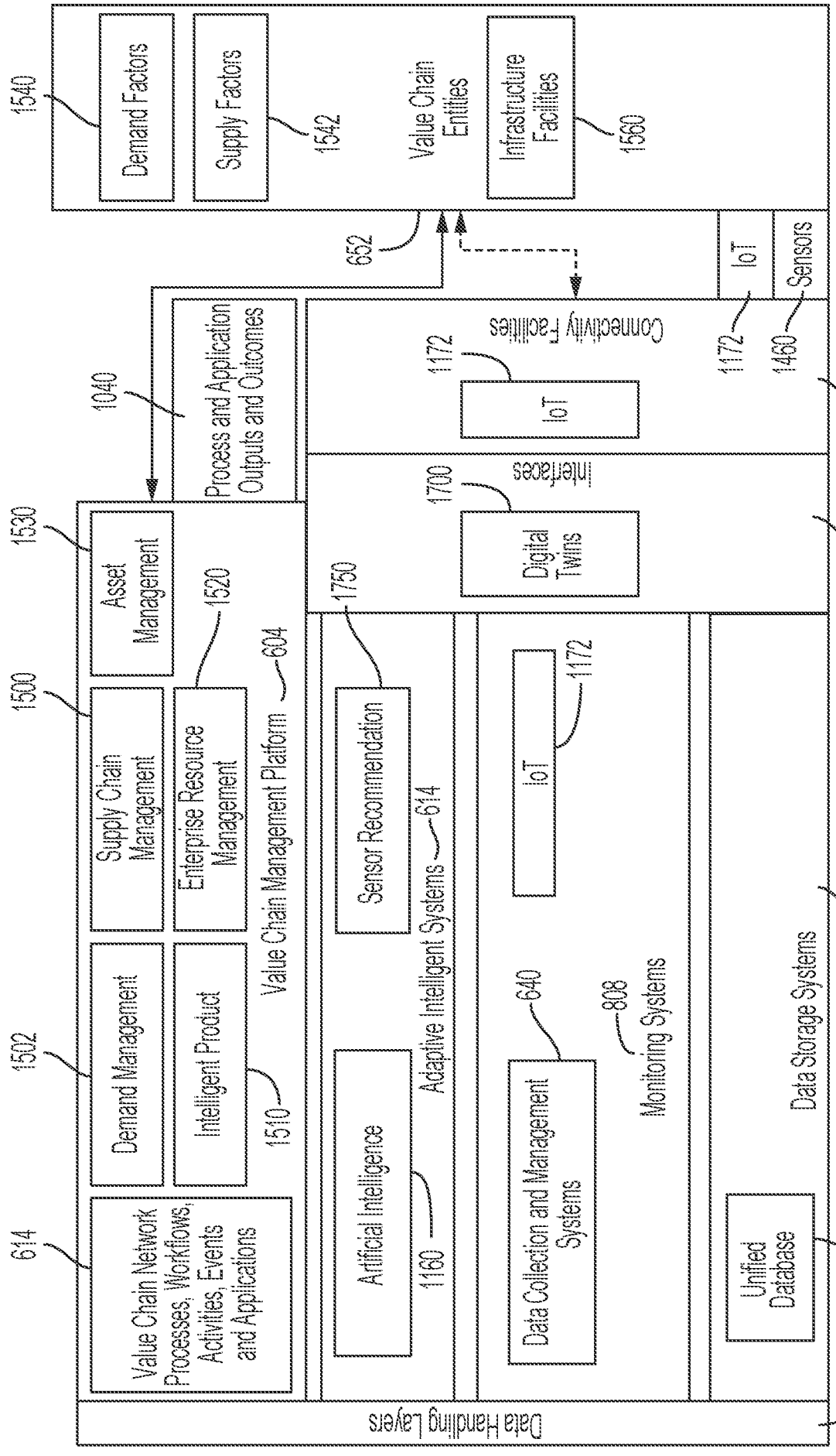

1540
Demand Factors
Supply Factors
1542
Value Chain Entities
Infrastructure Facilities
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652
IoT
Sensors
1172
1460
Connectivity Facilities
1172
IoT
642
1700
Interfaces
Digital Twins
702
1750
Sensor Recommendation
1172
IoT
Adaptive Intelligent Systems
614
640
Data Collection and Management Systems
808
Monitoring Systems
624
Data Storage Systems
1590
Unified Database
608
Data Handling Layers
1040
Process and Application Outputs and Outcomes
1530
Asset Management
1520
Enterprise Resource Management
1500
Supply Chain Management
604
Value Chain Management Platform
1502
Demand Management
1510
Intelligent Product
614
Value Chain Network Processes, Workflows, Activities, Events and Applications
1160
Artificial Intelligence

FIG. 49

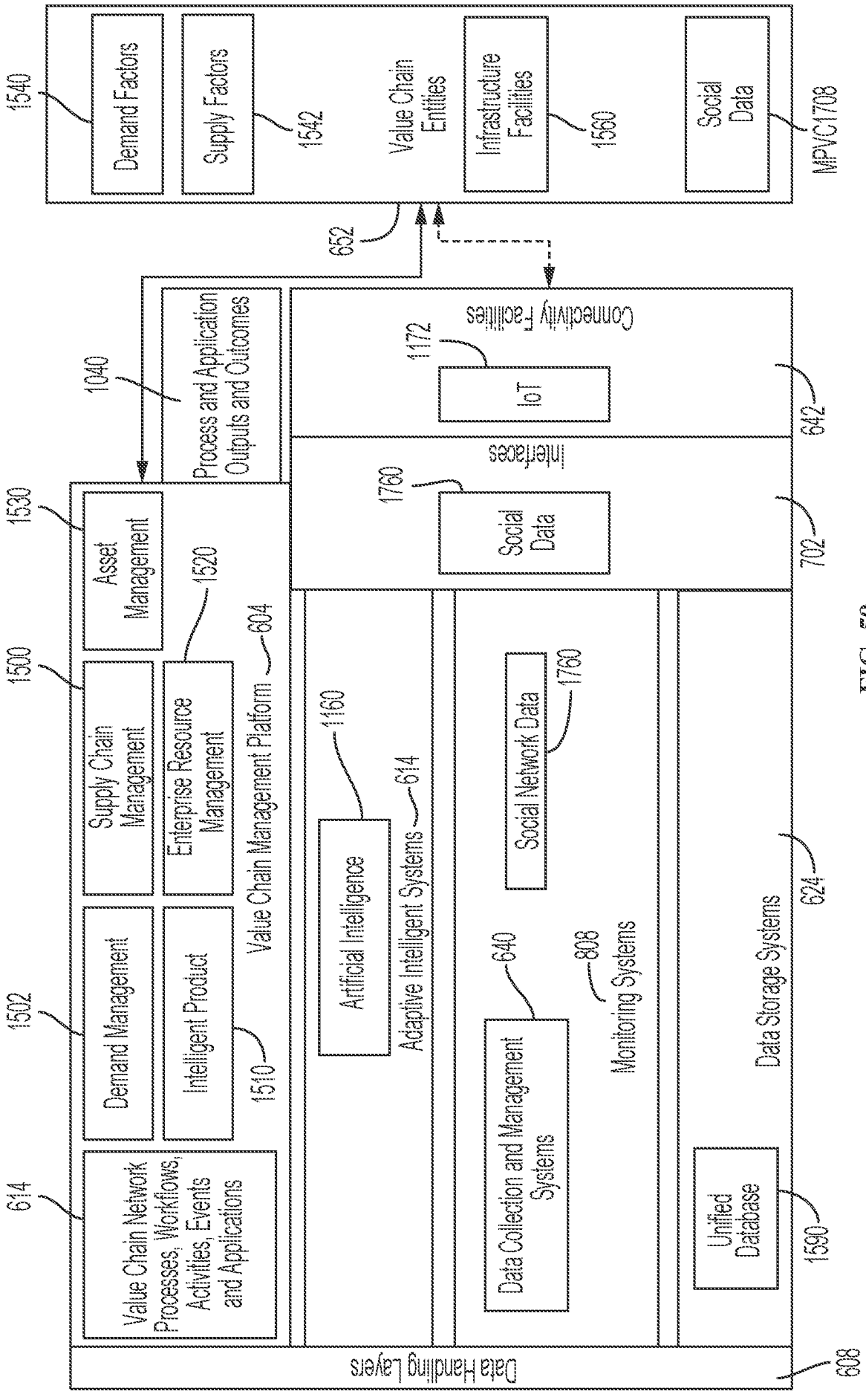

1540
Demand Factors
Supply Factors
1542
Value Chain Entities
Infrastructure Facilities
1560
Social Data
MPVC1708
652
1040
Process and Application Outputs and Outcomes
Connectivity Facilities
1172
IoT
642
Interfaces
1760
Social Data
702
1530
Asset Management
1520
Enterprise Resource Management
1500
Supply Chain Management
Value Chain Management Platform
604
1502
Demand Management
Intelligent Product
1510
614
Value Chain Network Processes, Workflows, Activities, Events and Applications
1160
Artificial Intelligence
Adaptive Intelligent Systems
614
Social Network Data
1760
640
Data Collection and Management Systems
808
Monitoring Systems
624
Data Storage Systems
1590
Unified Database
Data Handling Layers
608

FIG. 50

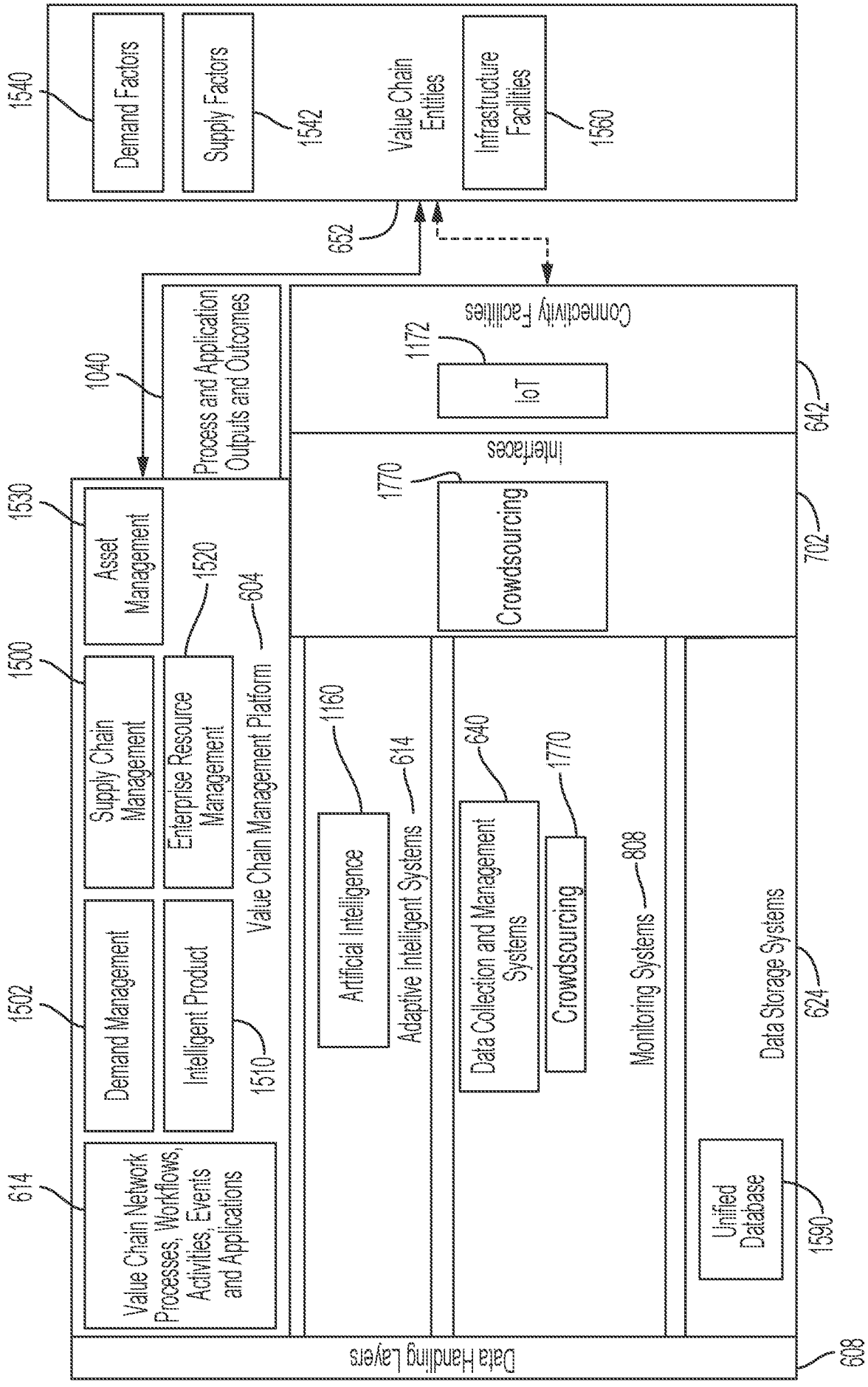

1540
Demand Factors
Supply Factors
1542
Value Chain Entities
Infrastructure Facilities
1560
652
1040
Process and Application Outputs and Outcomes
Connectivity Facilities
1172
IoT
642
Interfaces
1770
Crowdsourcing
702
1530
Asset Management
1520
604
1500
Supply Chain Management
Enterprise Resource Management
Value Chain Management Platform
1160
Artificial Intelligence
614
Adaptive Intelligent Systems
640
Data Collection and Management Systems
1770
Crowdsourcing
808
Monitoring Systems
1502
Demand Management
Intelligent Product
1510
624
Data Storage Systems
614
Value Chain Network Processes, Workflows, Activities, Events and Applications
1590
Unified Database
Data Handling Layers
608

FIG 51

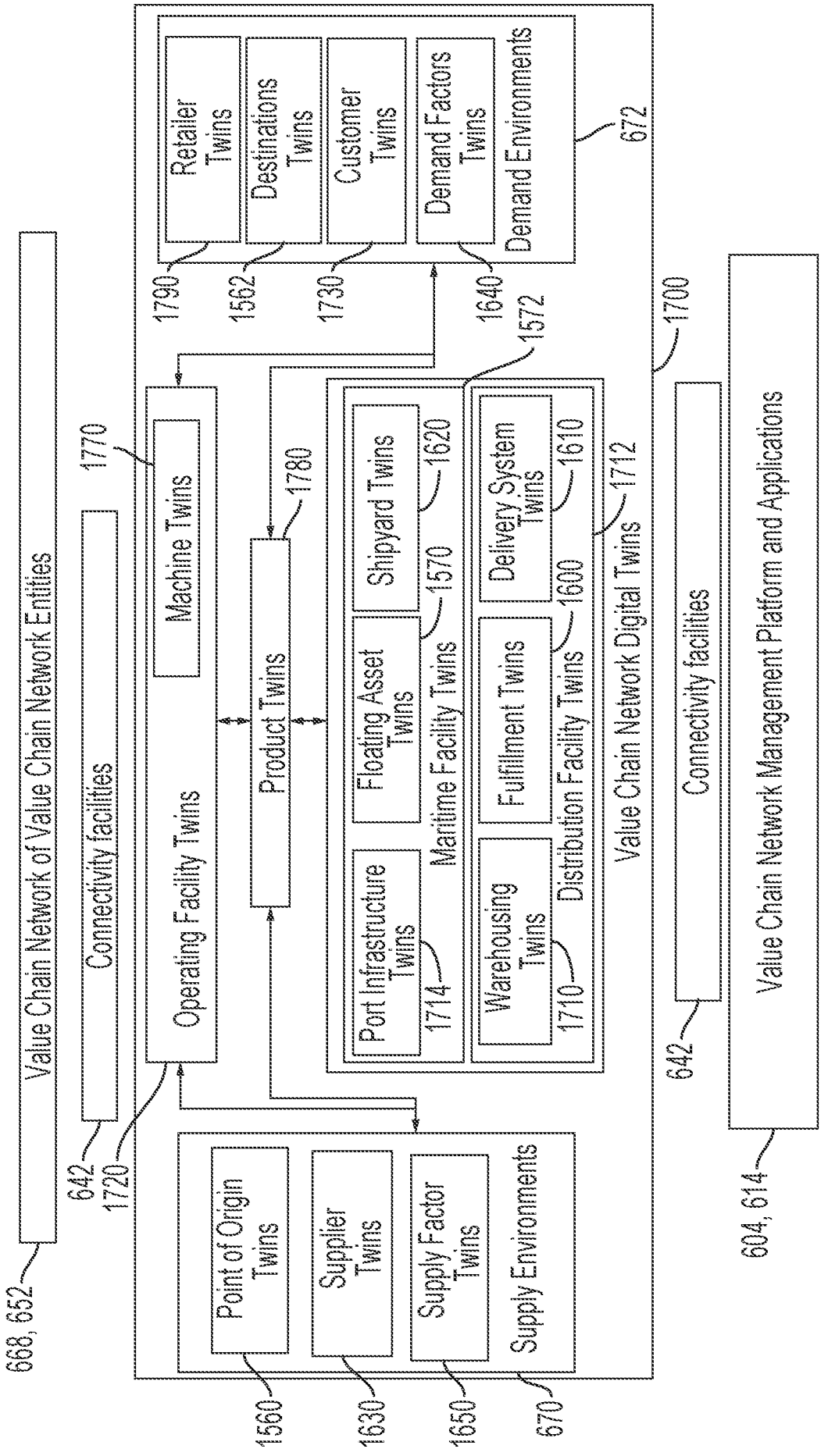

Value Chain Network of Value Chain Network Entities
668, 652
Connectivity facilities
642
1720
1770
Operating Facility Twins
Machine Twins
Product Twins
1780
Maritime Facility Twins
Floating Asset Twins
Shipyard Twins
1570
1620
Port Infrastructure Twins
1714
Distribution Facility Twins
Fulfillment Twins
Warehousing Twins
1600
1610
1710
Value Chain Network Digital Twins
1712
1572
1700
Supply Environments
Point of Origin Twins
Supplier Twins
Supply Factor Twins
1560
1630
1650
670
Demand Environments
Retailer Twins
Destinations Twins
Customer Twins
Demand Factors Twins
1790
1562
1730
1640
672
Connectivity facilities
642
Value Chain Network Management Platform and Applications
604, 614

FIG 52

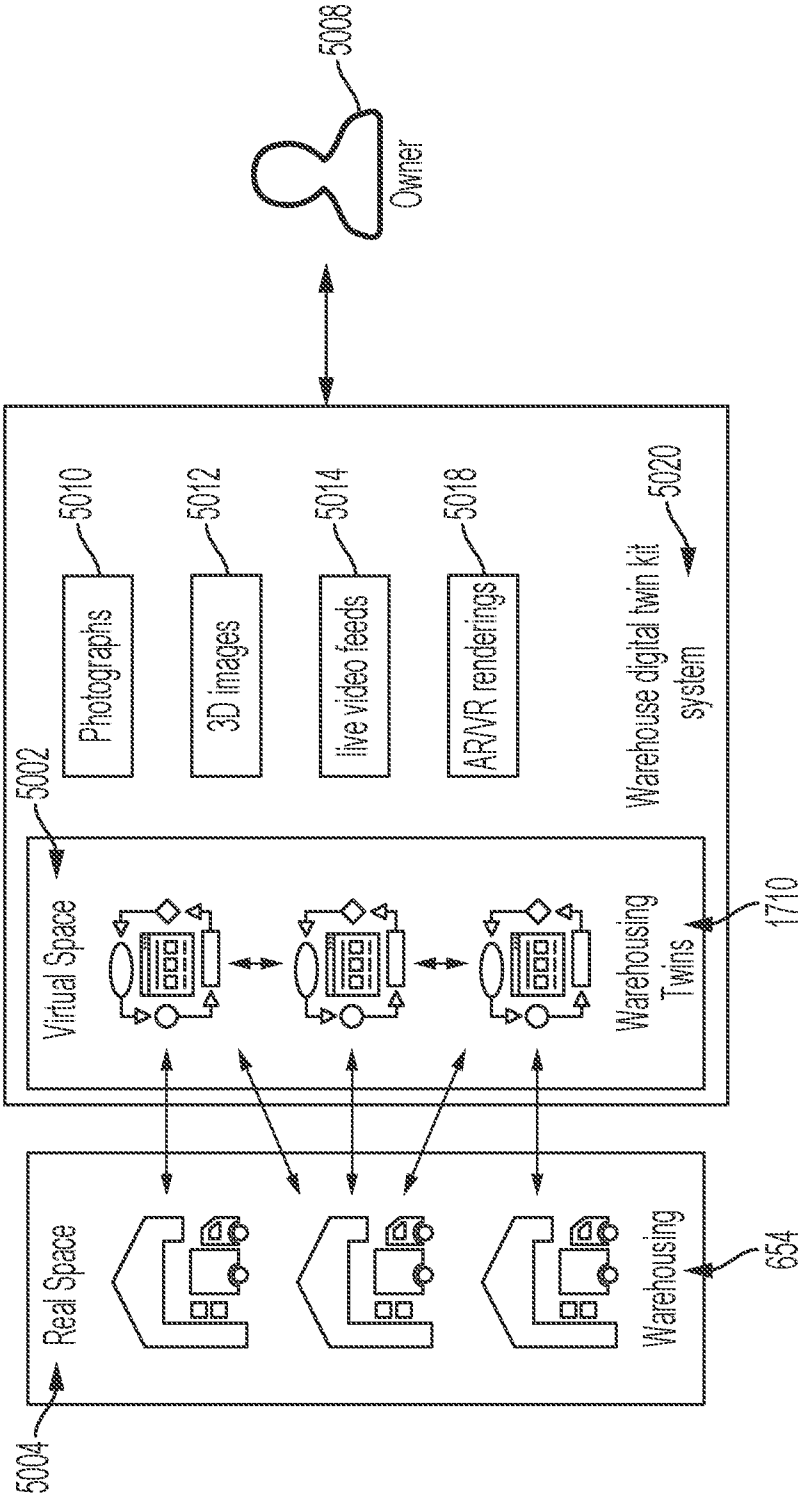

5008
Owner
5010
Photographs
5012
3D images
5014
live video feeds
5018
AR/VR renderings
5020
Warehouse digital twin kit system
5002
Virtual Space
Warehousing Twins
1710
Real Space
Warehousing
654
5004

FIG 53

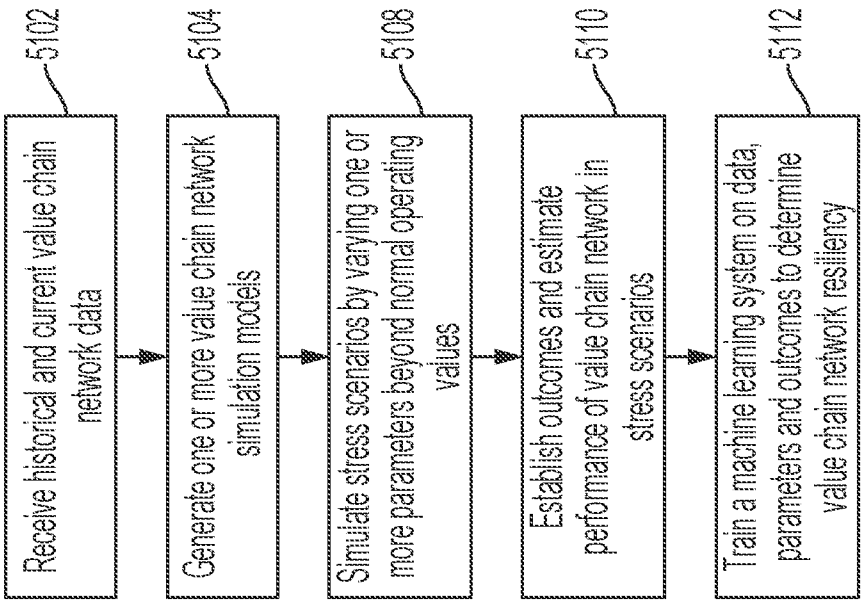

5102
Receive historical and current value chain network data
5104
Generate one or more value chain network simulation models
5108
Simulate stress scenarios by varying one or more parameters beyond normal operating values
5110
Establish outcomes and estimate performance of value chain network in stress scenarios
5112
Train a machine learning system on data, parameters and outcomes to determine value chain network resiliency

FIG 54

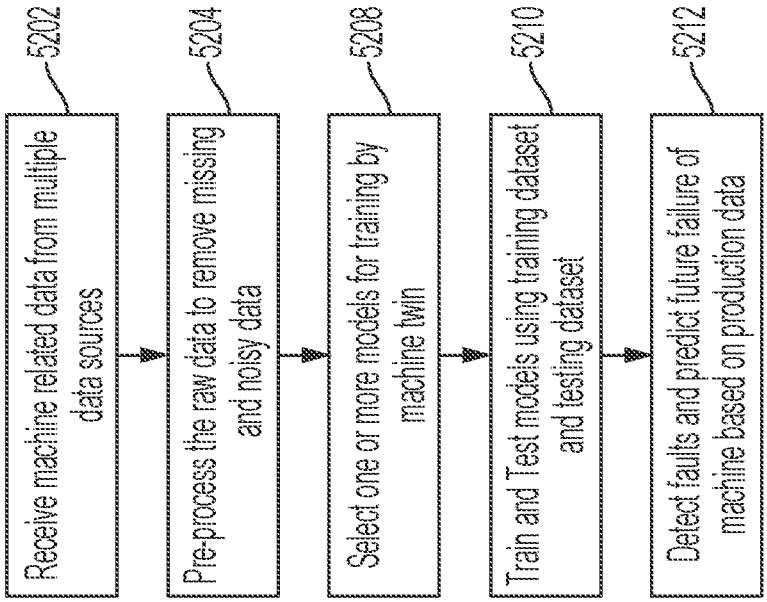

5202
Receive machine related data from multiple data sources
5204
Pre-process the raw data to remove missing and noisy data
5208
Select one or more models for training by machine twin
5210
Train and Test models using training dataset and testing dataset
5212
Detect faults and predict future failure of machine based on production data

FIG 55

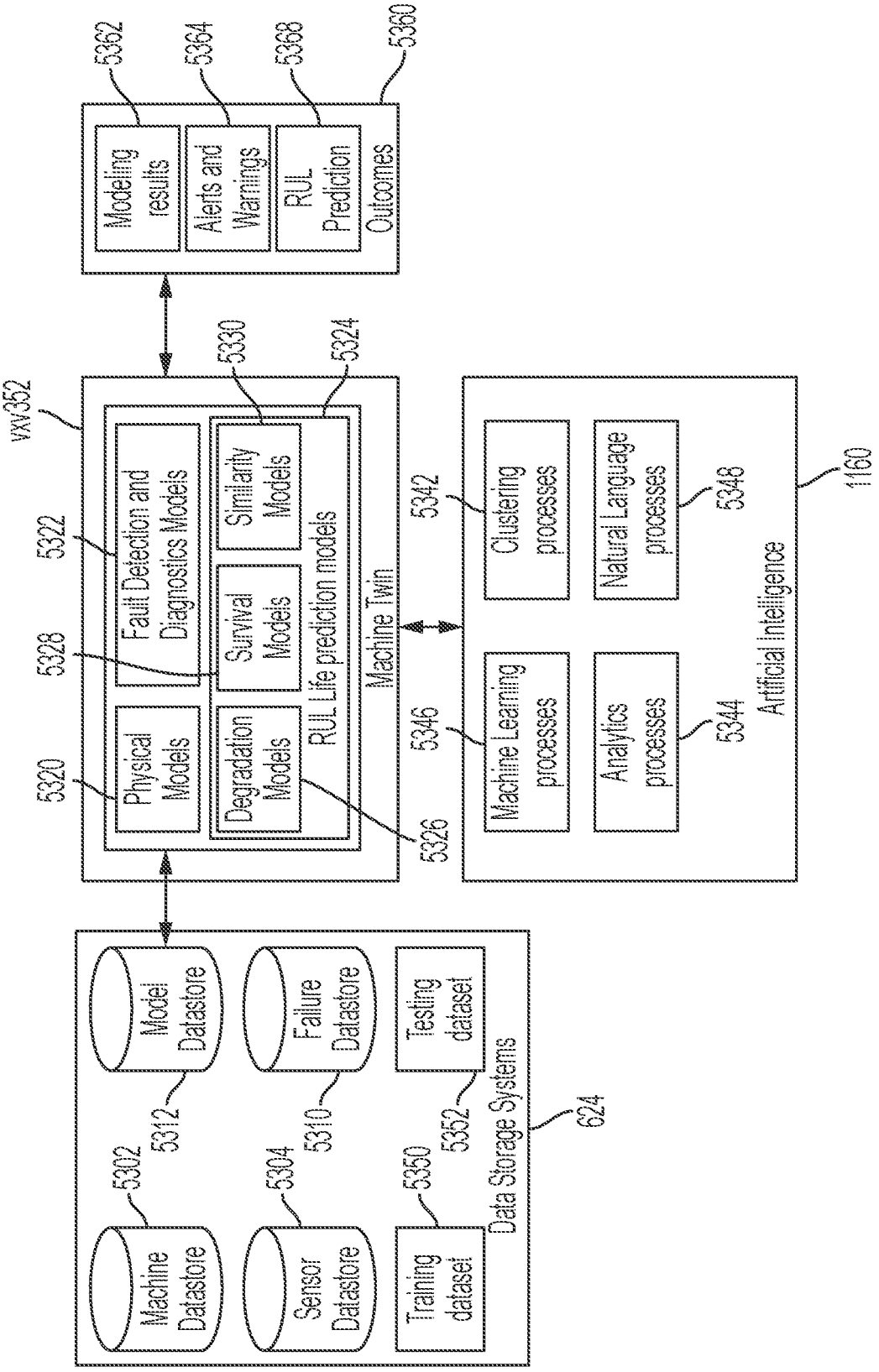

5362
5364
5368
5360
Modeling results
Alerts and Warnings
RUL Prediction
Outcomes
vxv352
5330
5324
5322
5328
5320
Physical Models
Fault Detection and Diagnostics Models
Survival Models
Similarity Models
Degradation Models
RUL Life prediction models
5326
Machine Twin
5342
5346
Machine Learning processes
Clustering processes
Analytics processes
Natural Language processes
5344
5348
Artificial Intelligence
1160
Model Datastore
Failure Datastore
Testing dataset
5312
5310
5352
5302
5304
5350
Machine Datastore
Sensor Datastore
Training dataset
Data Storage Systems
624

FIG 56

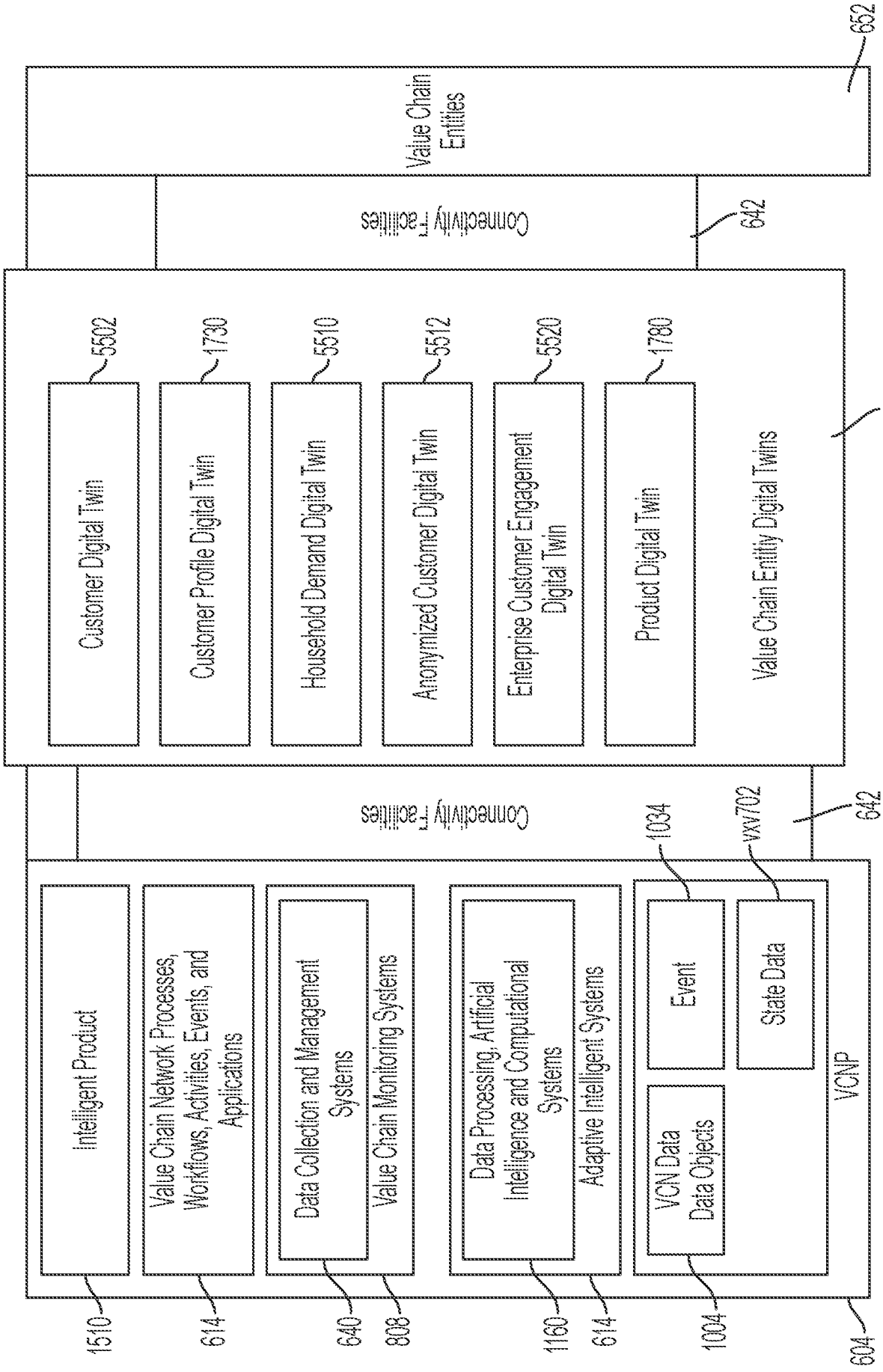

652
Value Chain Entities
Connectivity Facilities
642
5502
Customer Digital Twin
1730
Customer Profile Digital Twin
5510
Household Demand Digital Twin
5512
Anonymized Customer Digital Twin
5520
Enterprise Customer Engagement Digital Twin
1780
Product Digital Twin
Value Chain Entity Digital Twins
1700
Connectivity Facilities
642
1034
vxv702
Intelligent Product
Value Chain Network Processes, Workflows, Activities, Events, and Applications
Data Collection and Management Systems
Value Chain Monitoring Systems
Data Processing, Artificial Intelligence and Computational Systems
Adaptive Intelligent Systems
Event
State Data
VCN Data Data Objects
VCNP
1510
614
640
808
1160
614
1004
604

FIG 57

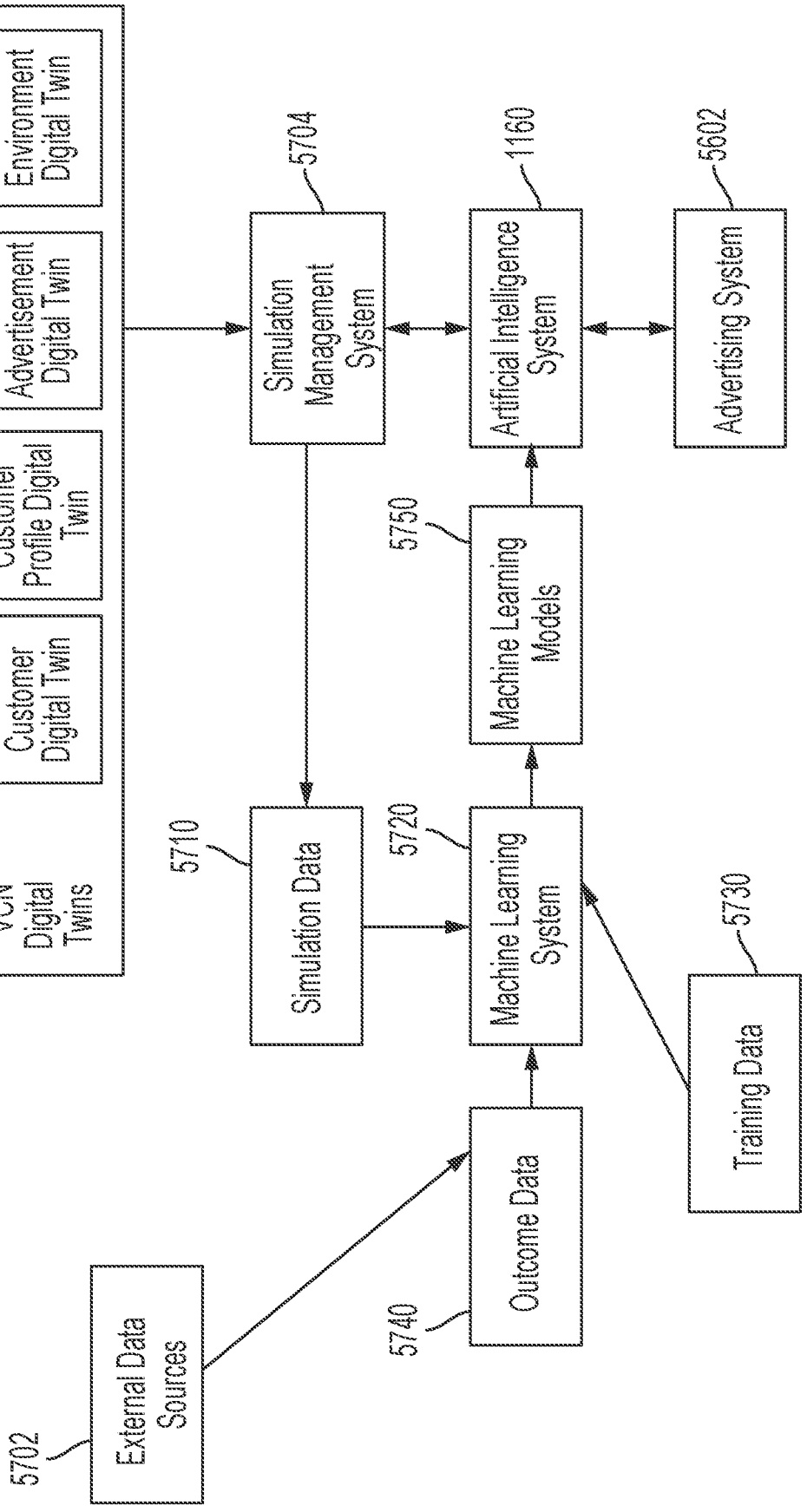

5804
Environment Digital Twin
5802
Advertisement Digital Twin
1730
Customer Profile Digital Twin
5502
Customer Digital Twin
VCN Digital Twins
1700
5704
Simulation Management System
1160
Artificial Intelligence System
5602
Advertising System
5750
Machine Learning Models
5710
Simulation Data
5720
Machine Learning System
5730
Training Data
5740
Outcome Data
5702
External Data Sources

FIG 58

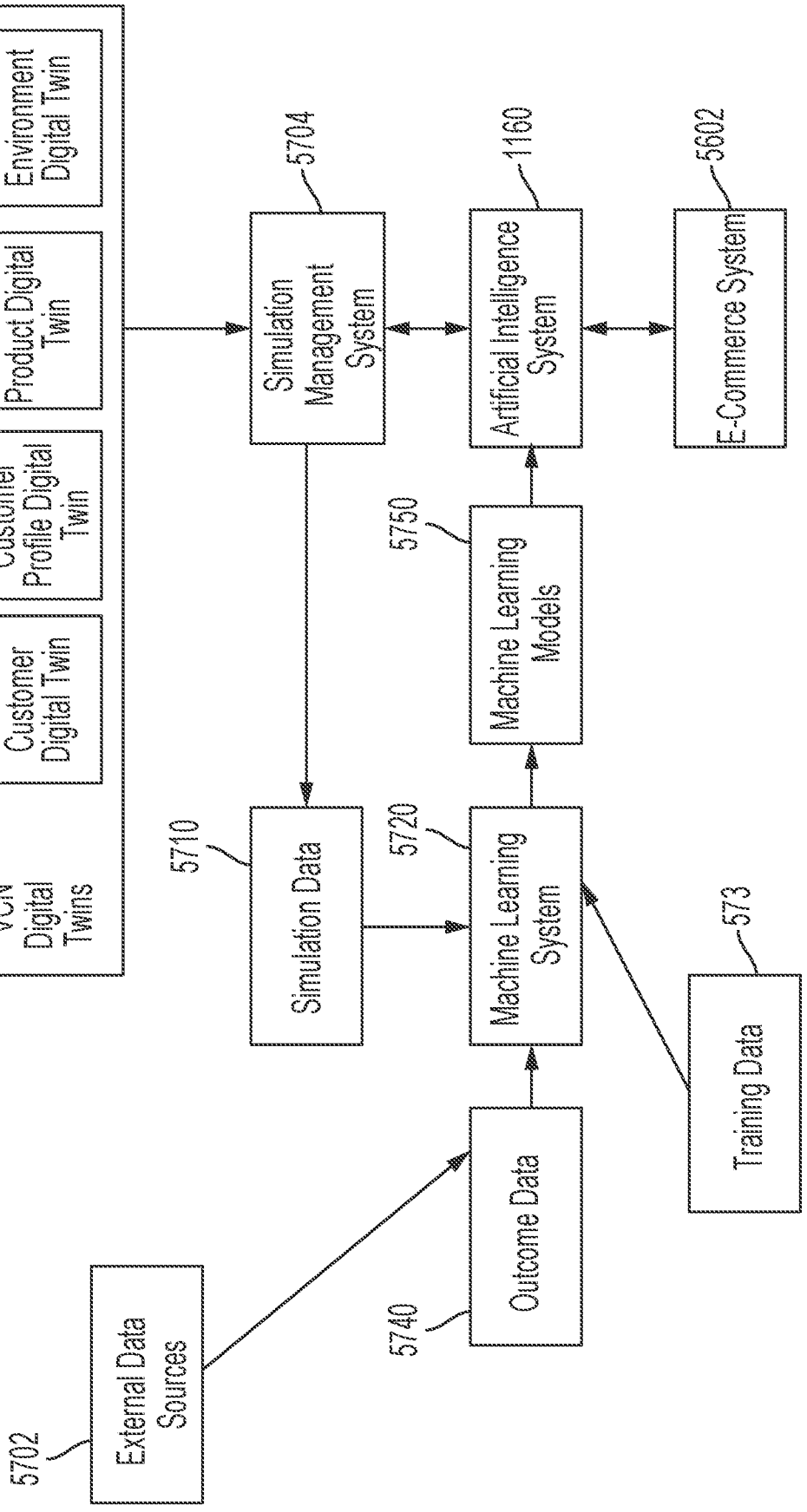

5803
Environment Digital Twin
1780
Product Digital Twin
1730
Customer Profile Digital Twin
5502
Customer Digital Twin
VCN Digital Twins
1700
5704
Simulation Management System
1160
Artificial Intelligence System
5602
E-Commerce System
5750
Machine Learning Models
5710
Simulation Data
5720
Machine Learning System
573
Training Data
5740
Outcome Data
5702
External Data Sources

FIG 59

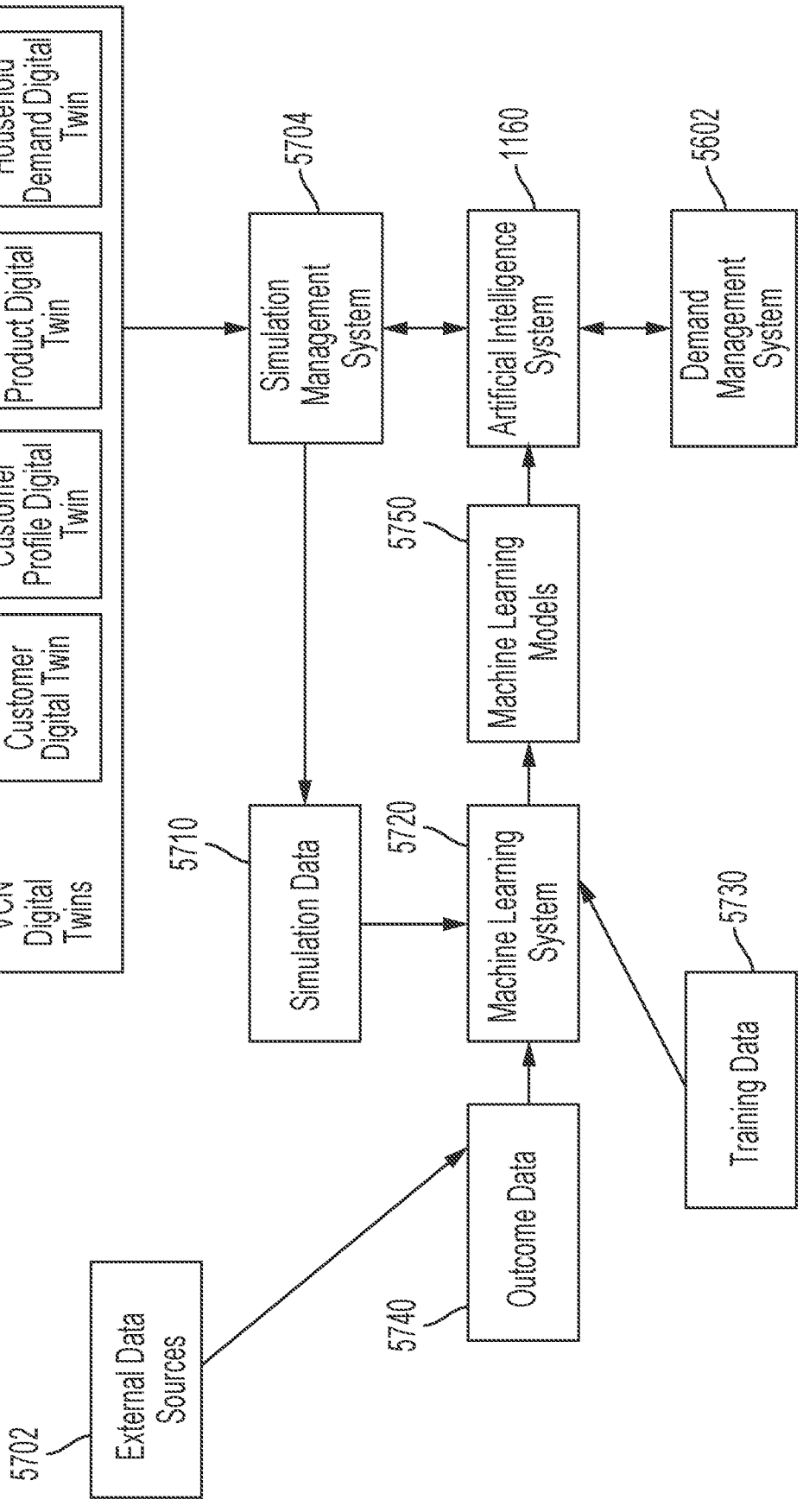

VCN Digital Twins
1700
Customer Digital Twin
5502
Customer Profile Digital Twin
1730
Product Digital Twin
1780
Household Demand Digital Twin
5902
External Data Sources
5702
Simulation Data
5710
Simulation Management System
5704
Outcome Data
5740
Machine Learning System
5720
Machine Learning Models
5750
Artificial Intelligence System
1160
Training Data
5730
Demand Management System
5602

FIG. 60

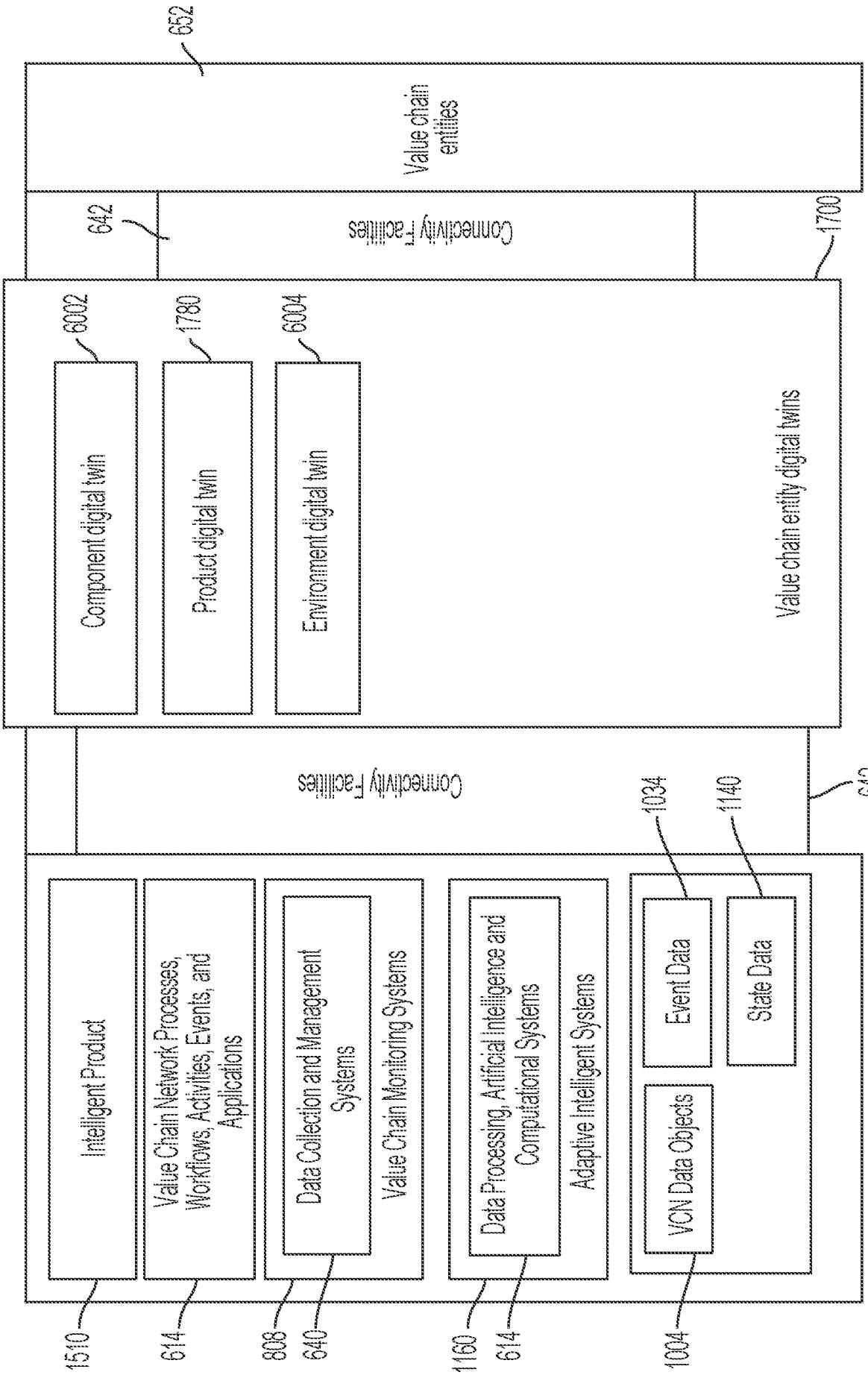

652
Value chain entities
642
Connectivity Facilities
1700
6002
Component digital twin
1780
Product digital twin
6004
Environment digital twin
Value chain entity digital twins
Connectivity Facilities
642
1034
1140
Intelligent Product
Value Chain Network Processes, Workflows, Activities, Events, and Applications
Data Collection and Management Systems
Value Chain Monitoring Systems
Data Processing, Artificial Intelligence and Computational Systems
Adaptive Intelligent Systems
Event Data
State Data
VCN Data Objects
1510
614
808
640
1160
614
1004

FIG. 61

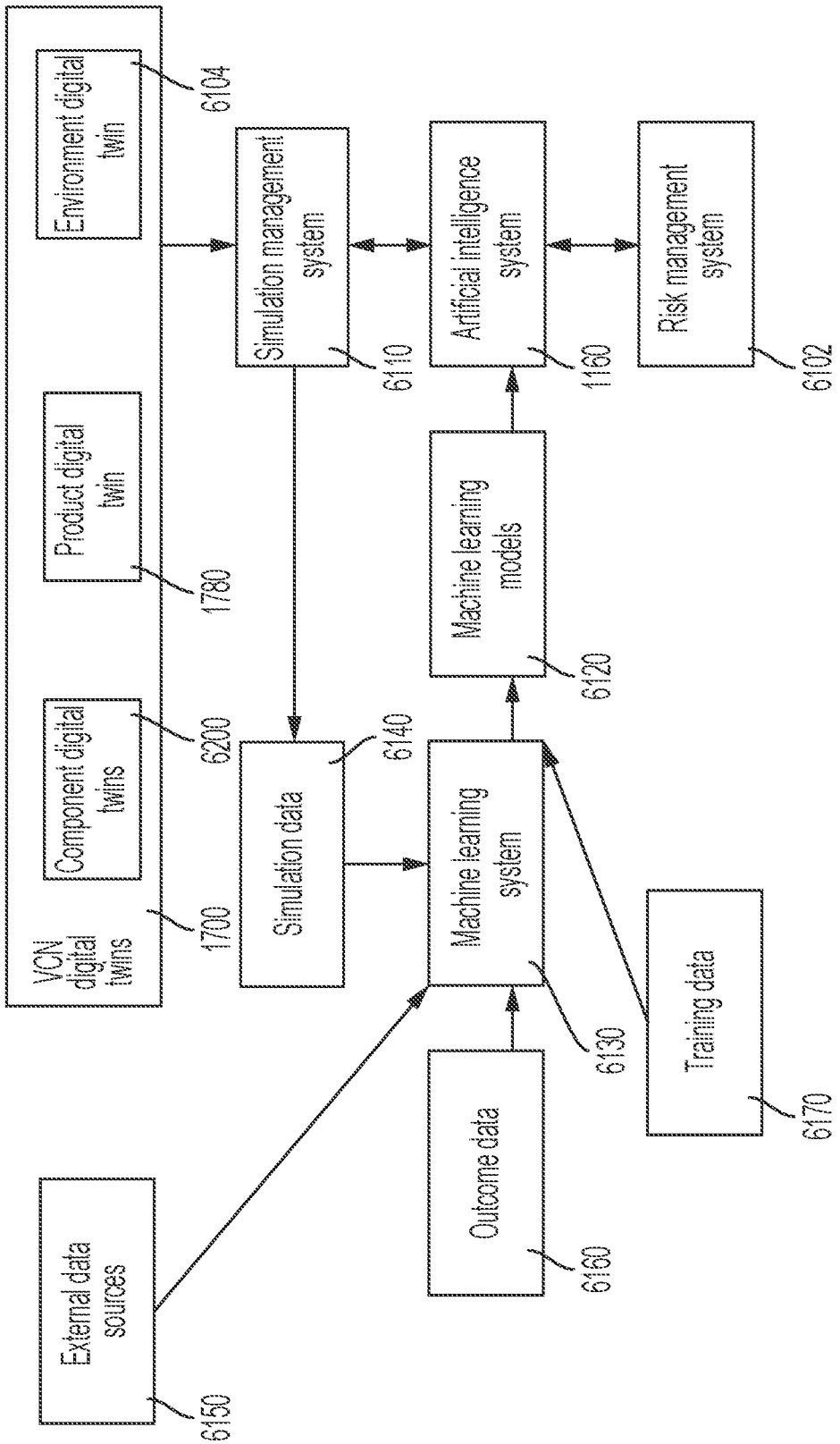

VCN digital twins
1700
Environment digital twin
6104
Product digital twin
1780
Component digital twins
6200
Simulation management system
6110
Artificial intelligence system
1160
Risk management system
6102
Machine learning models
6120
Simulation data
6140
Machine learning system
6130
Training data
6170
Outcome data
6160
External data sources
6150

FIG. 62

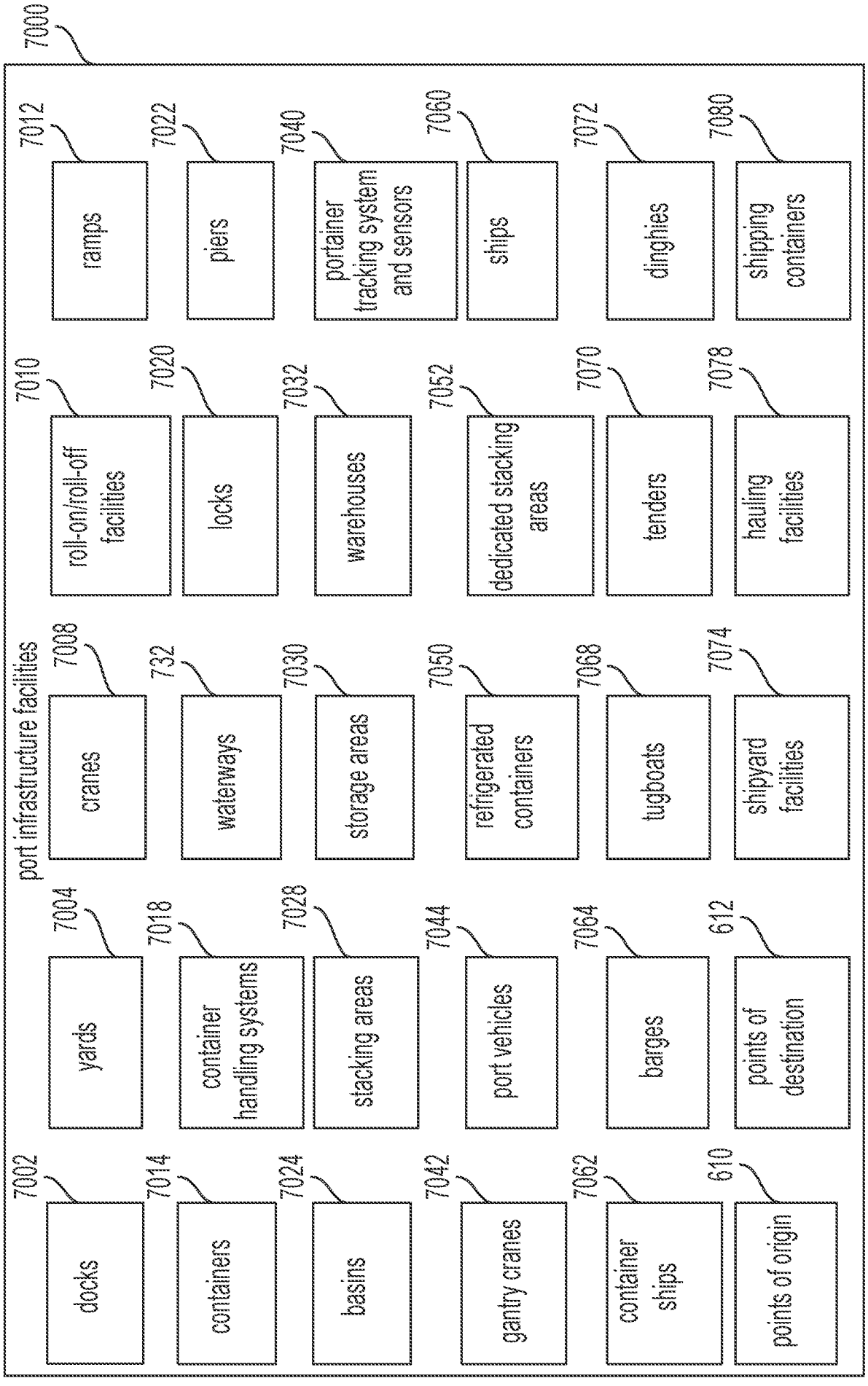

7000
port infrastructure facilities
7002
docks
7004
yards
7008
cranes
7010
roll-on/roll-off facilities
7012
ramps
7014
containers
7018
container handling systems
732
waterways
7020
locks
7022
piers
7024
basins
7028
stacking areas
7030
storage areas
7032
warehouses
7040
portainer tracking system and sensors
7042
gantry cranes
7044
port vehicles
7050
refrigerated containers
7052
dedicated stacking areas
7060
ships
7062
container ships
7064
barges
7068
tugboats
7070
tenders
7072
dinghies
610
points of origin
612
points of destination
7074
shipyard facilities
7078
hauling facilities
7080
shipping containers

FIG. 63

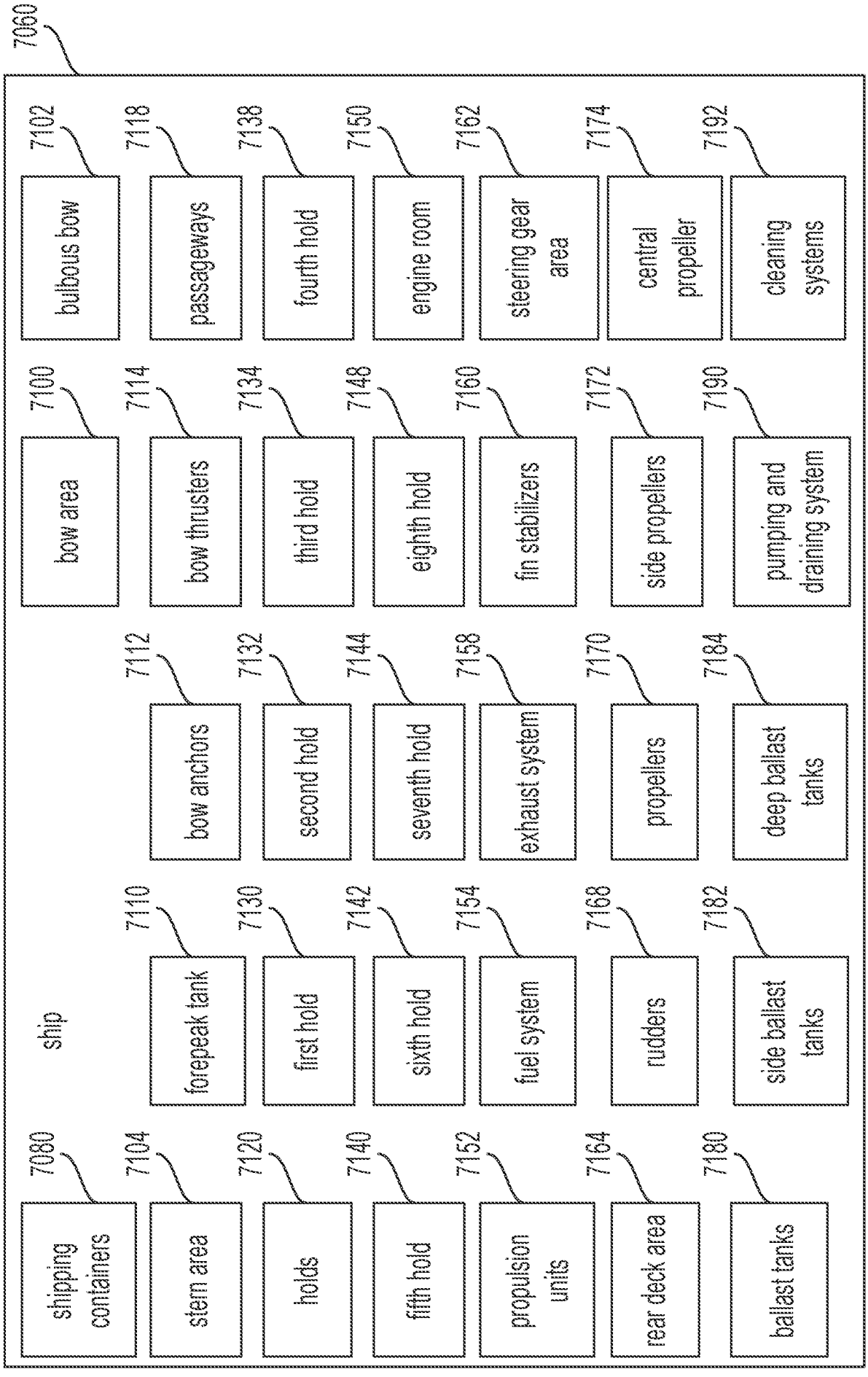

7060
ship
7080
shipping containers
7100
bow area
7102
bulbous bow
7104
stern area
7110
forepeak tank
7112
bow anchors
7114
bow thrusters
7118
passageways
7120
holds
7130
first hold
7132
second hold
7134
third hold
7138
fourth hold
7140
fifth hold
7142
sixth hold
7144
seventh hold
7148
eighth hold
7150
engine room
7152
propulsion units
7154
fuel system
7158
exhaust system
7160
fin stabilizers
7162
steering gear area
7164
rear deck area
7168
rudders
7170
propellers
7172
side propellers
7174
central propeller
7180
ballast tanks
7182
side ballast tanks
7184
deep ballast tanks
7190
pumping and draining system
7192
cleaning systems

FIG. 64

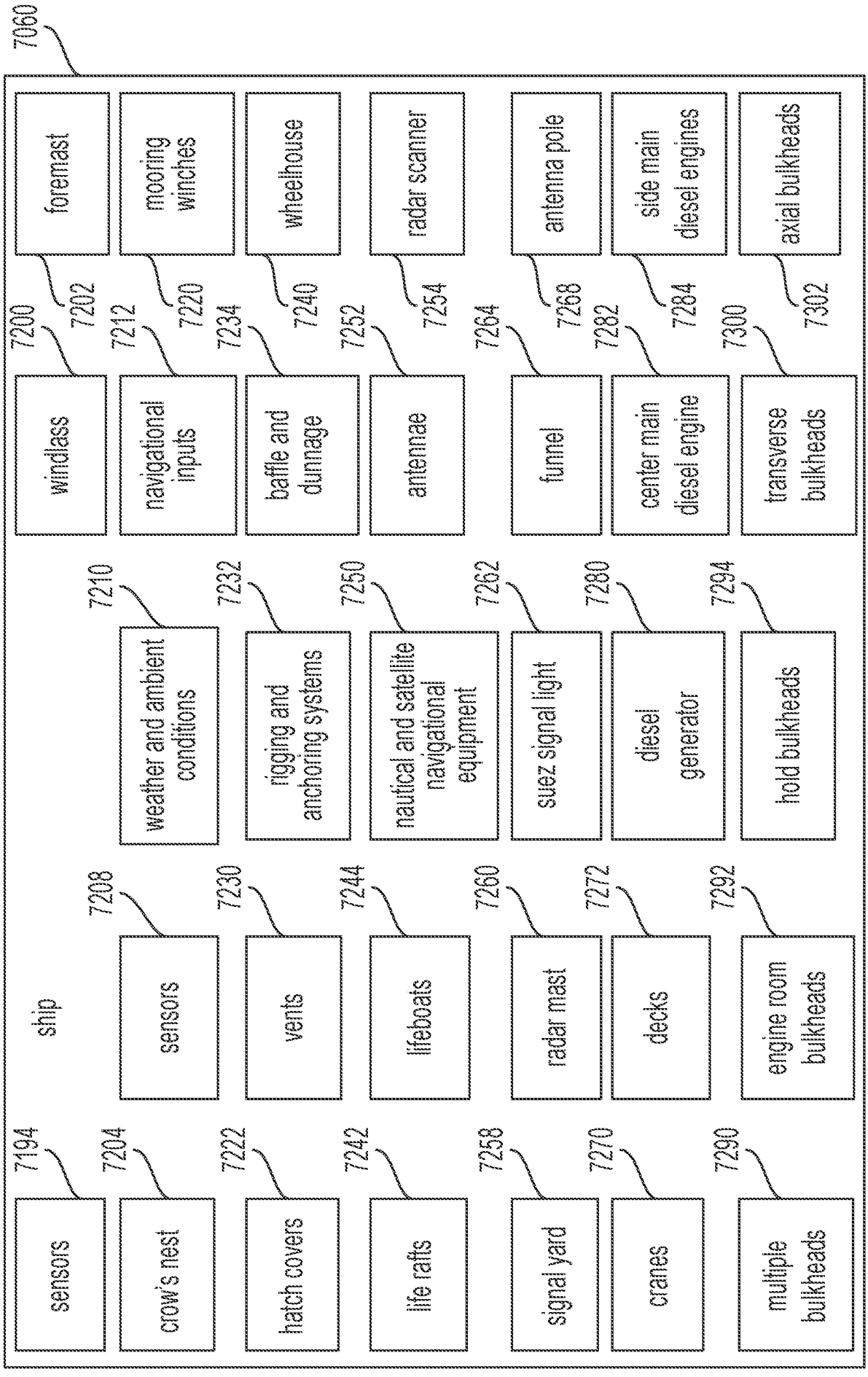

7060
ship
7194
sensors
7204
crow's nest
7222
hatch covers
7242
life rafts
7258
signal yard
7270
cranes
7290
multiple bulkheads
7208
sensors
7230
vents
7244
lifeboats
7260
radar mast
7272
decks
7292
engine room bulkheads
7210
weather and ambient conditions
7232
rigging and anchoring systems
7250
nautical and satellite navigational equipment
7262
suez signal light
7280
diesel generator
7294
hold bulkheads
7200
windlass
7212
navigational inputs
7234
baffle and dunnage
7252
antennae
7264
funnel
7282
center main diesel engine
7300
transverse bulkheads
7202
foremast
7220
mooring winches
7240
wheelhouse
7254
radar scanner
7268
antenna pole
7284
side main diesel engines
7302
axial bulkheads

FIG. 65

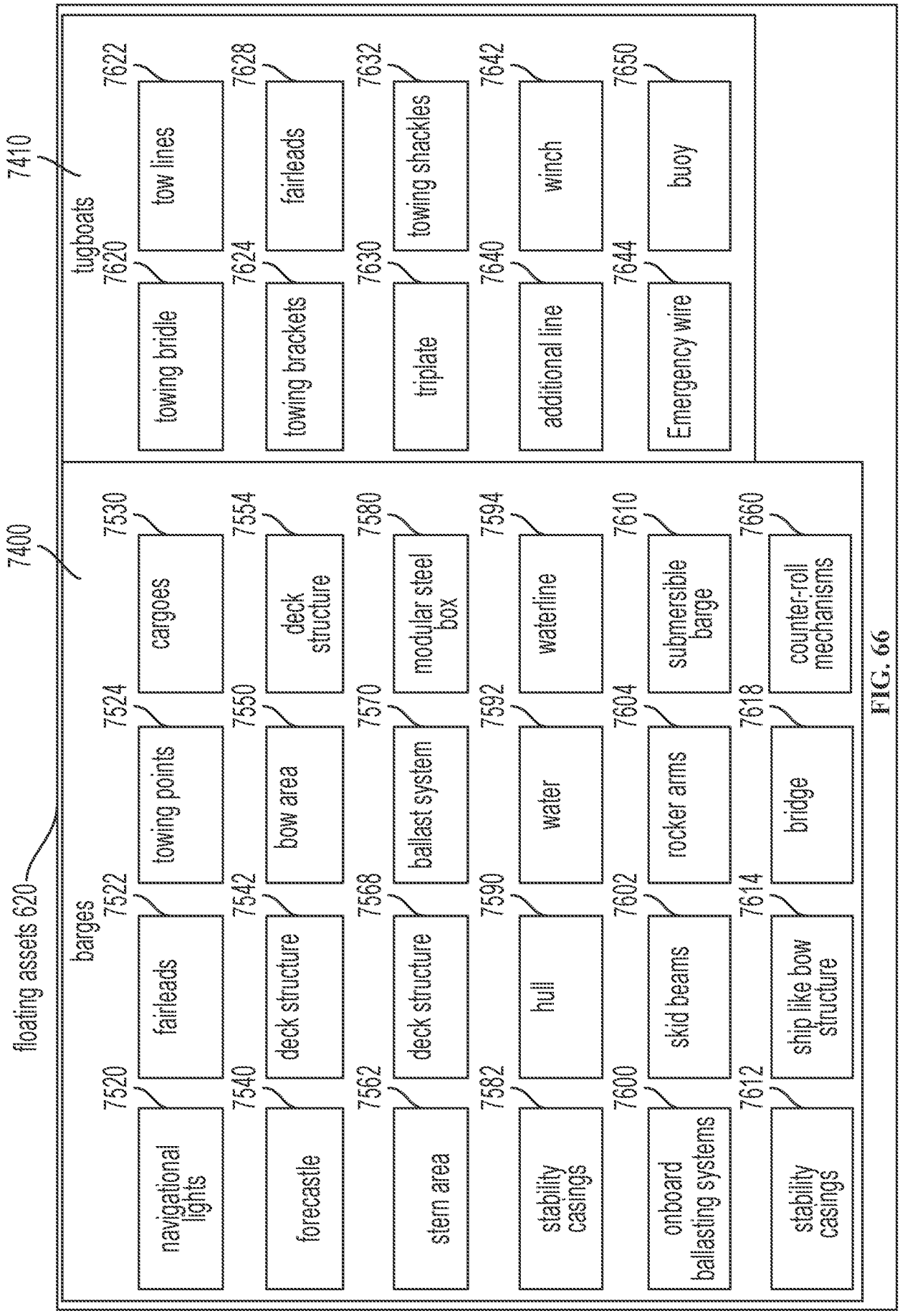

floating assets 620
7400
barges
7520
navigational lights
7522
fairleads
7524
towing points
7530
cargoes
7540
forecastle
7542
deck structure
7550
bow area
7554
deck structure
7562
stern area
7568
deck structure
7570
ballast system
7580
modular steel box
7582
stability casings
7590
hull
7592
water
7594
waterline
7600
onboard ballasting systems
7602
skid beams
7604
rocker arms
7610
submersible barge
7612
stability casings
7614
ship like bow structure
7618
bridge
7660
counter-roll mechanisms
7410
tugboats
7620
towing bridle
7622
tow lines
7624
towing brackets
7628
fairleads
7630
triplate
7632
towing shackles
7640
additional line
7642
winch
7644
Emergency wire
7650
buoy

FIG. 66

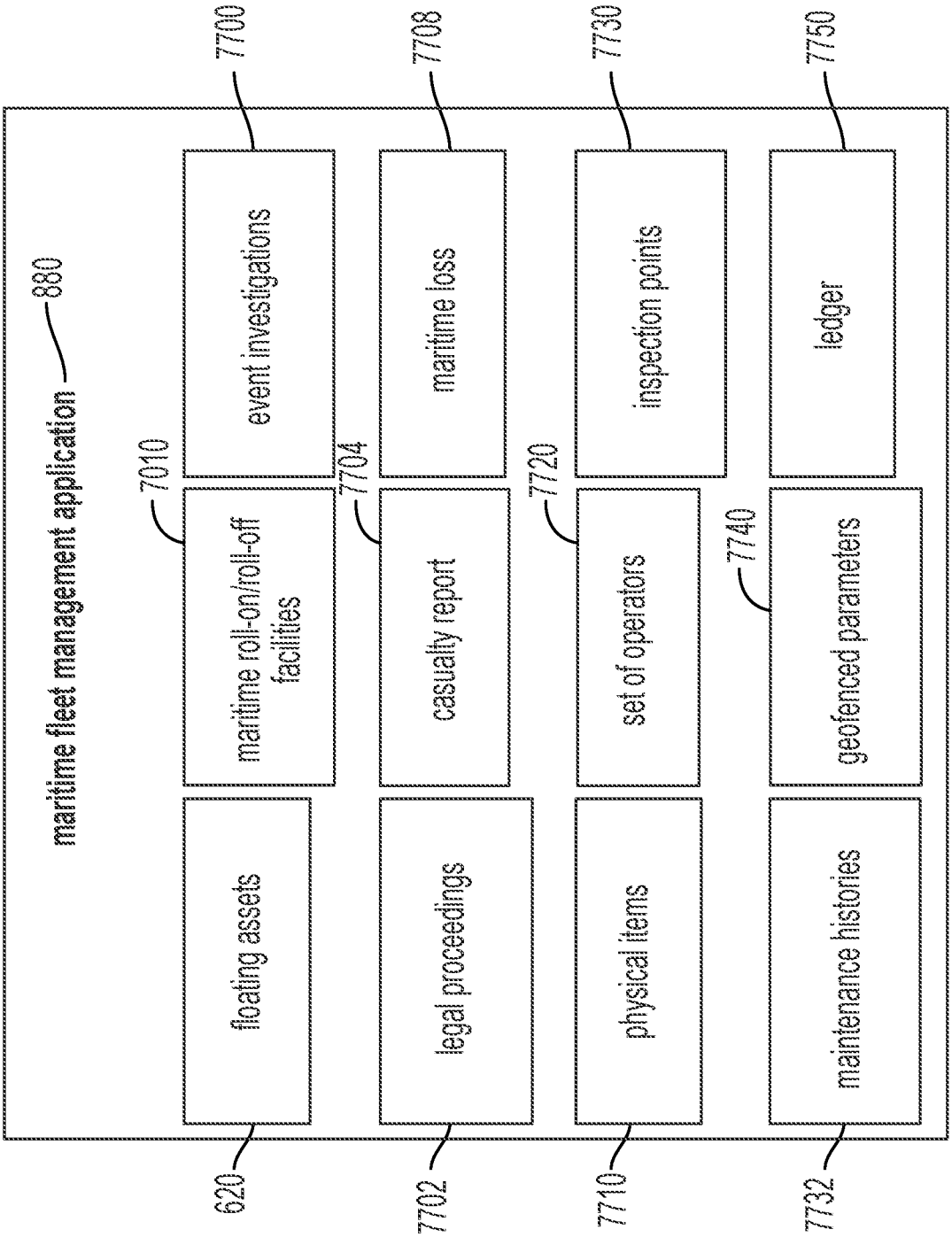

maritime fleet management application
880
7700
event investigations
7708
maritime loss
7730
inspection points
7750
ledger
7010
maritime roll-on/roll-off facilities
7704
casualty report
7720
set of operators
7740
geofenced parameters
620
floating assets
7702
legal proceedings
7710
physical items
7732
maintenance histories

FIG. 67

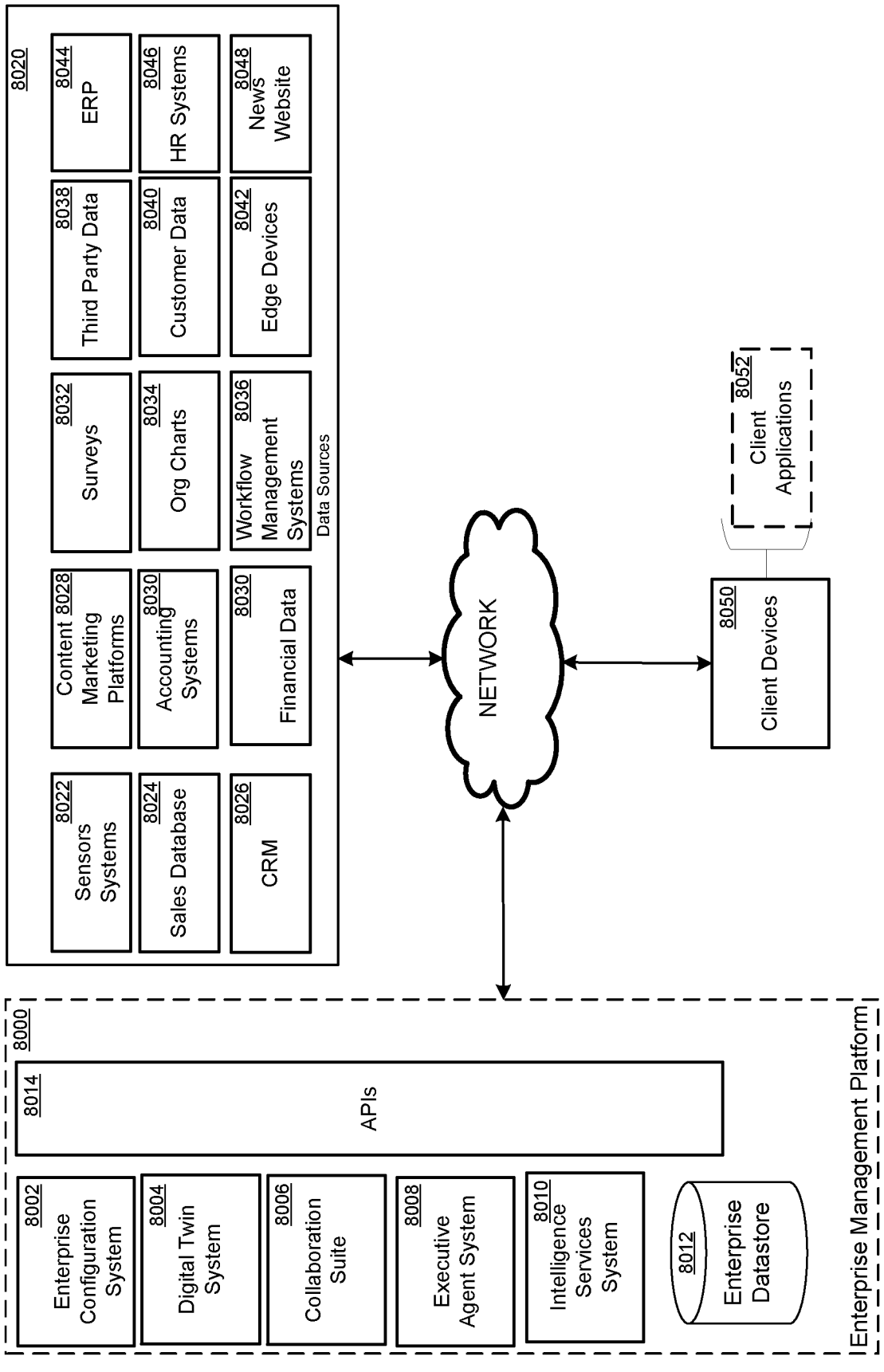

8000
Enterprise Management Platform
8002
Enterprise Configuration System
8004
Digital Twin System
8006
Collaboration Suite
8008
Executive Agent System
8010
Intelligence Services System
8012
Enterprise Datastore
8014
APIs
NETWORK
8020
Data Sources
8022
Sensors Systems
8024
Sales Database
8026
CRM
Content 8028
Marketing Platforms
Accounting 8030
Systems
8030
Financial Data
8032
Surveys
8034
Org Charts
Workflow 8036
Management Systems
8038
Third Party Data
8040
Customer Data
8042
Edge Devices
8044
ERP
8046
HR Systems
8048
News Website
8050
Client Devices
8052
Client Applications

FIG. 68

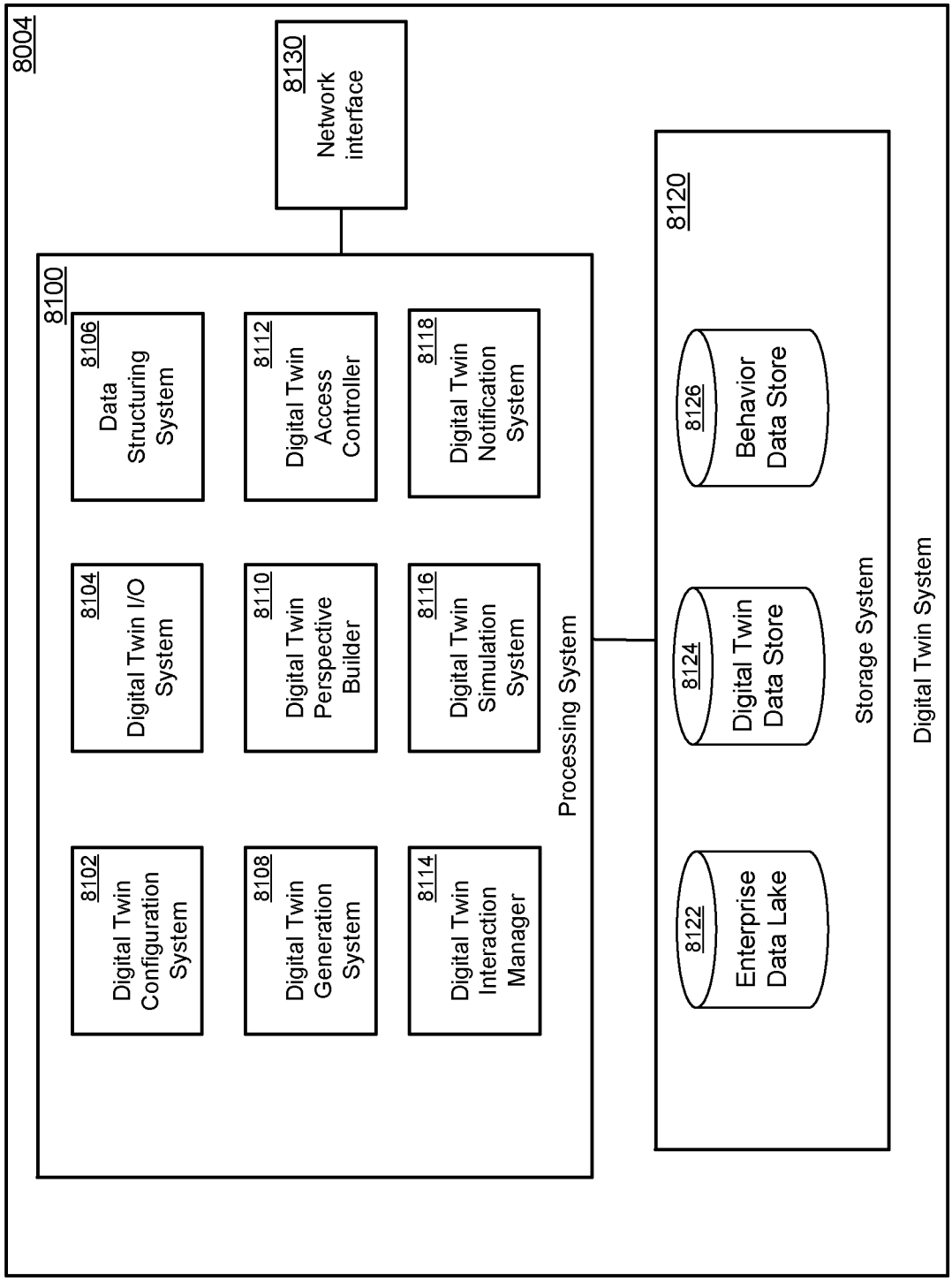

8004
8130
Network interface
8100
8106
Data Structuring System
8112
Digital Twin Access Controller
8118
Digital Twin Notification System
8104
Digital Twin I/O System
8110
Digital Twin Perspective Builder
8116
Digital Twin Simulation System
8102
Digital Twin Configuration System
8108
Digital Twin Generation System
8114
Digital Twin Interaction Manager
Processing System
8120
8126
Behavior Data Store
8124
Digital Twin Data Store
8122
Enterprise Data Lake
Storage System
Digital Twin System

FIG. 69

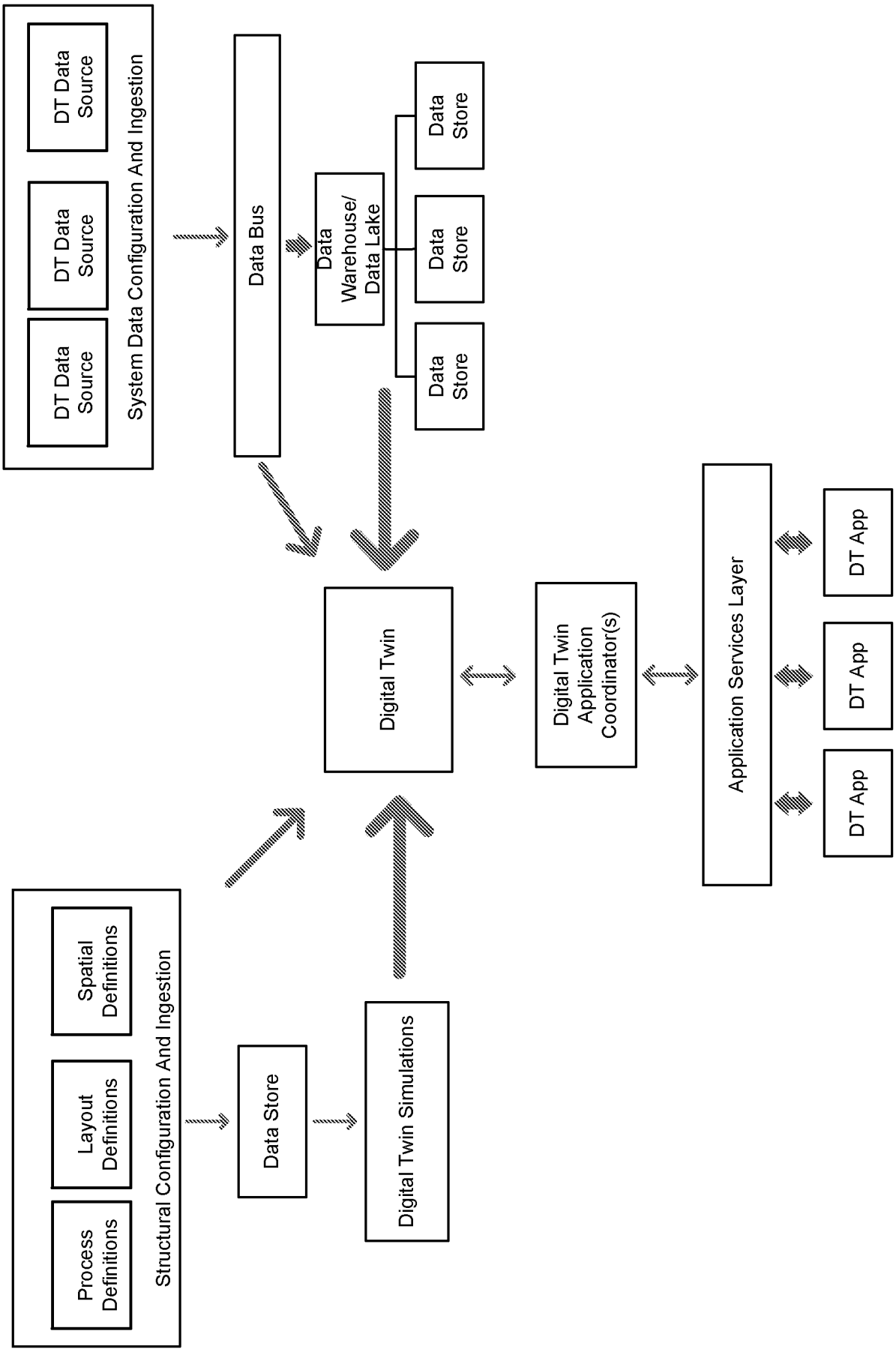

Process Definitions
Layout Definitions
Spatial Definitions
Structural Configuration And Ingestion
Data Store
Digital Twin Simulations
DT Data Source
DT Data Source
DT Data Source
System Data Configuration And Ingestion
Data Bus
Data Warehouse/ Data Lake
Data Store
Data Store
Data Store
Digital Twin
Digital Twin Application Coordinator(s)
Application Services Layer
DT App
DT App
DT App

FIG. 70

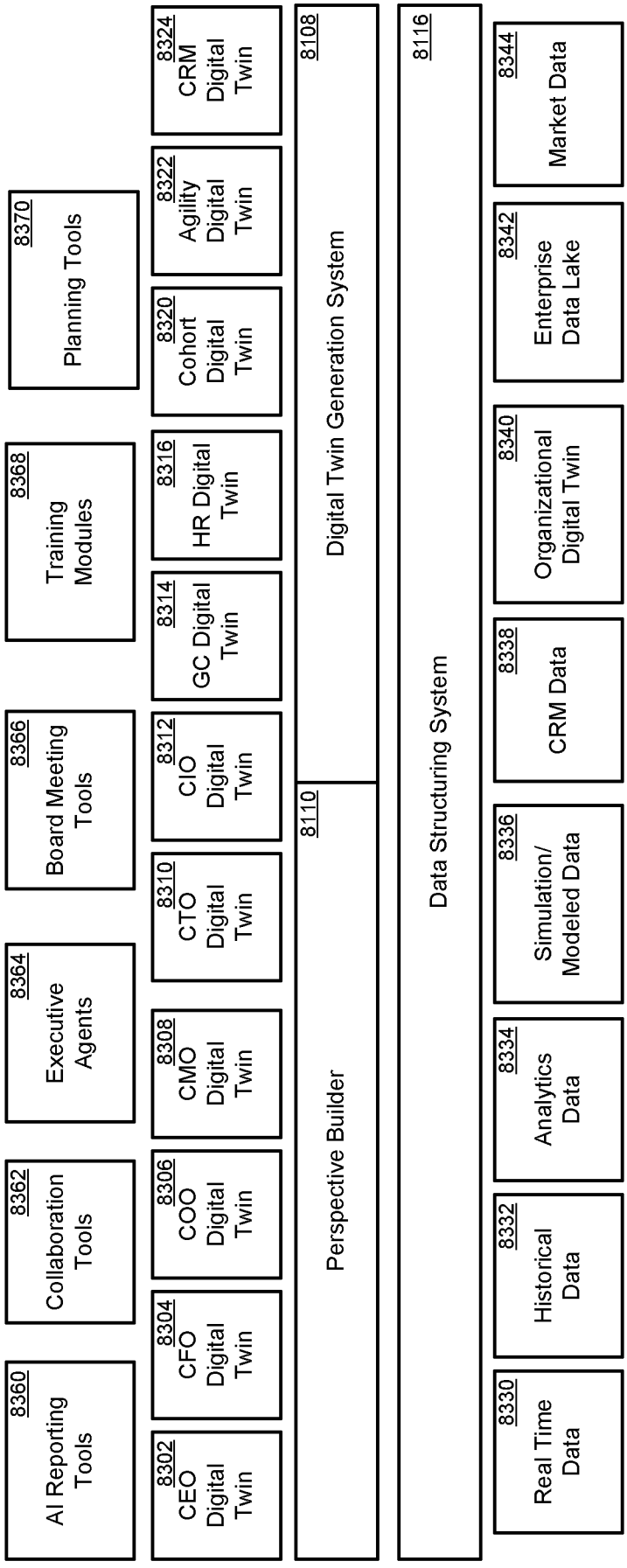

8360
AI Reporting Tools
8362
Collaboration Tools
8364
Executive Agents
8366
Board Meeting Tools
8368
Training Modules
8370
Planning Tools
8302
CEO Digital Twin
8304
CFO Digital Twin
8306
COO Digital Twin
8308
CMO Digital Twin
8310
CTO Digital Twin
8312
CIO Digital Twin
8314
GC Digital Twin
8316
HR Digital Twin
8320
Cohort Digital Twin
8322
Agility Digital Twin
8324
CRM Digital Twin
8110
Perspective Builder
8108
Digital Twin Generation System
8116
Data Structuring System
8330
Real Time Data
8332
Historical Data
8334
Analytics Data
8336
Simulation/ Modeled Data
8338
CRM Data
8340
Organizational Digital Twin
8342
Enterprise Data Lake
8344
Market Data

FIG. 71

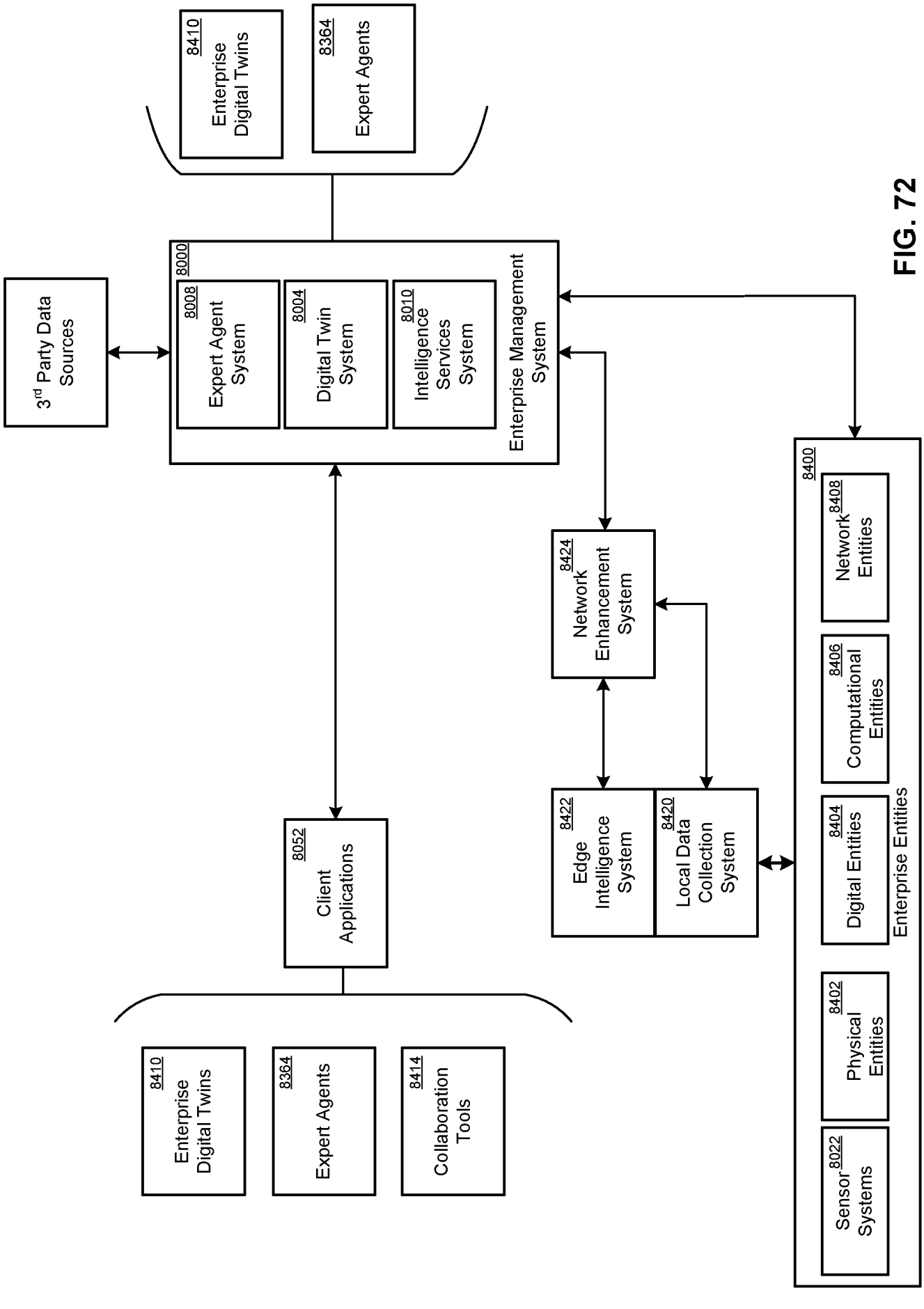

8410
Enterprise Digital Twins
8364
Expert Agents
3rd Party Data Sources
8000
Enterprise Management System
8008
Expert Agent System
8004
Digital Twin System
8010
Intelligence Services System
8052
Client Applications
8424
Network Enhancement System
8422
Edge Intelligence System
8420
Local Data Collection System
8400
Enterprise Entities
8408
Network Entities
8406
Computational Entities
8404
Digital Entities
8402
Physical Entities
8022
Sensor Systems
8410
Enterprise Digital Twins
8364
Expert Agents
8414
Collaboration Tools

FIG. 72

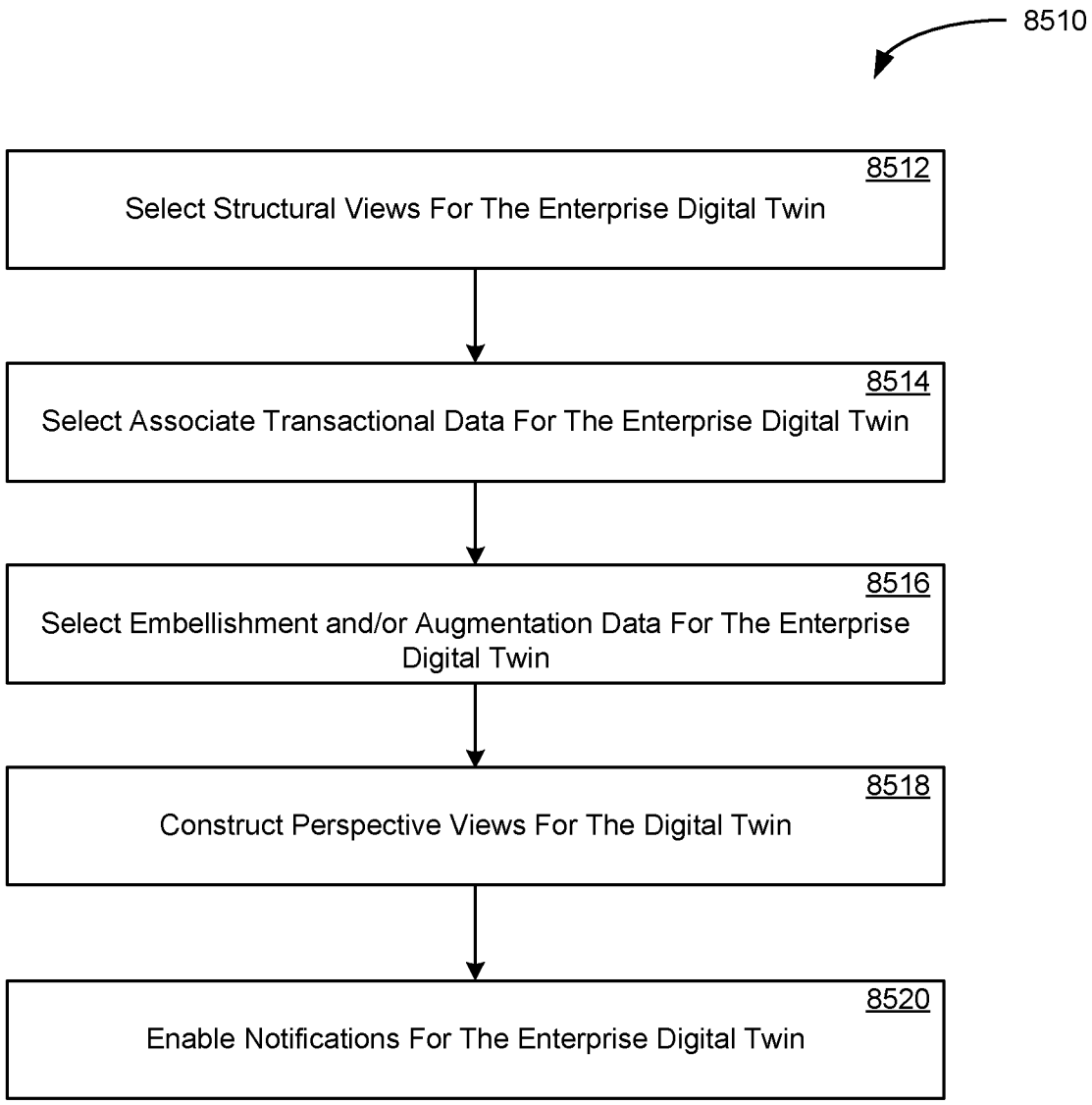

8510
8512
Select Structural Views For The Enterprise Digital Twin
8514
Select Associate Transactional Data For The Enterprise Digital Twin
8516
Select Embellishment and/or Augmentation Data For The Enterprise Digital Twin
8518
Construct Perspective Views For The Digital Twin
8520
Enable Notifications For The Enterprise Digital Twin

FIG. 73

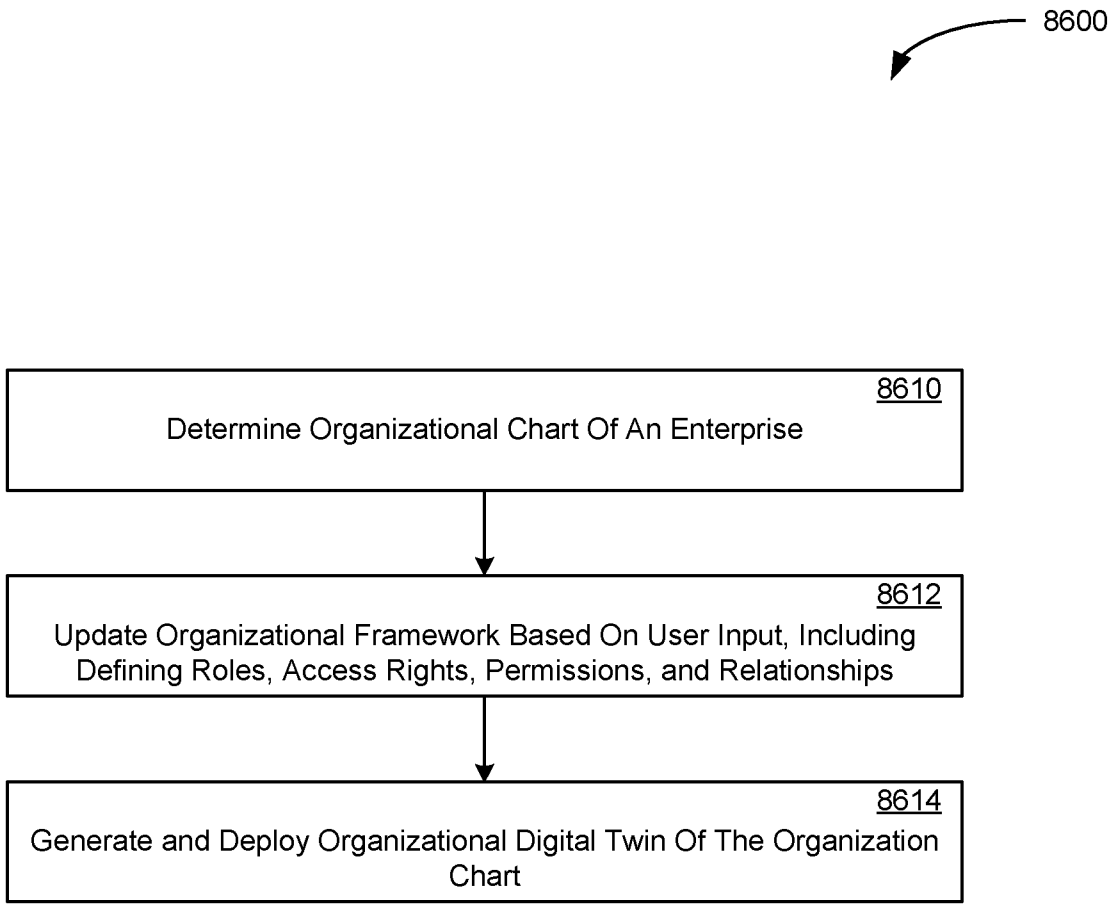

8600
8610
Determine Organizational Chart Of An Enterprise
8612
Update Organizational Framework Based On User Input, Including Defining Roles, Access Rights, Permissions, and Relationships
8614
Generate and Deploy Organizational Digital Twin Of The Organization Chart

FIG. 74

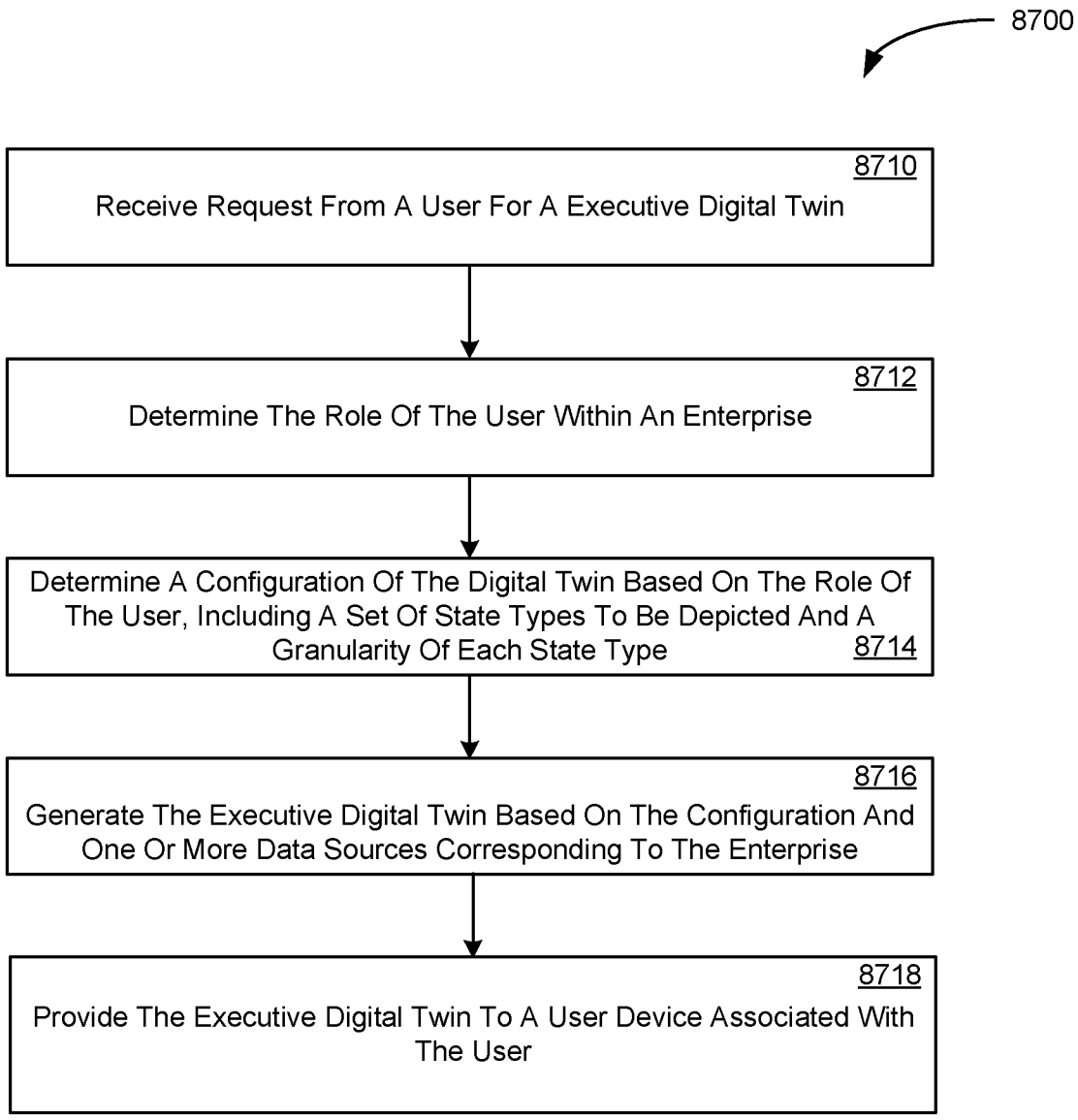

8700
8710
Receive Request From A User For A Executive Digital Twin
8712
Determine The Role Of The User Within An Enterprise
Determine A Configuration Of The Digital Twin Based On The Role Of The User, Including A Set Of State Types To Be Depicted And A Granularity Of Each State Type
8714
8716
Generate The Executive Digital Twin Based On The Configuration And One Or More Data Sources Corresponding To The Enterprise
8718
Provide The Executive Digital Twin To A User Device Associated With The User

FIG. 75

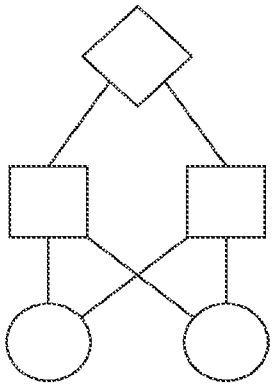


FIG. 78

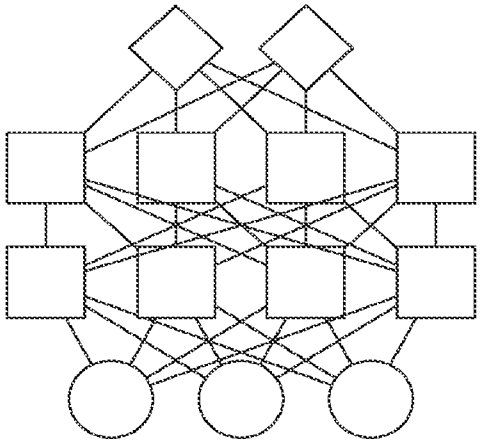


FIG. 80

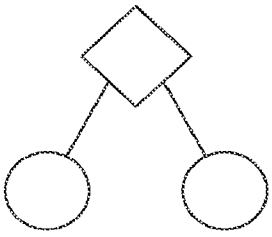


FIG. 77

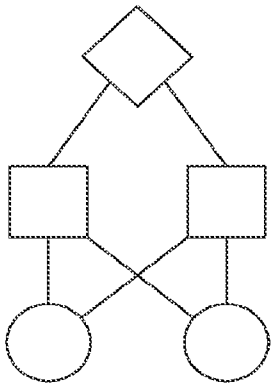


FIG. 79

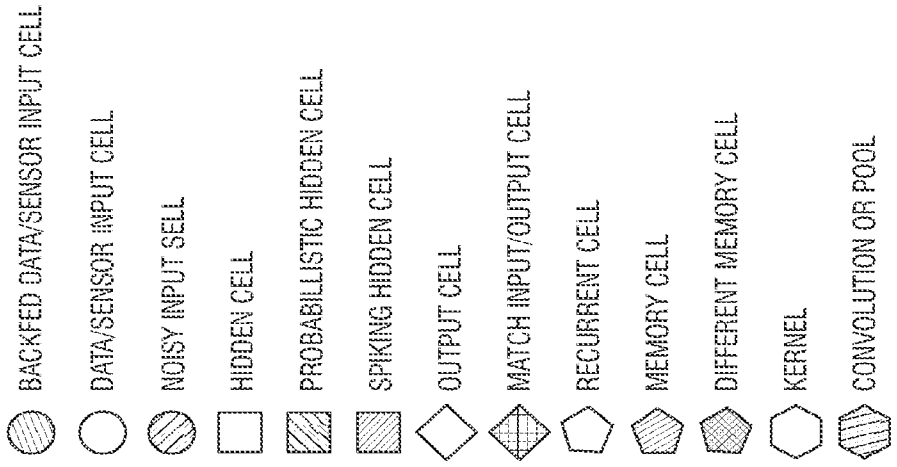


FIG. 76

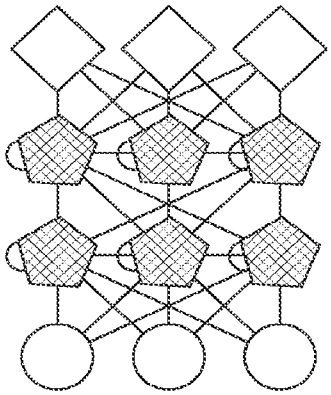


FIG. 83

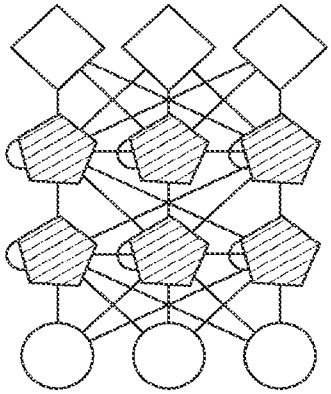


FIG. 82

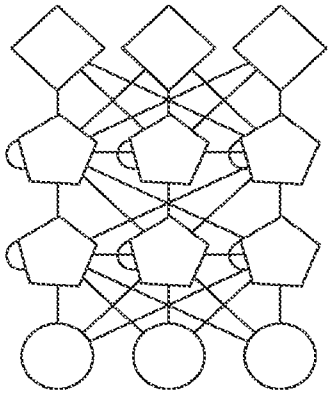


FIG. 81

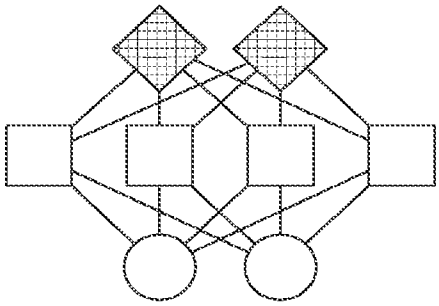


FIG. 87

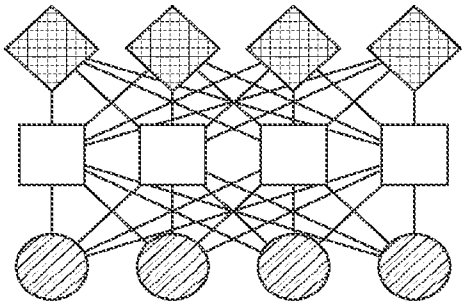


FIG. 86

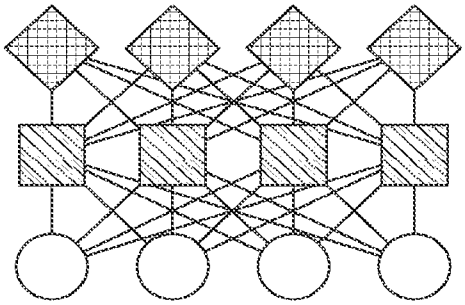


FIG. 85

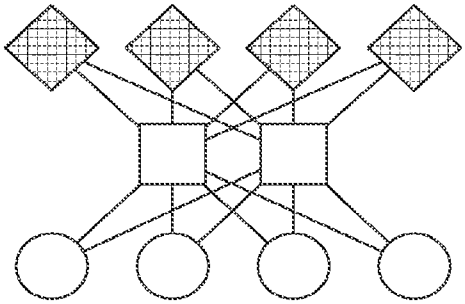


FIG. 84

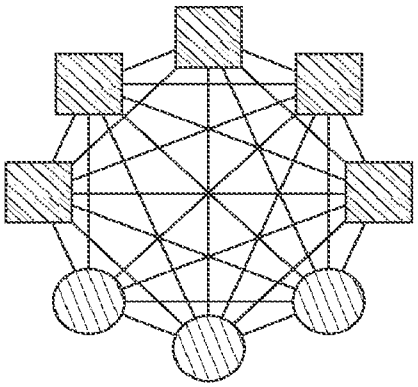


FIG. 90

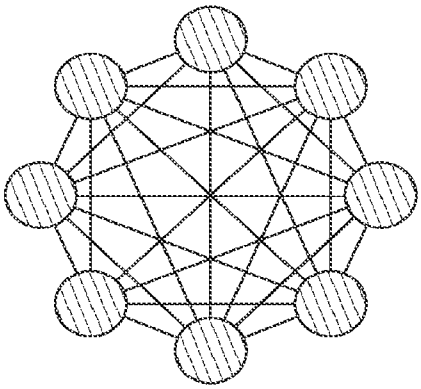


FIG. 89

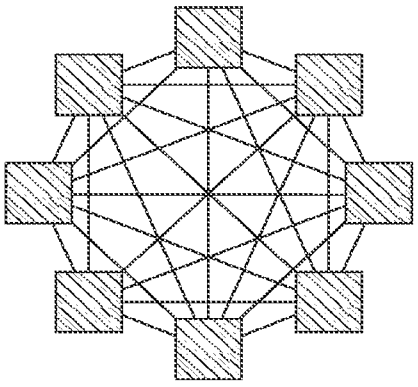


FIG. 88

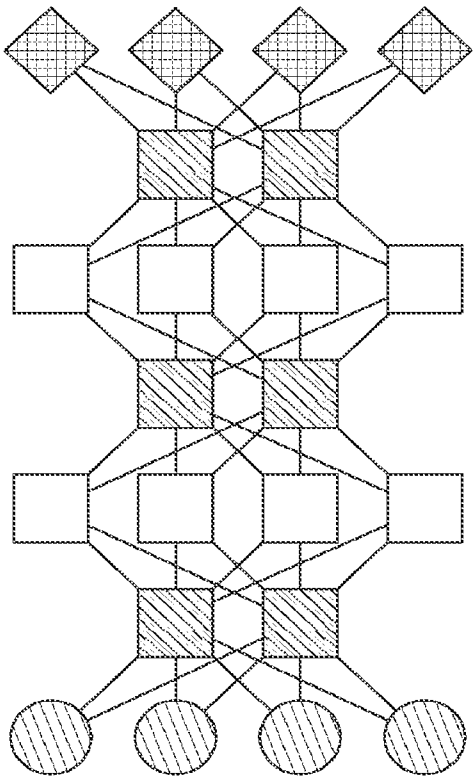


FIG. 92

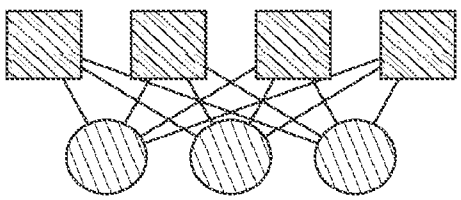


FIG. 91

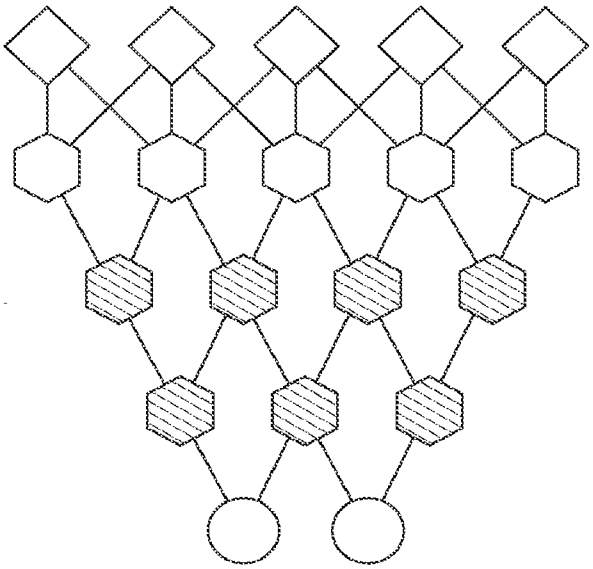


FIG. 94

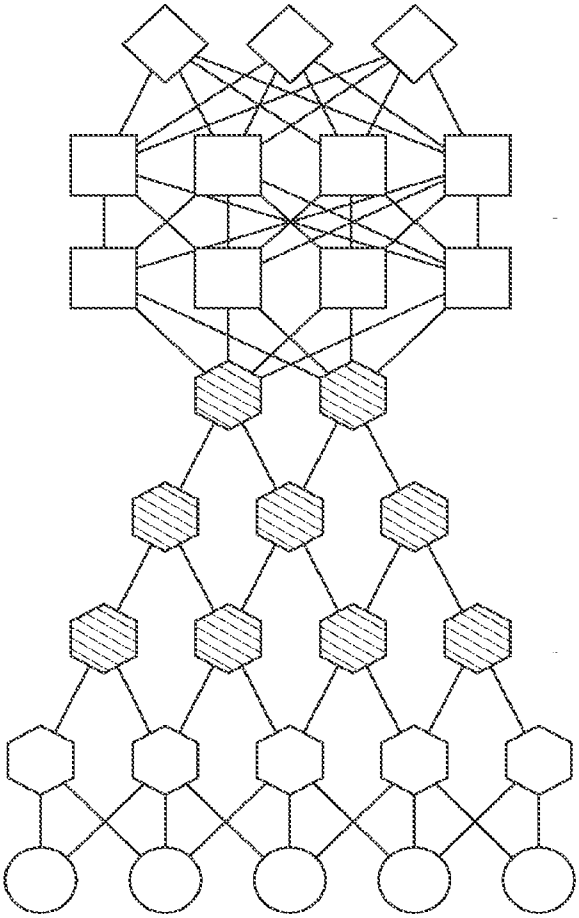


FIG. 93

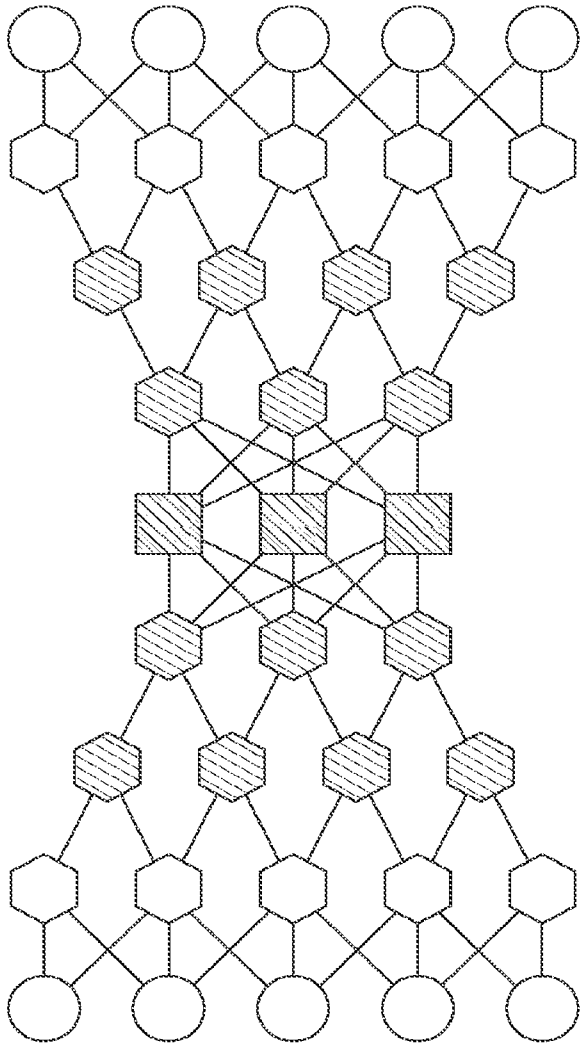


FIG. 95

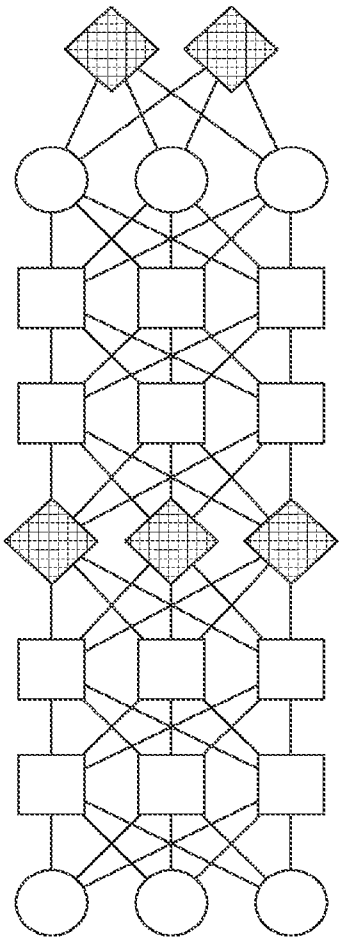


FIG. 96

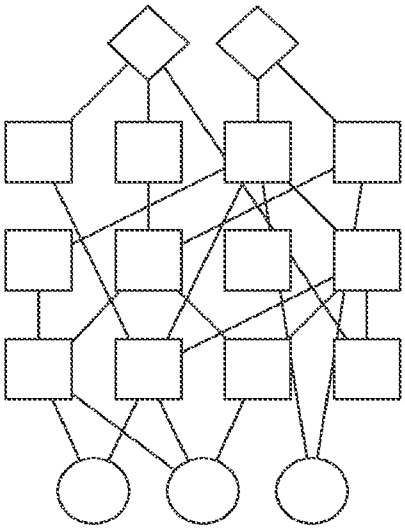


FIG. 98

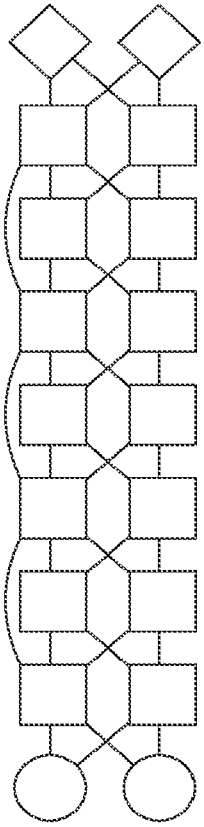


FIG. 100

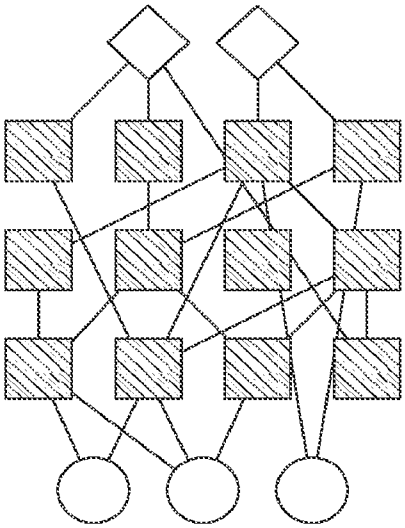


FIG. 97

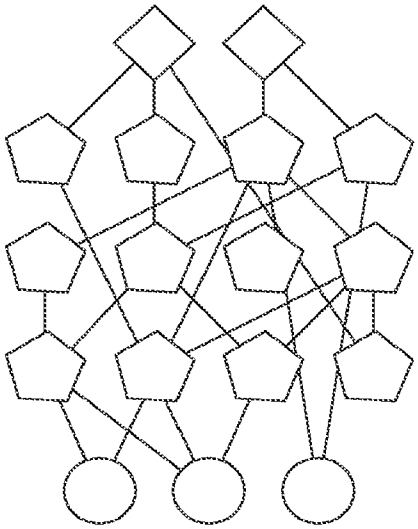


FIG. 99

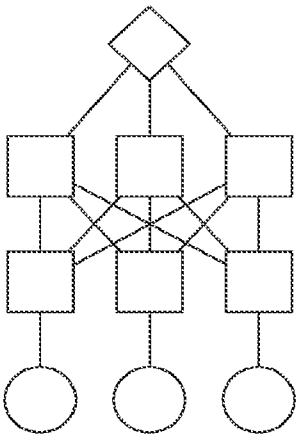


FIG. 102

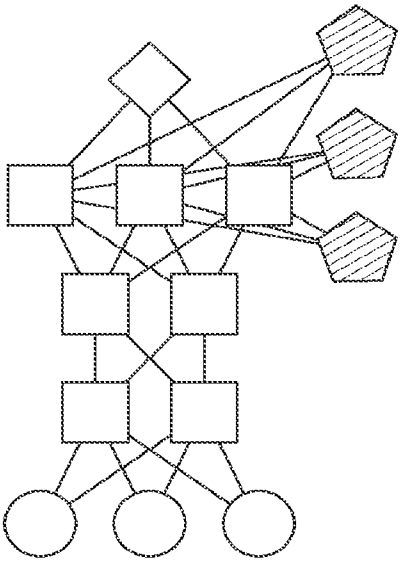


FIG. 103

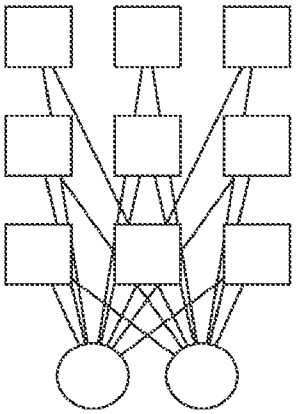


FIG. 101