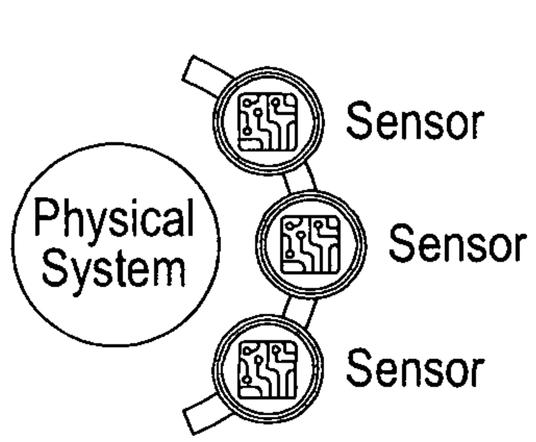

Sensor
Physical System
Sensor
Sensor

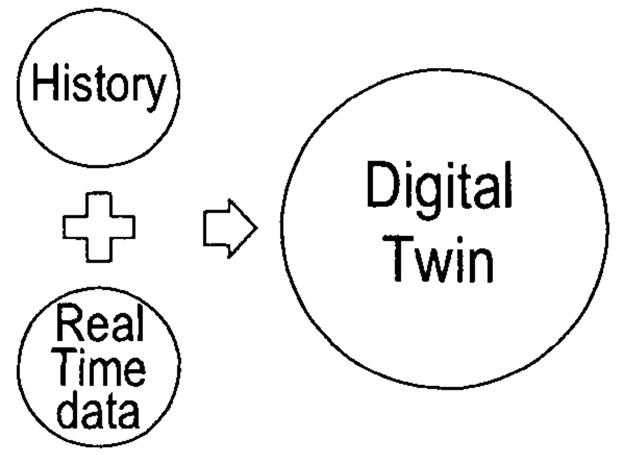

History
Real Time data
Digital Twin

Fig. 1

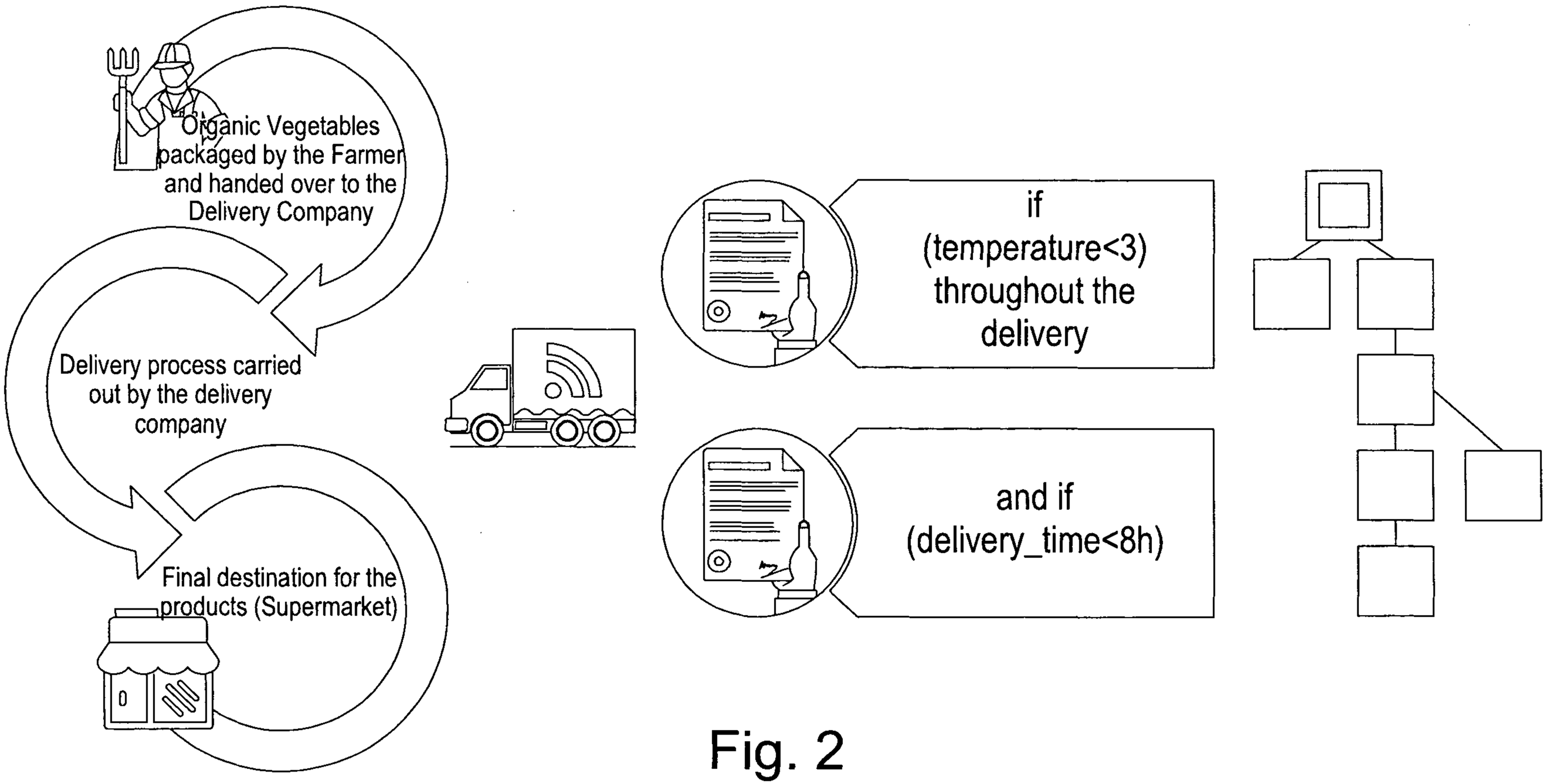

Organic Vegetables packaged by the Farmer and handed over to the Delivery Company
Delivery process carried out by the delivery company
Final destination for the products (Supermarket)
if (temperature<3) throughout the delivery
and if (delivery_time<8h)

Fig. 2

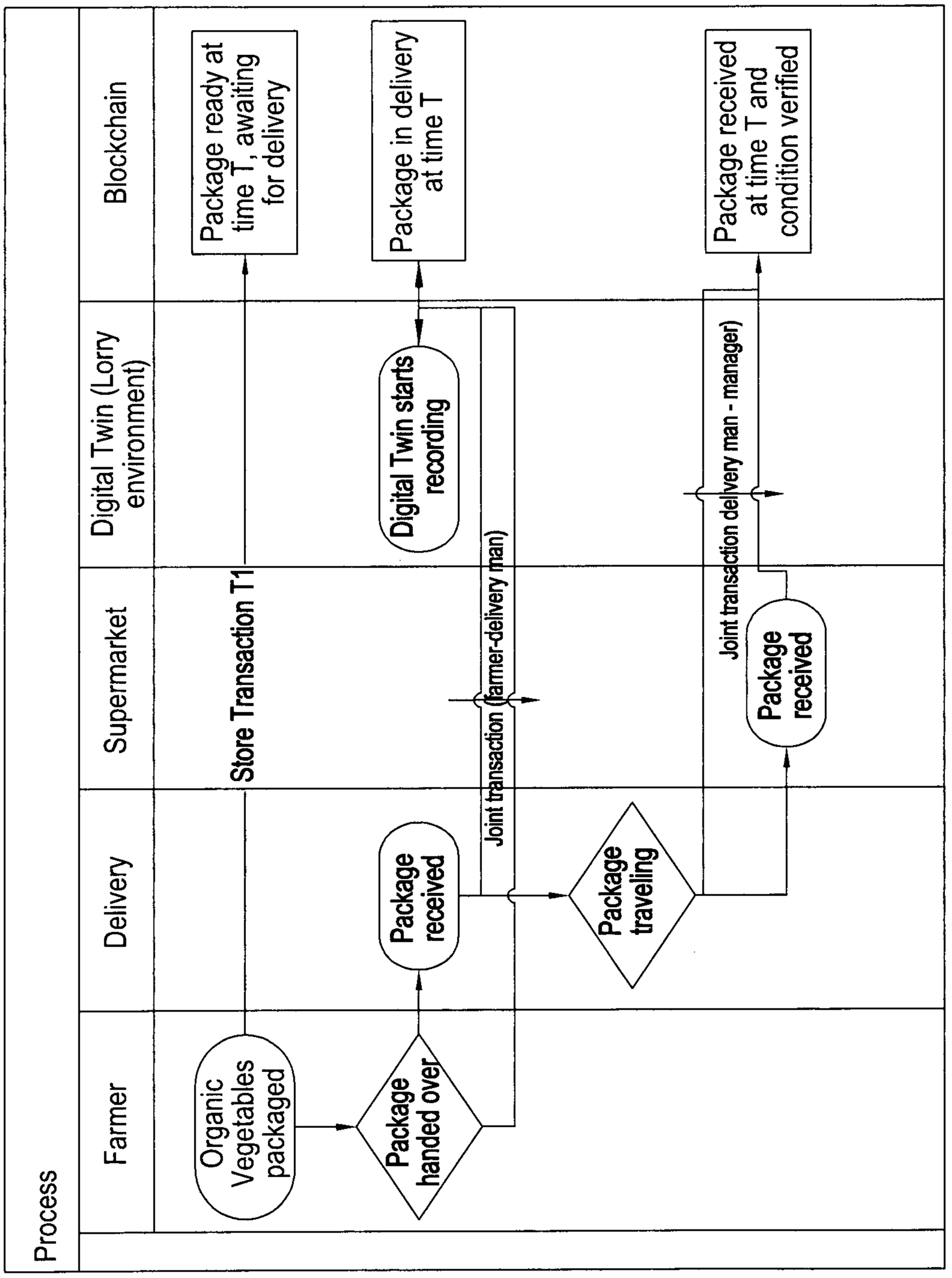

Process
Farmer
Delivery
Supermarket
Digital Twin (Lorry environment)
Blockchain
Organic Vegetables packaged
Package handed over
Package received
Package traveling
Package received
Store Transaction T1
Joint transaction (farmer-delivery man)
Digital Twin starts recording
Package ready at time T, awaiting for delivery
Package in delivery at time T
Joint transaction delivery man - manager)
Package received
Package received at time T and condition verified

Fig. 3

Fig. 4

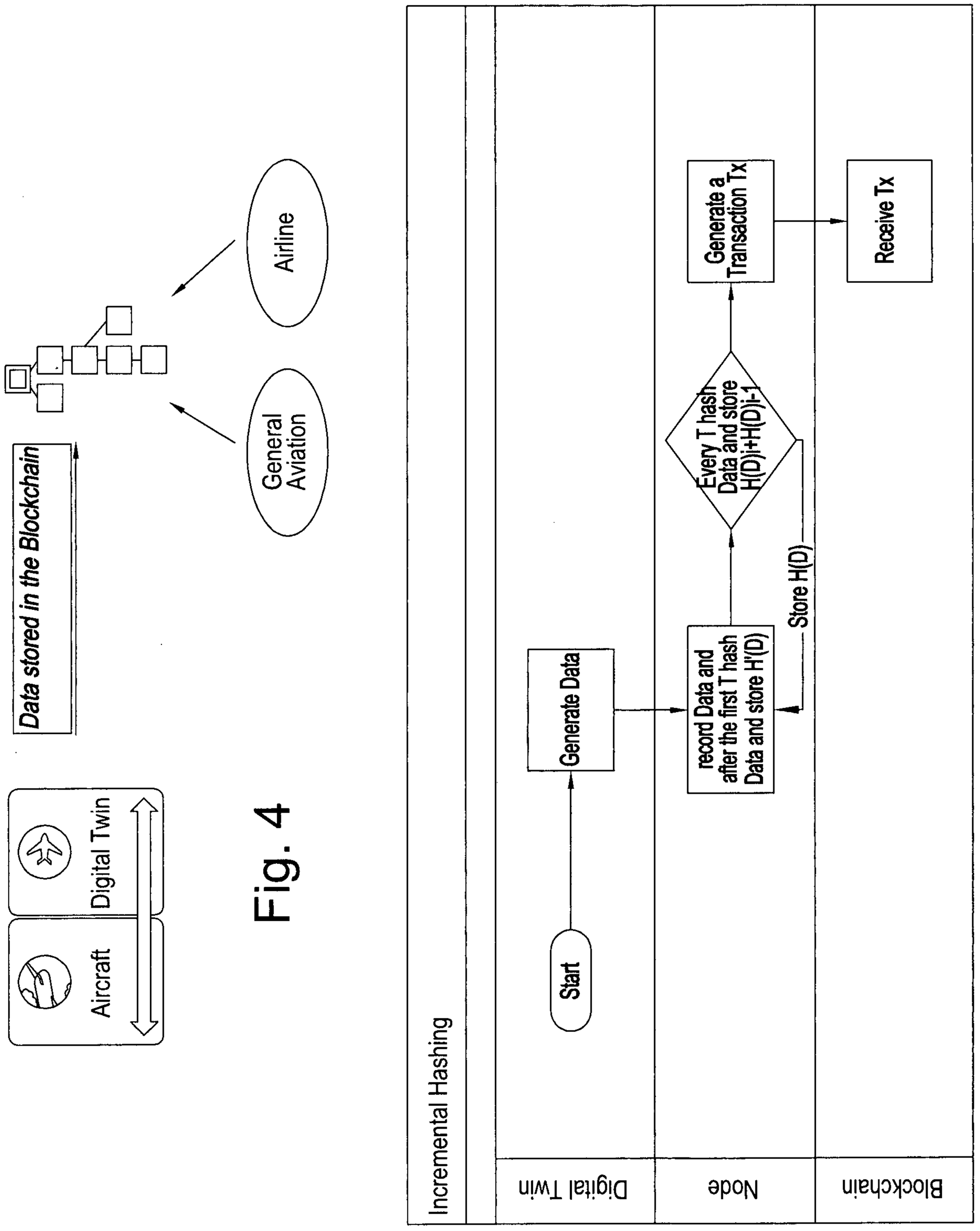

Incremental Hashing
Blockchain
Node
Digital Twin
Start
Generate Data
record Data and after the first T hash Data and store H'(D)
Store H(D)
Every T hash Data and store H(D)i+H(D)i-1
Generate a Transaction Tx
Receive Tx
Aircraft
Digital Twin
Data stored in the Blockchain
Airline
General Aviation

Fig. 5

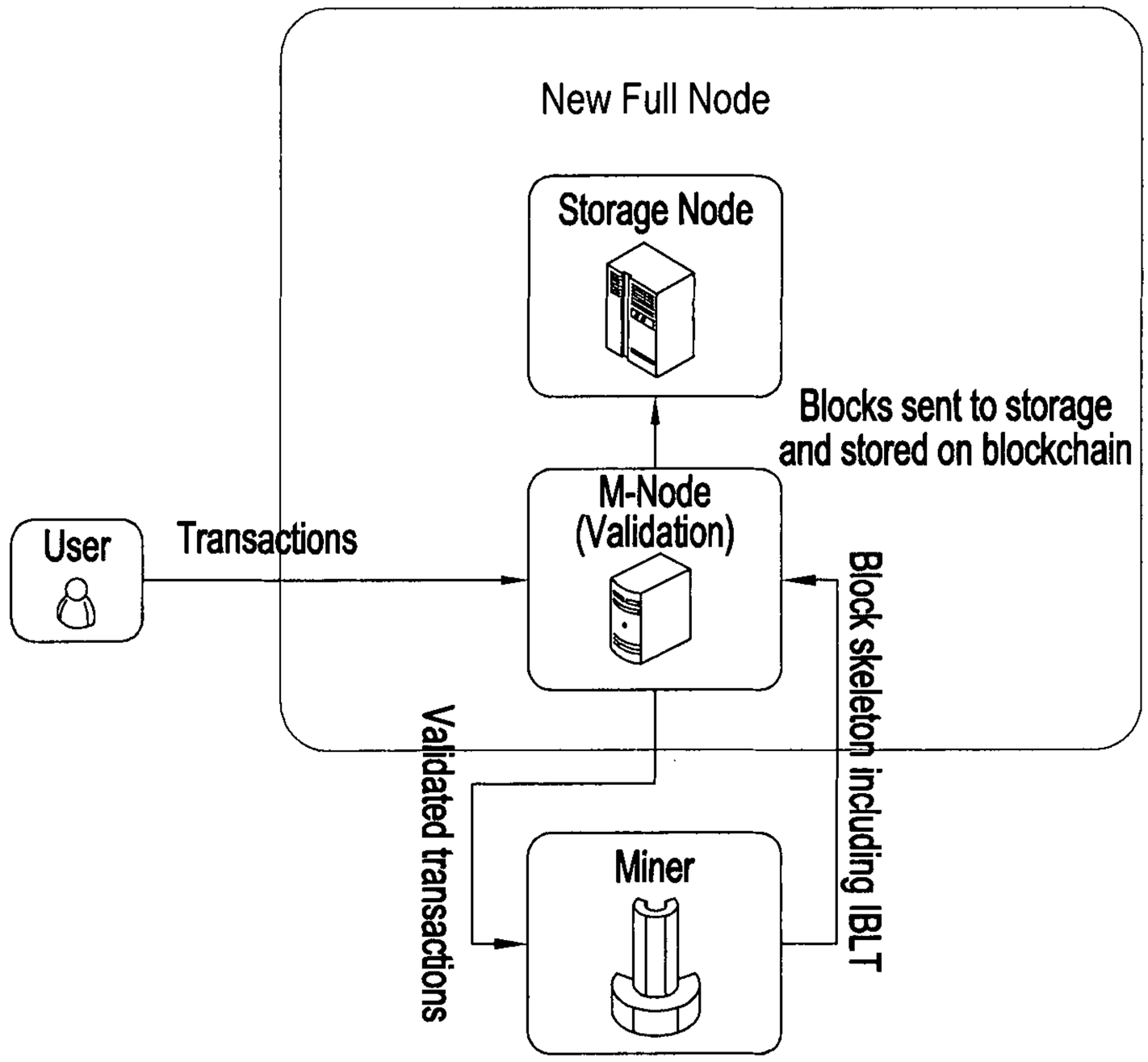

New Full Node
Storage Node
Blocks sent to storage and stored on blockchain
M-Node (Validation)
User
Transactions
Block skeleton including IBLT
Validated transactions
Miner

Fig. 6

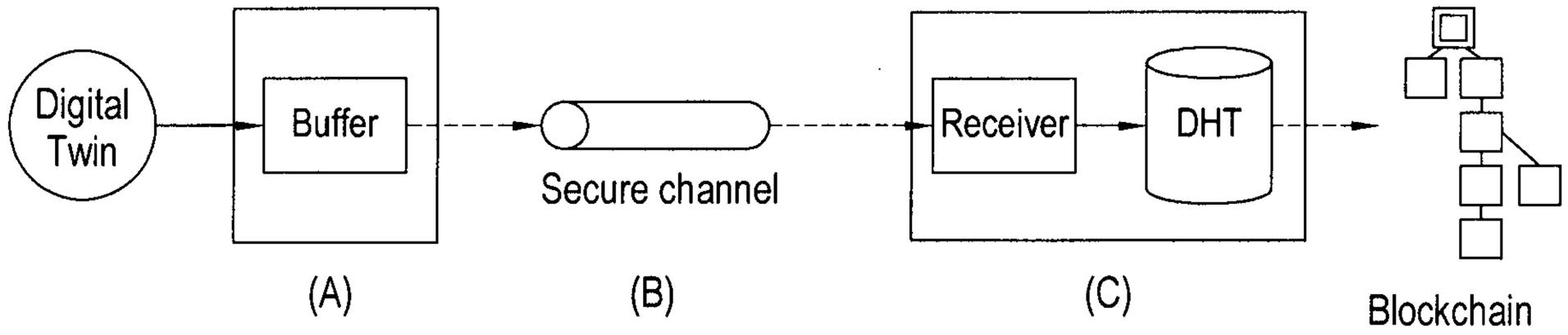

Digital Twin
Buffer
Secure channel
Receiver
DHT
Blockchain
(A)
(B)
(C)

Fig. 7

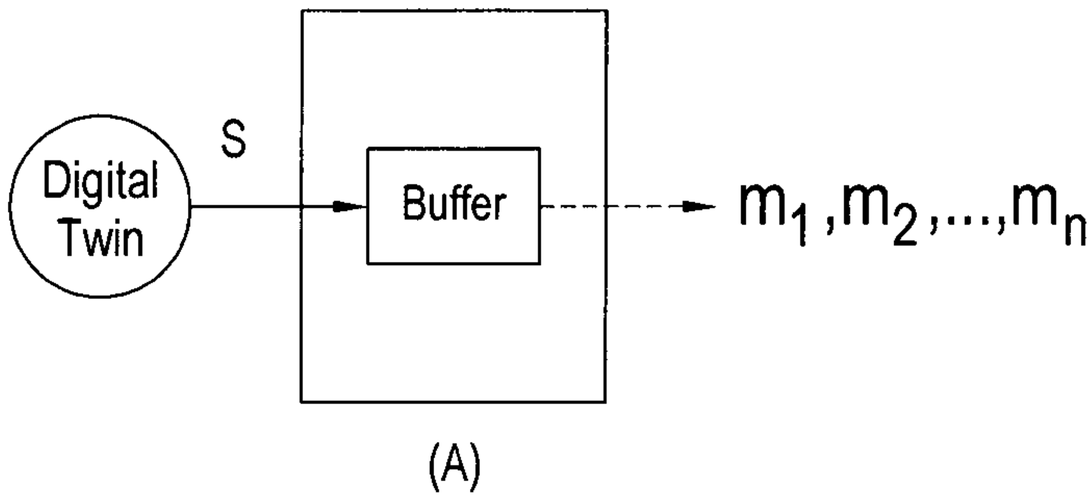

Digital Twin
S
Buffer
$m_1, m_2, \ldots, m_n$
(A)

Fig. 8

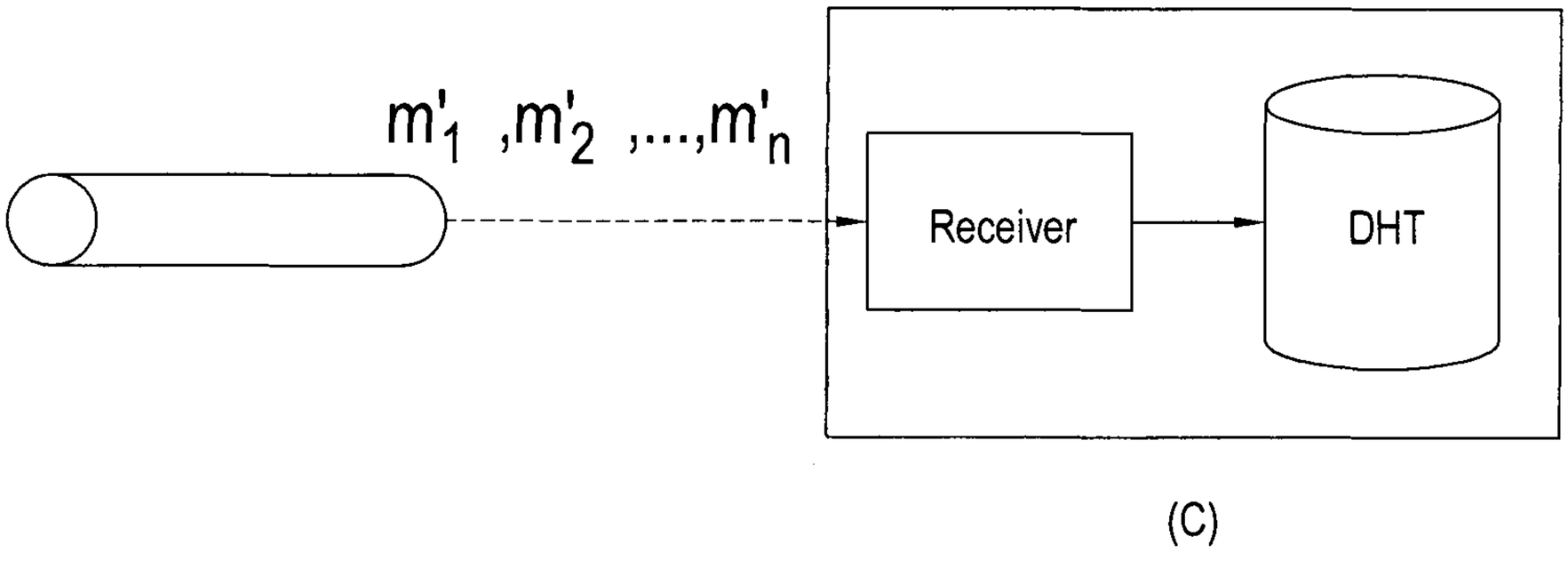

m'1 ,m'2 ,...,m'n
Receiver
DHT
(C)

Fig. 9

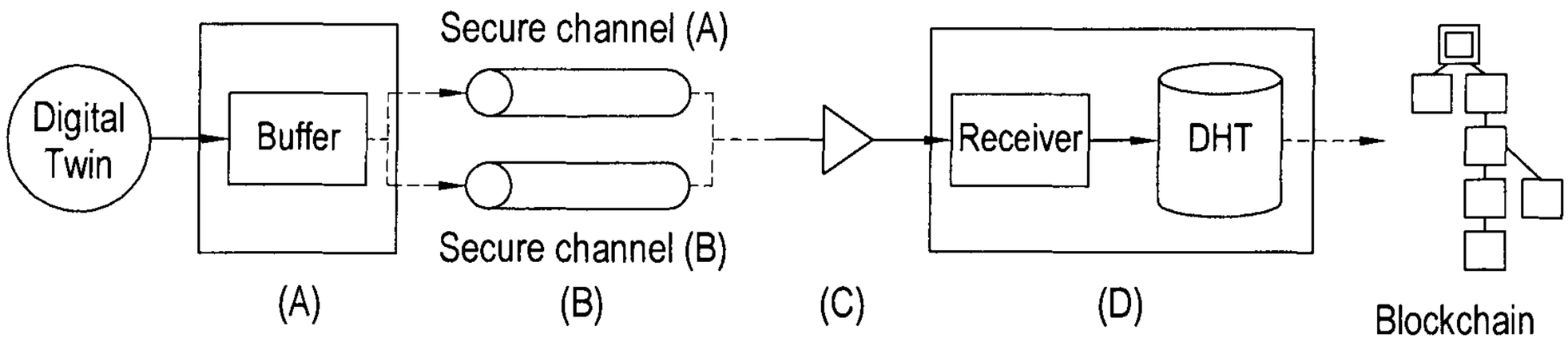

Digital Twin
Buffer
Secure channel (A)
Secure channel (B)
Receiver
DHT
Blockchain
(A)
(B)
(C)
(D)

Fig. 10

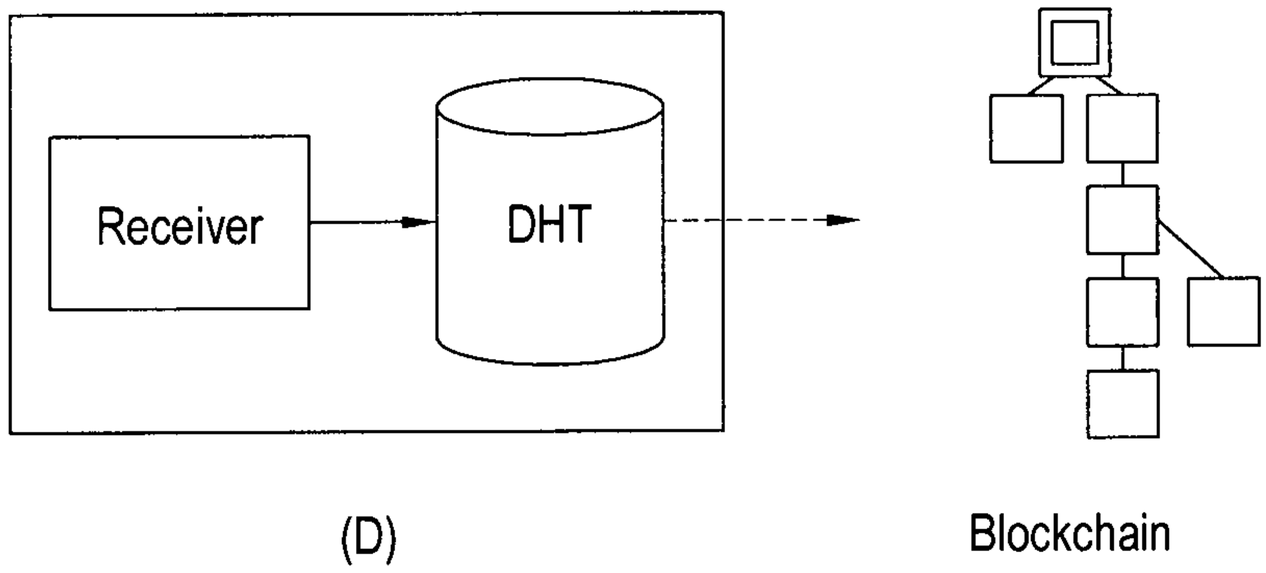

Receiver
DHT
(D)
Blockchain

Fig. 11

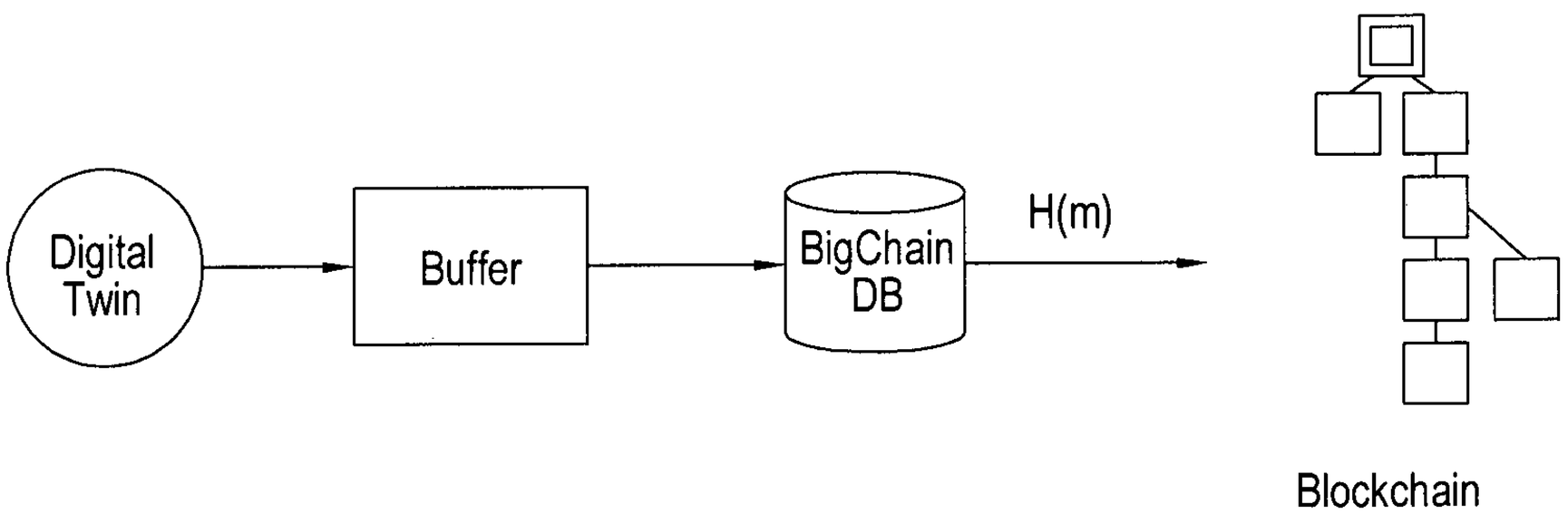

Digital Twin
Buffer
BigChain DB
H(m)
Blockchain

Fig. 12

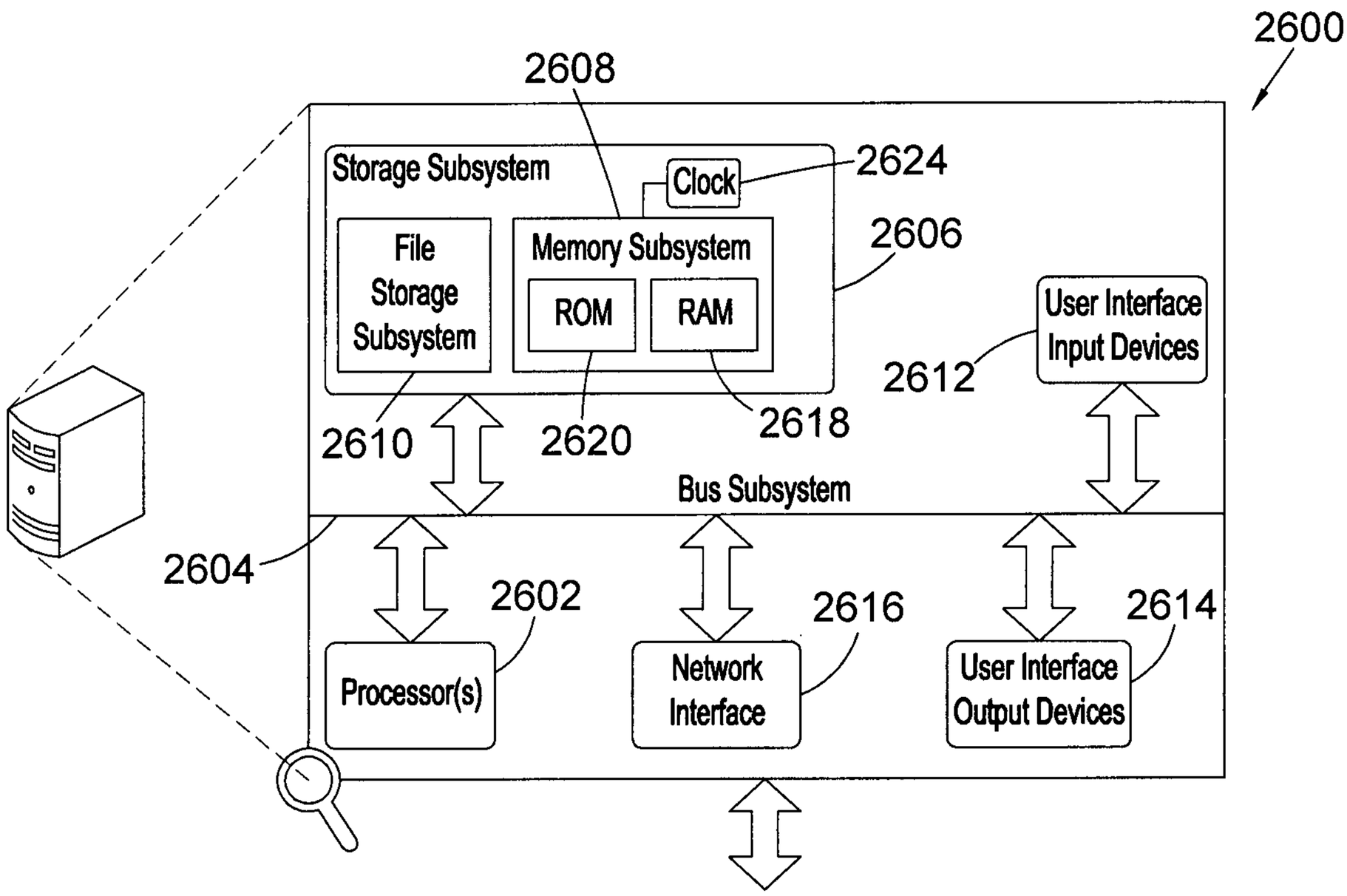

2600
2608
Storage Subsystem
Clock
2624
File Storage Subsystem
Memory Subsystem
ROM
RAM
2606
User Interface Input Devices
2612
2610
2620
2618
Bus Subsystem
2604
2602
2616
2614
Processor(s)
Network Interface
User Interface Output Devices

Fig. 13