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(12) **United States Patent**
Crabtree et al.

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(45) **Date of Patent: Sep. 22, 2020**

(54) **SYSTEM AND METHODS FOR SANDBOXED MALWARE ANALYSIS AND AUTOMATED PATCH DEVELOPMENT, DEPLOYMENT AND VALIDATION**

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(73) Assignee: **QOMPLX, INC.**, Tysons, VA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 209 days.

(21) Appl. No.: **15/887,496**

(22) Filed: **Feb. 2, 2018**

(65) **Prior Publication Data**

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Related U.S. Application Data

(63) Continuation-in-part of application No. 15/818,733, filed on Nov. 20, 2017, which is a

(Continued)

(51) **Int. Cl.**

G06F 21/53	(2013.01)
G06F 21/56	(2013.01)
G06F 21/57	(2013.01)
G06F 8/65	(2018.01)
G06F 9/455	(2018.01)
H04L 29/06	(2006.01)

(Continued)

(52) **U.S. Cl.**
CPC ***G06F 21/53*** (2013.01); ***G06F 8/65*** (2013.01); ***G06F 9/455*** (2013.01); ***G06F 21/566*** (2013.01); ***G06F 21/577*** (2013.01); ***G06Q 40/08*** (2013.01); ***H04L 63/1425*** (2013.01); ***H04L 63/1433*** (2013.01); *G06F 2221/033* (2013.01); *G06F 2221/2149* (2013.01); *G06N 20/00* (2019.01); *G06Q 50/01* (2013.01)

(58) **Field of Classification Search**
CPC . G06F 21/53; G06F 9/455; G06F 8/65; G06F 21/577; G06F 21/566; G06F 2221/2149; G06F 2221/033; G06F 11/3058; H04L 63/1433; H04L 63/1425; G06Q 40/08; G06Q 50/01; G06N 20/00
See application file for complete search history.

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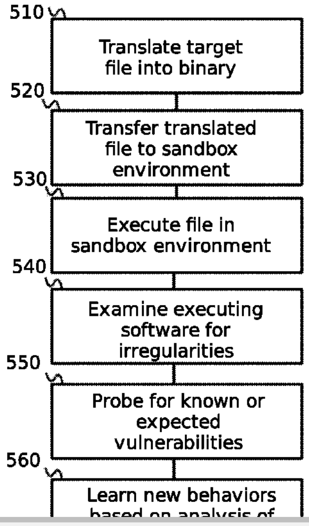
Primary Examiner — Cheng-Feng Huang
(74) *Attorney, Agent, or Firm* — Brian S. Boon; Brian R. Galvin; Galvin Patent Law LLC

(57) **ABSTRACT**

A system and methods for sandboxed malware analysis and automated patch development, deployment and validation, that uses a business operating system, vulnerability scoring engine, binary translation engine, sandbox simulation engine, at least one network endpoint, at least one database, a network, and a combination of machine learning and vulnerability probing techniques, to analyze software, locate any vulnerabilities or malicious behavior, and attempt to patch and prevent undesired behavior from occurring, autonomously.

2 Claims, 12 Drawing Sheets


510
Translate target file into binary
520
Transfer translated file to sandbox environment
530
Execute file in sandbox environment
540
Examine executing software for irregularities
550
Probe for known or expected vulnerabilities
560
Learn new behaviors based on analysis of

Related U.S. Application Data

continuation-in-part of application No. 15/725,274, filed on Oct. 4, 2017, now Pat. No. 10,609,079, which is a continuation-in-part of application No. 15/655,113, filed on Jul. 20, 2017, which is a continuation-in-part of application No. 15/616,427, filed on Jun. 7, 2017, and a continuation-in-part of application No. 15/237,625, filed on Aug. 15, 2016, now Pat. No. 10,248,910, which is a continuation-in-part of application No. 15/206,195, filed on Jul. 8, 2016, which is a continuation-in-part of application No. 15/186,453, filed on Jun. 18, 2016, which is a continuation-in-part of application No. 15/166,158, filed on May 26, 2016, which is a continuation-in-part of application No. 15/141,752, filed on Apr. 28, 2016, which is a continuation-in-part of application No. 15/091,563, filed on Apr. 5, 2016, now Pat. No. 10,204,147, and a continuation-in-part of application No. 14/986,536, filed on Dec. 31, 2015, now Pat. No. 10,210,255, and a continuation-in-part of application No. 14/925,974, filed on Oct. 28, 2015, application No. 15/887,496, which is a continuation-in-part of application No. 15/823,285, filed on Nov. 27, 2017, which is a continuation-in-part of application No. 15/788,718, filed on Oct. 19, 2017, which is a continuation-in-part of application No. 15/788,002, filed on Oct. 19, 2017, which is a continuation-in-part of application No. 15/787,601, filed on Oct. 18, 2017, which is a continuation-in-part of application No. 15/616,427, filed on Jun. 7, 2017, which is a continuation-in-part of application No. 14/925,974, filed on Oct. 28, 2015.

(60) Provisional application No. 62/568,307, filed on Oct. 4, 2017, provisional application No. 62/568,305, filed on Oct. 4, 2017, provisional application No. 62/568,312, filed on Oct. 4, 2017.

(51) **Int. Cl.**

G06Q 40/08	(2012.01)
G06N 20/00	(2019.01)
G06Q 50/00	(2012.01)

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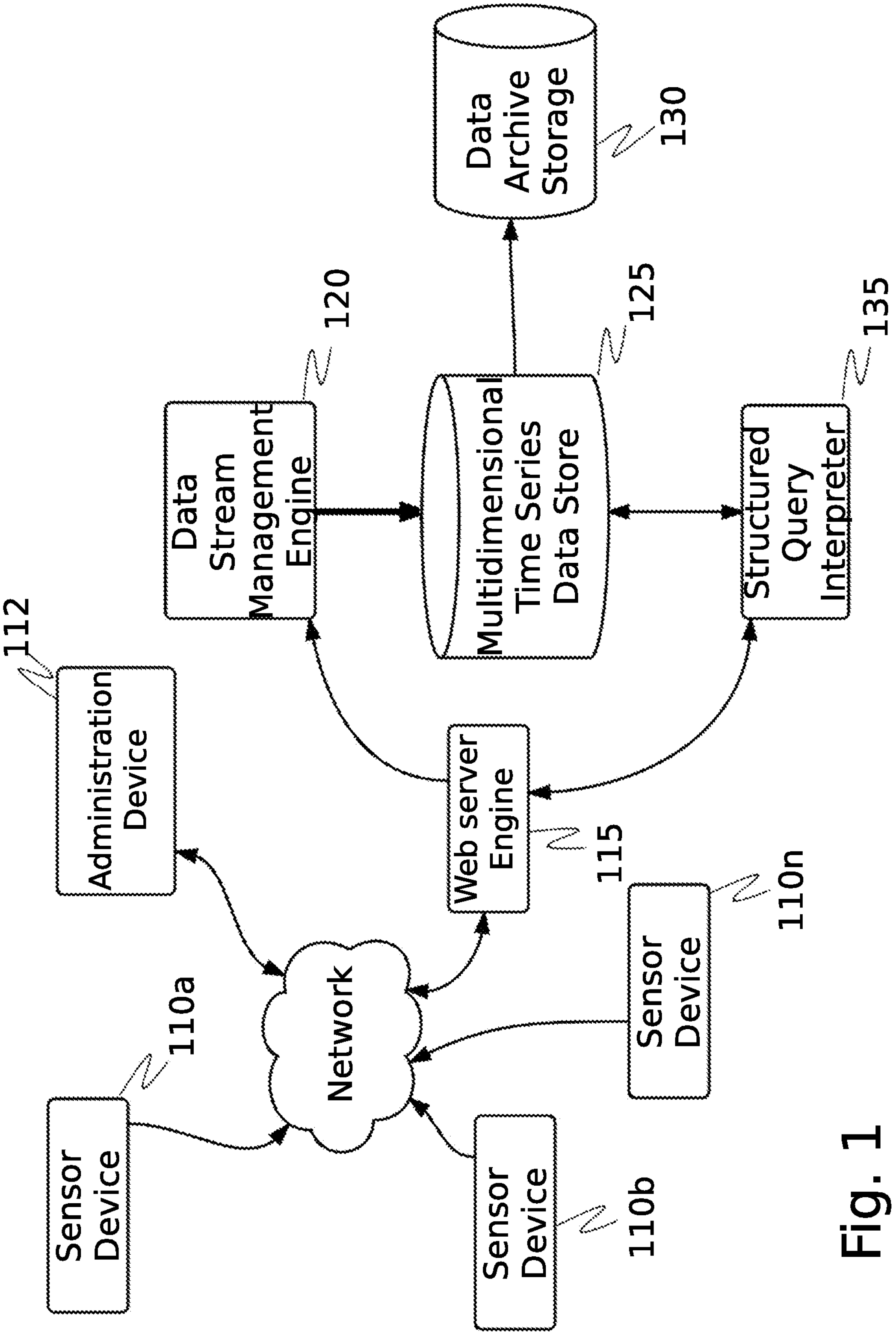
Data Archive Storage
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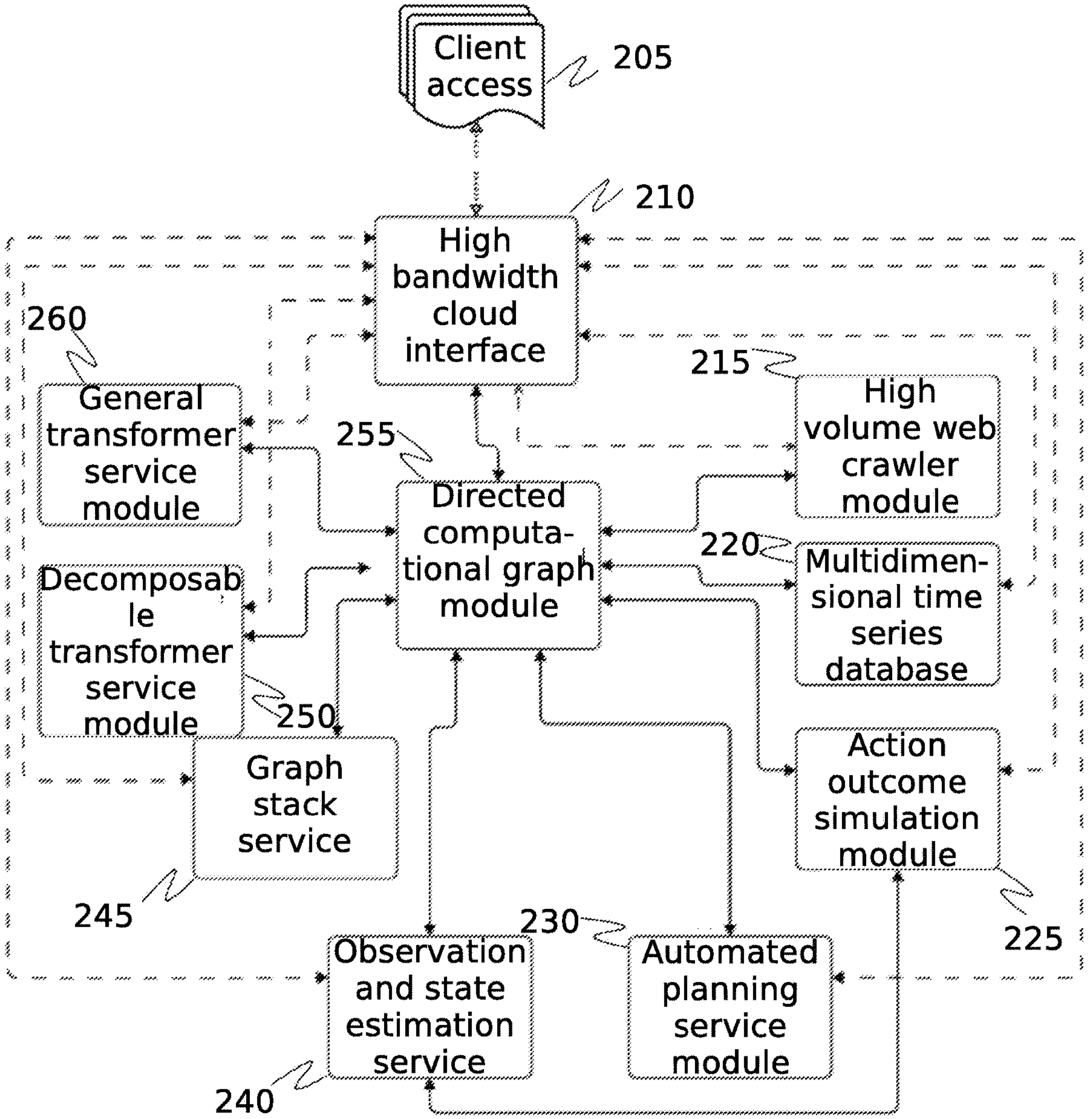
Data Stream Management Engine
120
Multidimensional Time Series Data Store
125
Structured Query Interpreter
135
Administration Device
112
Web server Engine
115
Network
Sensor Device
110a
Sensor Device
110b
Sensor Device
110n

Fig. 1


Client access
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210
High bandwidth cloud interface
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General transformer service module
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High volume web crawler module
Directed computa-tional graph module
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Multidimen-sional time series database
Decomposab le transformer service module
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Graph stack service
Action outcome simulation module
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230
225
Observation and state estimation service
Automated planning service module
240

Fig. 2

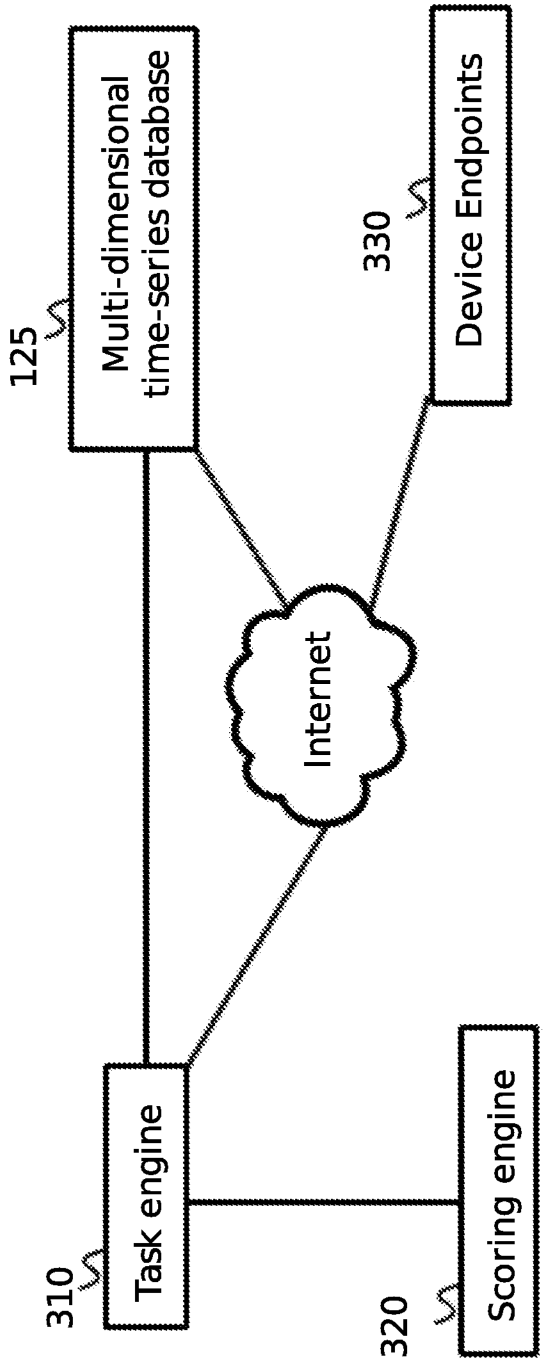
125
Multi-dimensional time-series database
330
Device Endpoints
Internet
310
Task engine
320
Scoring engine

Fig. 3

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