

Systems and Methods for Artificial Intelligence Use of Intelligent Signaling Network Data

Leo A. Wrobel, Inventor

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Title of Invention

Systems and Methods for Artificial Intelligence Use of Intelligent Signaling Network Data

Application Information

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CUSTOMER #		FILING DATE	-
CORRESPONDENCE ADDRESS	Leo Wrobel 100 Ovilla Oaks Dr. Suite 200 Ovilla, TX 75154 US	FIRST NAMED INVENTOR	Leo Anthony Wrobel

FIELD OF THE INVENTION

The disclosure relates to intelligent signaling networks and artificial intelligence. It concerns systems and methods in which data generated by communications signaling is supplied as an information source to AI and correlated with information outside the signaling network. The resulting Synthetic Data may explain, measure, classify, locate, predict, or otherwise characterize phenomena external to the signaling function.

BACKGROUND OF THE INVENTION

Communications networks generate signaling data when communications are attempted, routed, managed, completed, redirected, or fail. Historically, that data has been used primarily for internal telecommunications functions such as routing, billing, maintenance, security, fraud detection, troubleshooting, and network management.

The inventor previously disclosed related uses of intelligent signaling message data in U.S. Patent Nos. 10,812,663 and 11,582,352. Those patents describe acquisition and analysis of signaling information, external data, data fusion, artificial intelligence processing, Synthetic Data, and the identification of unsuccessful emergency callers. The present disclosure builds on that technological foundation and generalizes it.

The earlier patents demonstrate that signaling observations can have evidentiary value beyond their original network control purpose. The present disclosure extends that principle so signaling observations can become a general machine readable intelligence source for AI, including where semantic communication content is not acquired or analyzed.

BRIEF SUMMARY OF THE INVENTION

The invention can be understood as a three part architecture. First, intelligent signaling network data supplies granular observations concerning communications activity. Second, AI combines, correlates, fuses, compares, or otherwise evaluates those observations with information external to the intelligent signaling network. Third, AI generates Synthetic Data describing something external to the signaling function.

The signaling network supplies one source of observations. External information supplies another. AI performs the correlation and produces information that is not native to the signaling network. The output is therefore not limited to routing, billing, security, maintenance, authentication, fraud detection, or other conventional carrier purposes.

FIG. 3 gives the examiner a single page view of this architecture before particular embodiments are developed.

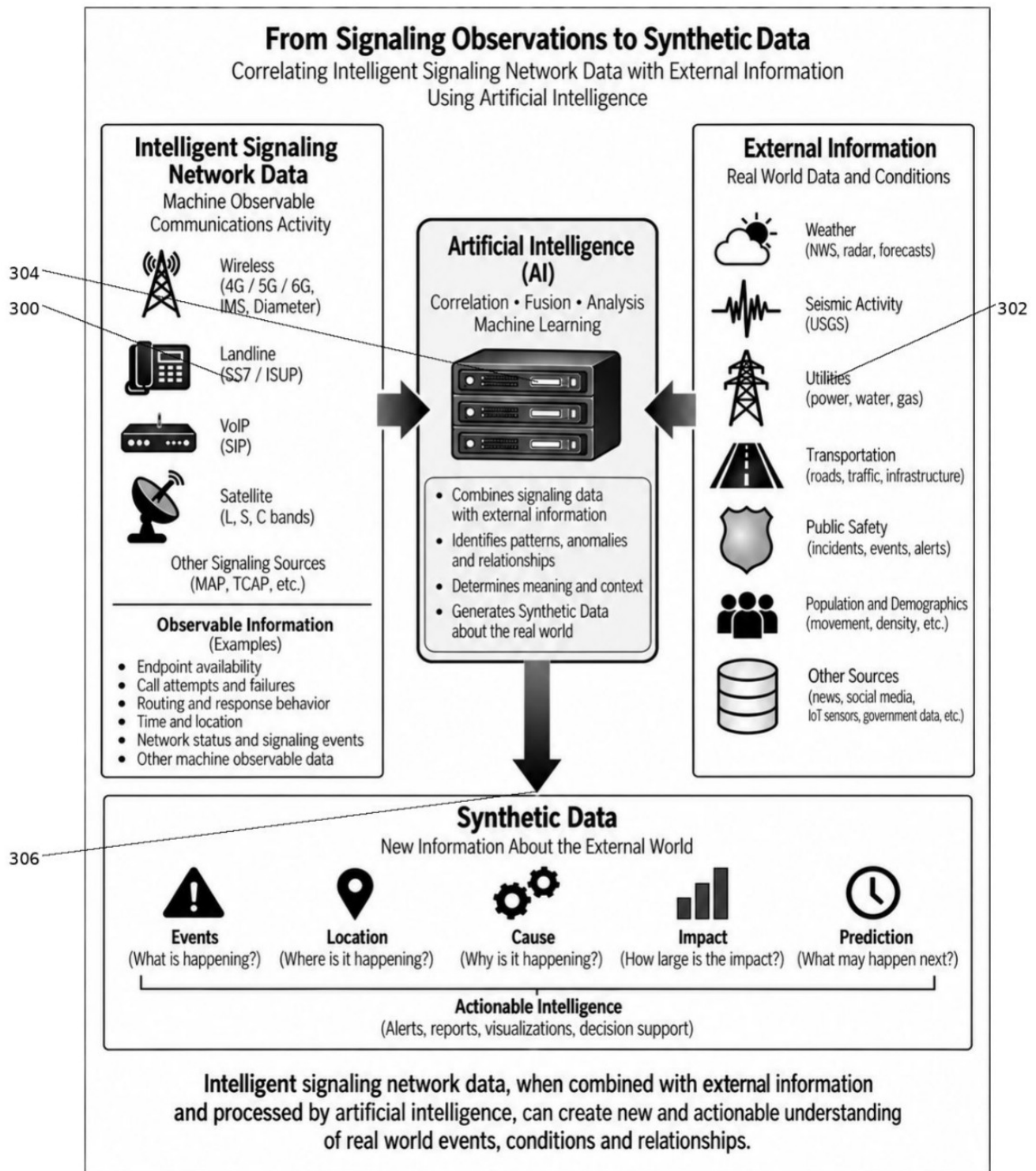


FIG. 3

The distinction is not merely the presence of AI. Conventional systems may use analytics or AI for network security, anomaly detection, fraud, authentication, routing, congestion management, billing, revenue assurance, troubleshooting, or quality management. Those systems use signaling data to learn something about the network, call, caller, device, facility, authenticity, risk, or communications transaction.

The present architecture uses signaling observations together with external information to determine something beyond the signaling function. The object of intelligence may be an external event, physical condition, relationship, behavior, activity, public concern, economic condition, geography, infrastructure condition, emergency, prediction, or other external phenomenon.

This distinction is consistent with the statutory treatment of methods. 35 U.S.C. § 100(b) defines a process to include a new use of a known process, machine, manufacture, composition of matter, or material, subject to the other conditions for patentability. Under 35 U.S.C. § 103, obviousness is assessed on the claimed invention as a whole. USPTO guidance likewise cautions against reducing a claimed combination to only its gist or data source. See MPEP § 2141.02 (citing *Stratoflex, Inc. v. Aeroquip Corp.*, 713 F.2d 1530 (Fed. Cir. 1983), and *W.L. Gore & Assocs., Inc. v. Garlock, Inc.*, 721 F.2d 1540 (Fed. Cir. 1983)).

FIG. 4 makes this boundary explicit.

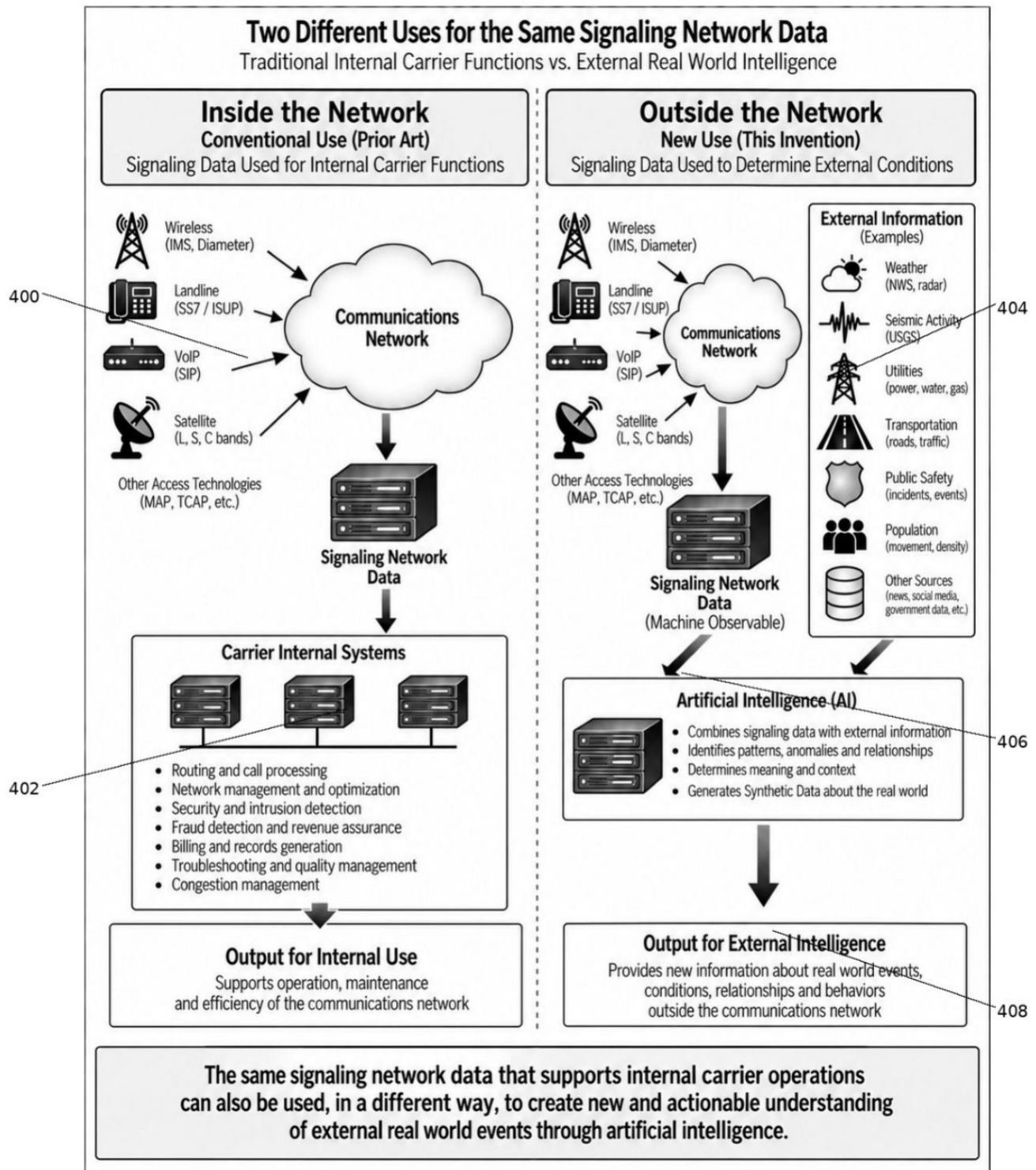


FIG. 4

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 illustrates a prior technological foundation including a common channel signaling interface, data analyzer, data fuser, external data source, artificial intelligence processor, and user interface.

FIG. 2 illustrates a prior process for selecting subscribers in a geographic area, obtaining signaling message data and external data, producing Synthetic Data, generating an alert, and displaying the alert.

FIG. 3 illustrates signaling observations 300 and external information 302 supplied to an AI correlation system 304 to generate Synthetic Data 306.

FIG. 4 illustrates signaling network data 400 used for conventional carrier functions 402 and, separately, external information 404 supplied with signaling data to AI 406 to produce external intelligence 408.

FIG. 5 illustrates communications networks 500, granular signaling observations 502, data processing 504, a conventional CDR 506, and an Event Record 508.

FIG. 6 illustrates passive observation 600, active observation 602, iterative observation 604, and resulting signaling observations 606.

FIG. 7 illustrates an AI or control system 700, signaling inquiries 702, a communications network 704, and collected signaling observations 706.

FIG. 8 illustrates signaling observations 800, an AI analytics engine 802, geographic anomaly detection 804, external data correlation 806, and enhanced understanding 808.

FIG. 9 illustrates external information 900, AI correlation 902, Synthetic Data generation 904, and a severe weather example 906.

FIG. 10 illustrates target selection 1000, sampling sweeps 1002, response analysis 1004, geographic results 1006, and a dynamic AI decision process 1008.

FIG. 11 illustrates an emergency communication origin 1100, service provider network 1102, ESInet 1104, emergency communications center 1106, and emergency response 1108.

FIG. 12 illustrates an emergency communication origin 1200, originating network 1202, interconnection or transit network 1204, an upstream failure condition 1206, and an emergency communications center 1208.

FIG. 13 illustrates originating networks 1300, signaling observations 1302, a detection engine 1304, an emergency communications center 1306, AI correlation 1308, and actionable intelligence 1310.

FIG. 14 illustrates emergency call attempts 1400, signaling networks 1402, a detection engine 1404, operational alerts 1406, AI analysis 1408, and external information 1410.

FIG. 15 illustrates signaling observations 1500, external information 1502, an AI discovery engine 1504, an unknown pattern 1506, an identified external phenomenon 1508, and actionable intelligence 1510.

FIG. 16 illustrates signaling observations 1600, external information 1602, primary AI analysis 1604, Synthetic Data 1606, a secondary AI or authorized agent 1608, real world action 1610, and iterative refinement 1612.

FIG. 17 illustrates signaling network information 1700, external information 1702, collection and correlation processing 1704, determination of a potentially reportable condition 1706, regulatory notice preparation and routing 1708, regulatory recipients 1710, and an operational user interface 1712.

FIG. 18 illustrates conventional signaling uses 1800, conventional network directed outputs 1802, signaling and external information 1804, AI correlation and Synthetic Data generation 1806, external world uses 1808, and the resulting distinction in technological purpose and information product 1810.

FIG. 19 illustrates machine observable signaling sources 1900, AI correlation 1902, representative real world applications 1904, and actionable intelligence 1906.

DETAILED DESCRIPTION OF THE INVENTION

FIG. 1 reproduces a representative architecture from the inventor's earlier work. Data analyzer system 150 includes common channel signal interface 152, data analyzer 154, data fuser 214 with artificial intelligence processor 216, external data 212, and user interface 156. FIG. 2 illustrates a related process in which subscribers are selected 304, signaling message data is obtained 306, external data is obtained 308, the information is fused to produce Synthetic Data 310, an alert is produced 312, and the alert is displayed 314. These figures provide technological context for the generalized architecture disclosed herein.

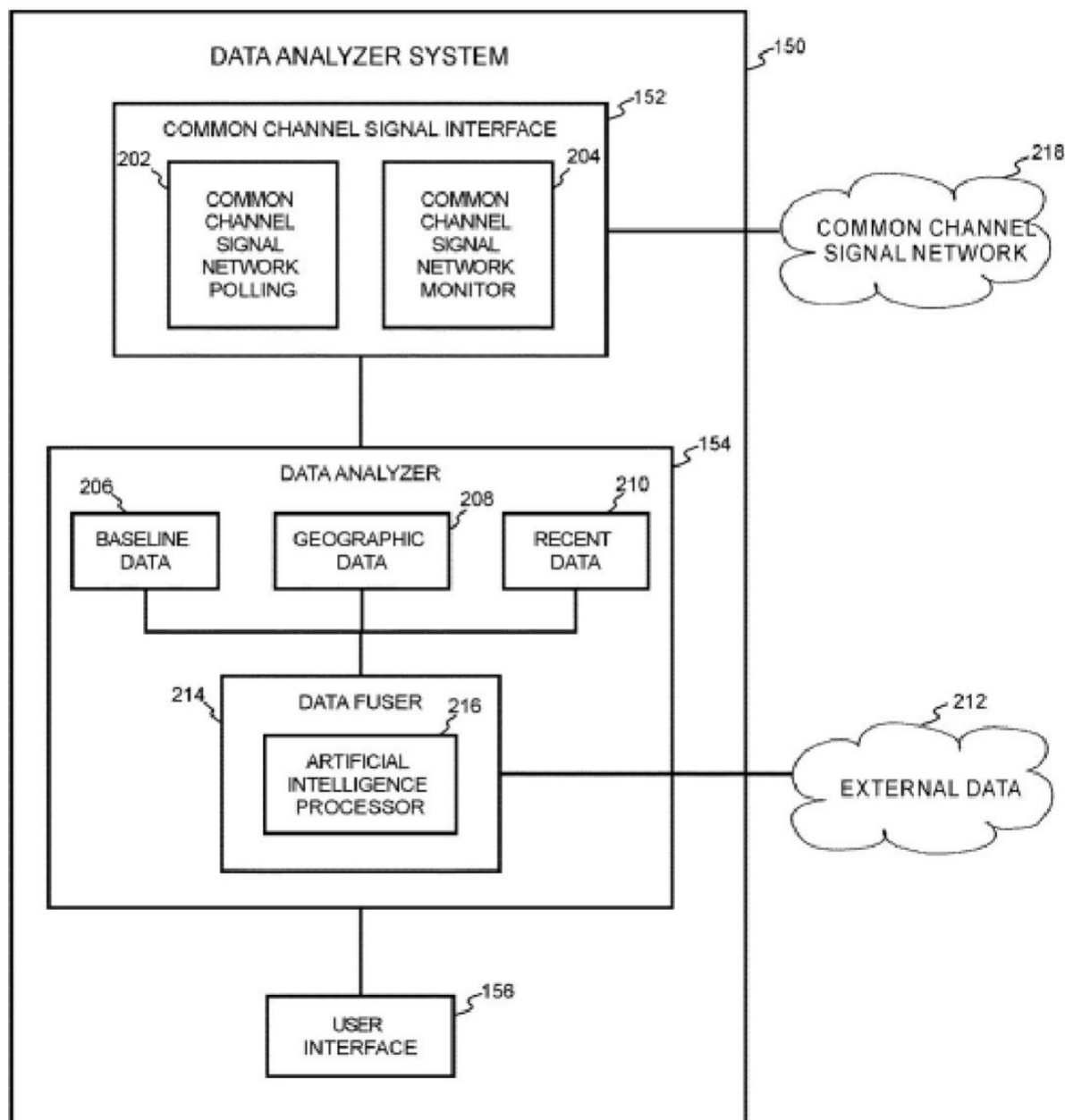


FIG. 1

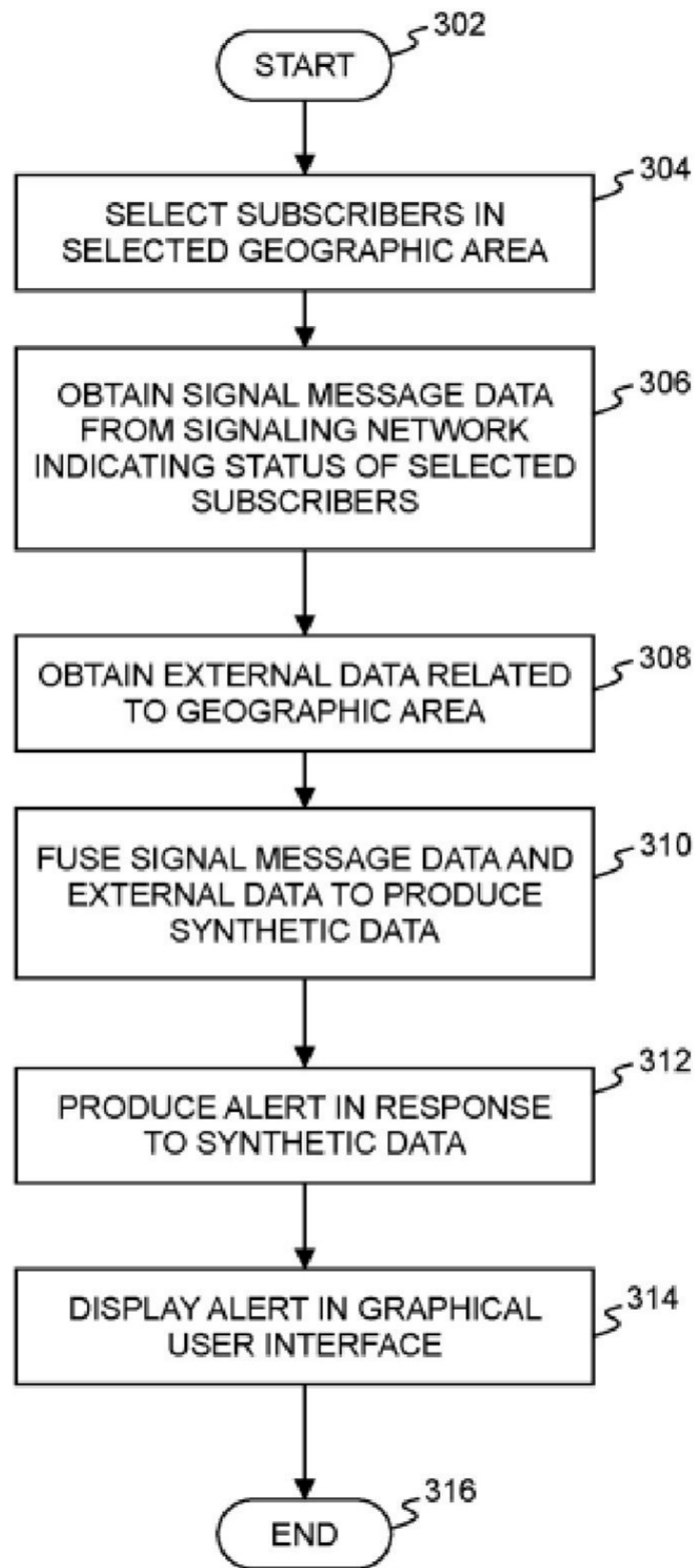


FIG. 2

SIGNALING OBSERVATIONS, DOWNSTREAM RECORDS, AND EVENT RECORDS

As shown in FIG. 5, communications networks 500 generate granular signaling observations 502. Processing 504 may assemble selected observations into a conventional CDR 506 or into a purpose specific Event Record 508 for AI processing and external correlation.

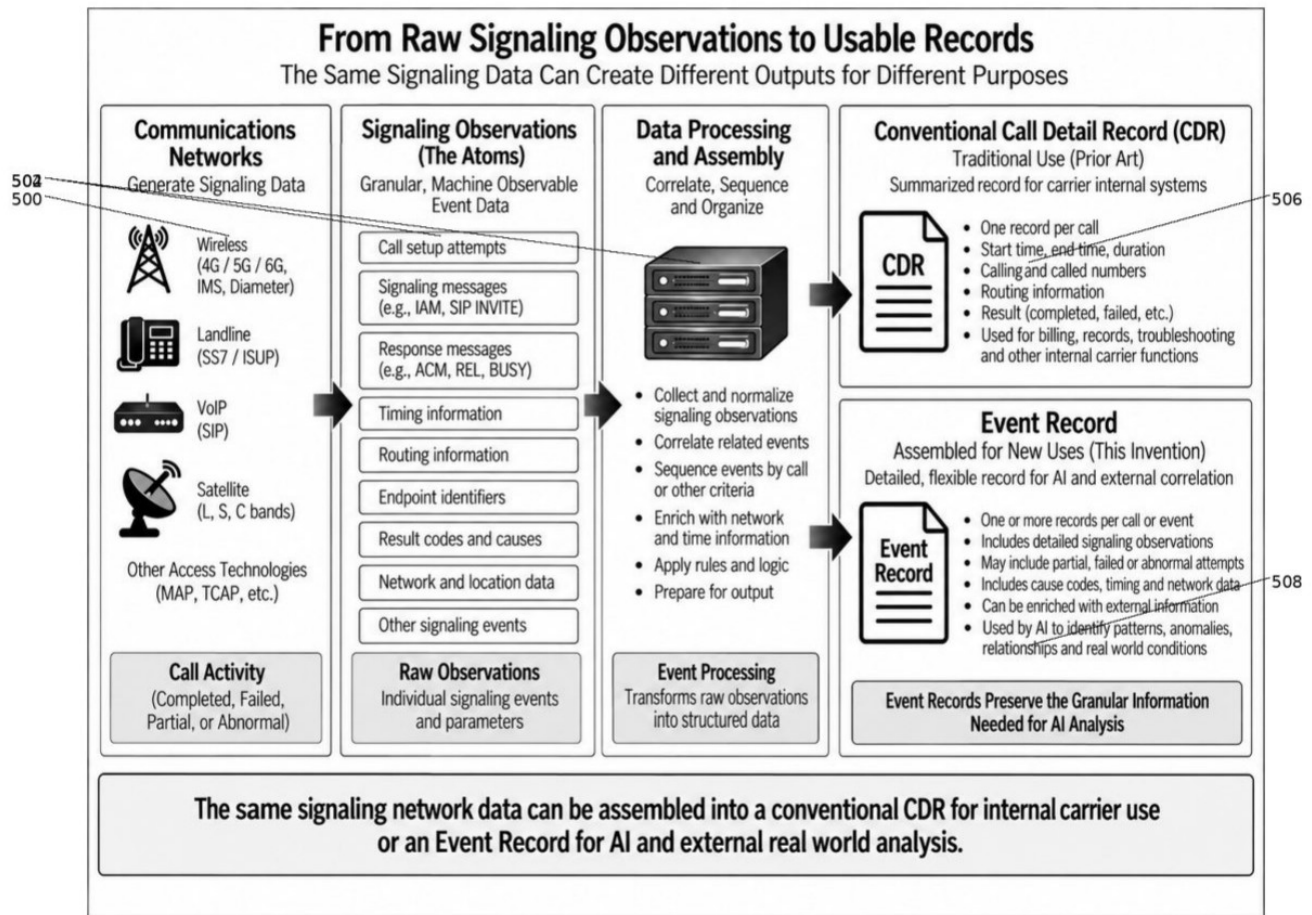


FIG. 5

Intelligent signaling messages and fields are granular observations generated during communications activity. They may include endpoint and network identifiers, routing information, timestamps, point codes, cause or result information, location related information, response characteristics, and other machine observable attributes.

A conventional Call Detail Record, or CDR, is one downstream record assembled from selected signaling observations for a particular telecommunications purpose. A CDR is useful, but it is not the signaling source itself and need not preserve every observation useful for another purpose.

The same signaling observations can be assembled differently. An Event Record is a purpose specific machine readable representation assembled from selected signaling observations for analysis, external correlation, AI processing, or another authorized use. It may preserve observations that a conventional CDR omits, summarize observations differently, or associate multiple signaling events according to time, geography, endpoint, condition, or another criterion.

Signaling observations are the atoms. A conventional CDR is one molecule assembled for a traditional purpose. An Event Record is another molecule assembled from the same signaling universe for a different purpose. Neither label limits the invention to a particular record format.

The asserted distinction is therefore not a new label for an old record or the discovery of an unrecognized property of an otherwise identical prior art process. The disclosed methodology permits different selection, assembly, preprocessing, external correlation, AI analysis, and resulting information products. Cf. MPEP § 2112.01(II), explaining that a newly recognized property or result of an otherwise old use does not alone establish a patentable process, while a new and nonobvious use may be patentable.

METHODS OF OBTAINING SIGNALING OBSERVATIONS

FIG. 6 illustrates passive observation 600, active observation 602, and iterative observation 604 as complementary acquisition modes that produce signaling observations 606.

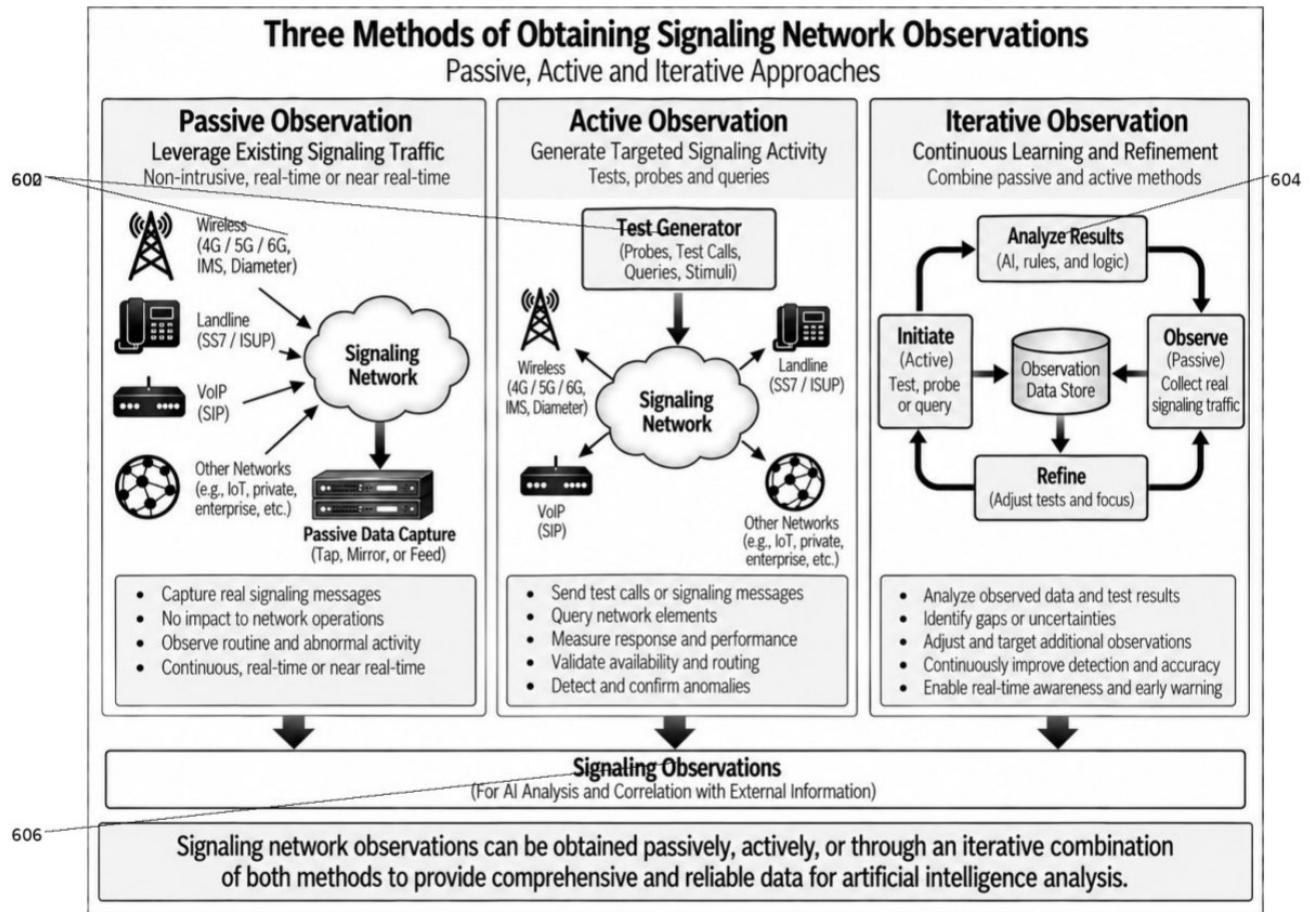


FIG. 6

Signaling observations may be obtained passively, actively, or iteratively. Passive observation uses signaling activity arising during ordinary communications activity. Active observation intentionally initiates authorized signaling inquiries, probes, polls, tests, sweeps, or other transactions to obtain machine observable responses or response characteristics. Iterative observation combines these approaches so an initial result can cause AI or another authorized system to request additional observations and refine the inquiry.

These categories describe methods of obtaining observations, not limitations on network architecture. An implementation may use SS7, ISUP, TCAP, MAP, SIP, Diameter, IMS, LTE, 4G, 5G, 6G, VoIP, landline, wireless, cable telephony, or another present or future signaling architecture.

ACTIVE OBSERVATION, SWEEPS, AND SAMPLING

In FIG. 7, AI or control system 700 determines the scope of signaling inquiries 702. Communications network 704 processes the inquiries and returns machine observable responses that become collected signaling observations 706.

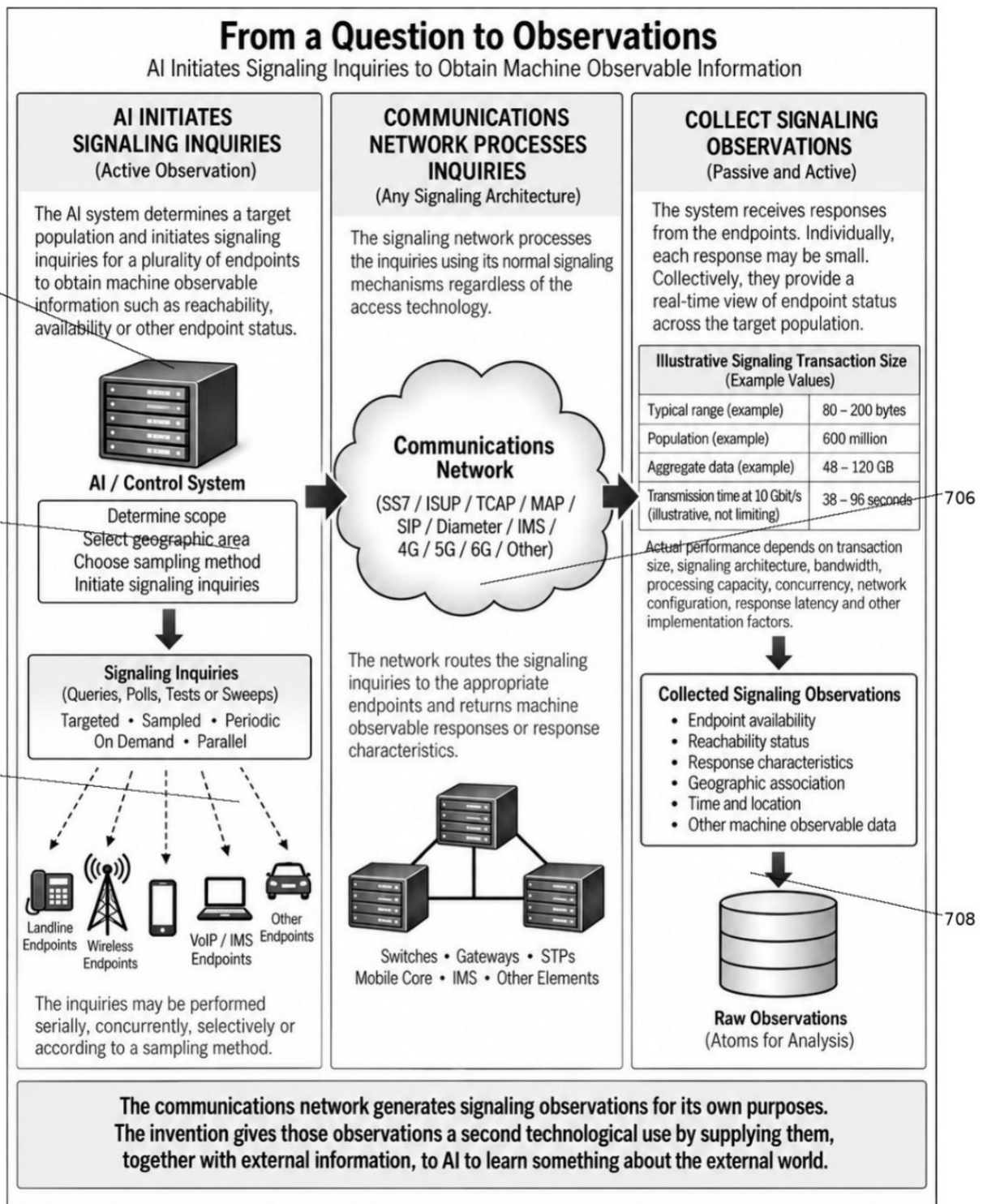


FIG. 7

In an active observation embodiment, AI or an authorized control system determines a target population and initiates signaling inquiries to obtain machine observable information such as reachability, availability, response characteristics, routing behavior, or other endpoint or network status. The inquiries may be targeted, sampled, periodic, on demand, serial, concurrent, parallel, geographically bounded, or otherwise selected according to the purpose of the inquiry.

The network processes the inquiries through its signaling mechanisms and returns machine observable responses or response characteristics. Individual transactions may be small, while a large population of responses can collectively provide a broad view of network or endpoint conditions. Actual throughput and completion time depend on transaction size, signaling architecture, bandwidth, processing capacity, concurrency, network configuration, response latency, policy, and implementation choices.

The invention does not require querying every endpoint. AI may select a representative sample from a central office area, wireless service area, MTSO related population, geographic region, carrier population, or other grouping. If the sample provides sufficient confidence, AI may classify the area without querying the remaining population. If confidence is insufficient or conditions change, AI may increase the sample or initiate another sweep.

GEOGRAPHIC ANALYSIS AND ANOMALY DETECTION

FIG. 8 illustrates signaling observations 800 supplied to AI analytics engine 802. Geographic anomaly 804 may be correlated with external information 806 to produce enhanced understanding 808.

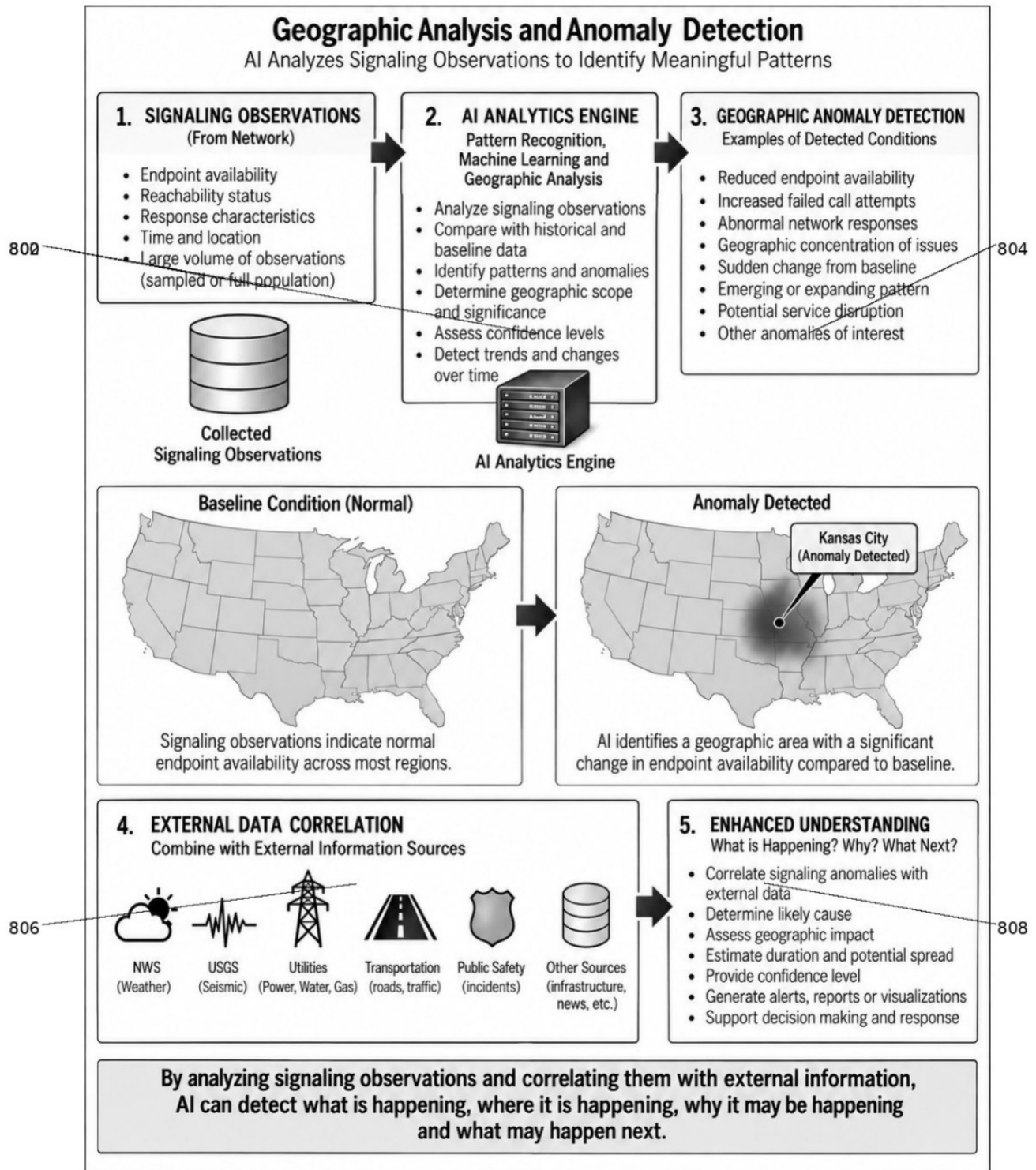


FIG. 8

Signaling observations may be aggregated geographically and compared with historical or contemporaneous baselines. AI may identify reduced endpoint availability, increased failed attempts, abnormal responses, geographic concentration, sudden deviation from baseline, an expanding pattern, or another anomaly of interest.

The signaling observations can establish that something changed and where the change is occurring without necessarily identifying the external cause. AI may then acquire or correlate weather, seismic, utility, transportation, infrastructure, public safety, governmental, commercial, or other external information to determine what the anomaly may represent.

SYNTHETIC DATA FROM CORRELATED OBSERVATIONS

FIG. 9 illustrates external information 900 combined through AI correlation 902 to generate Synthetic Data 904. Severe weather example 906 demonstrates one representative external phenomenon.

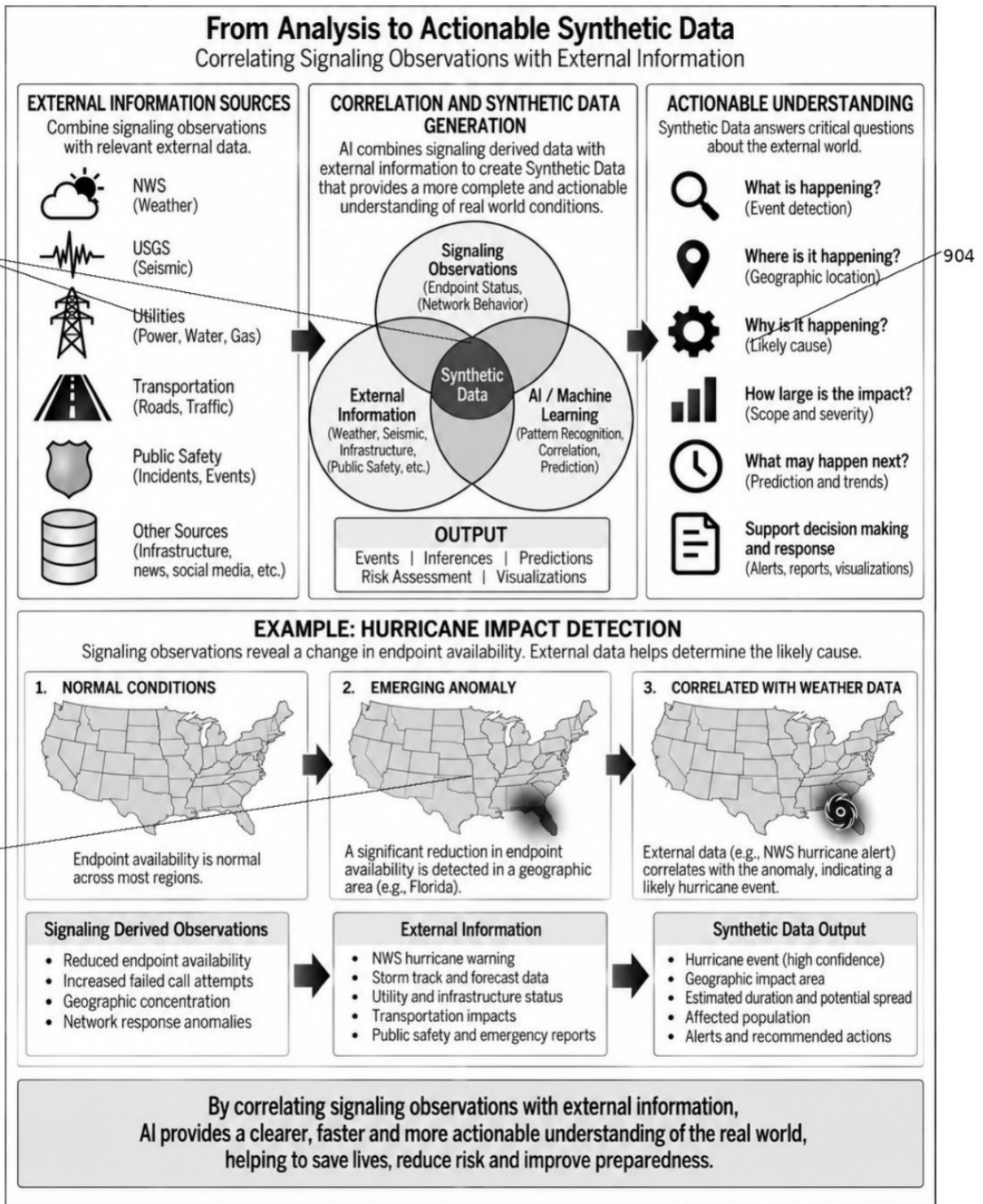


FIG. 9

Synthetic Data is generated when signaling derived observations and external information are combined, correlated, fused, compared, or otherwise processed by AI to produce new information about the external world. Depending on the embodiment, Synthetic Data may identify what is happening, where it is happening, why it may be happening, the size or severity of the impact, what may happen next, or what action should be considered.

A severe weather embodiment illustrates the distinction. A reduction in endpoint availability in a geographic area may first appear only as a signaling anomaly. Correlation with weather alerts, storm track information, utility status, transportation conditions, and public safety reports may support a Synthetic Data conclusion identifying a likely hurricane impact, affected area, estimated duration, confidence level, and recommended actions.

INTELLIGENT SAMPLING

FIG. 10 illustrates AI target selection 1000, sampling sweeps 1002, response analysis 1004, geographic results 1006, and dynamic decision process 1008.

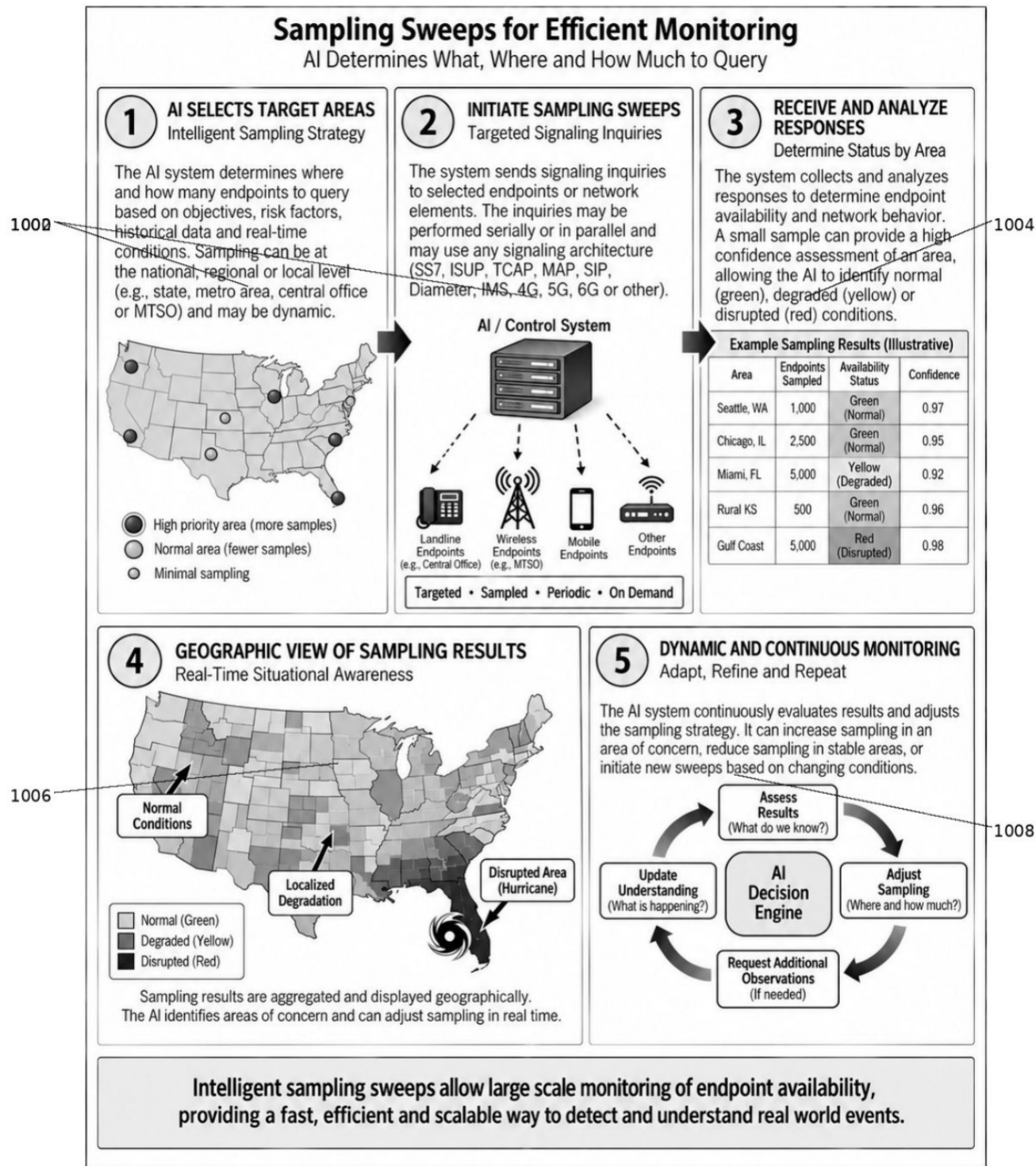


FIG. 10

Sampling may be dynamic. AI may determine where and how many endpoints to query based on objectives, risk factors, historical information, current conditions, confidence requirements, geographic scope, or prior results. A stable area may require only a small sample. An area showing degradation may receive a larger sample or repeated sweeps.

Results can cause AI to alter geographic scope, increase or decrease sample size, change frequency, select different endpoint classes, request additional external information, or initiate another inquiry. This permits large scale observation without requiring every implementation to interrogate every endpoint.

DEFINITIONS AND TERMINOLOGY

The following terms are used to promote clarity and are intended to be read broadly in light of the specification. Examples are illustrative and do not limit a term to a particular protocol, record format, network generation, model type, or implementation.

Intelligent Signaling Network Data. Machine observable information generated, carried, derived, stored, or otherwise made available in connection with signaling used to establish, route, manage, complete, fail, redirect, terminate, maintain, test, or otherwise support communications or communications networks.

Signaling Observation. An item, field, message, response, characteristic, relationship, measurement, derived feature, aggregation, or other machine observable information obtained from or based upon intelligent signaling network data.

Semantic Content. The substantive words, sounds, images, video, text, media, or other communicated meaning exchanged between endpoints, as distinguished from signaling observations concerning the communication or attempted communication.

External Information. Information not native to the signaling function being analyzed, including information concerning weather, seismic activity, geography, transportation, utilities, infrastructure, public safety, commerce, finance, sensors, government, history, time, population, demographics, news, Internet sources, or other external conditions or events.

Synthetic Data. New machine generated information produced at least in part from processing signaling observations with external information. Synthetic Data may describe, explain, classify, locate, measure, correlate, predict, quantify, recommend, or otherwise characterize an external event, condition, cause, relationship, behavior, activity, impact, risk, or other phenomenon.

Event Record. A purpose specific machine readable representation assembled, derived, selected, correlated, enriched, summarized, or otherwise constructed from one or more signaling observations, optionally with external information, for AI processing, external correlation, reporting, analysis, storage, action, or another authorized purpose. An Event Record need not correspond to one call, one session, one database row, or any particular record format.

Call Detail Record (CDR). A downstream record conventionally assembled from selected communications or signaling information for billing, accounting, records, troubleshooting, or other carrier purposes. A CDR is one possible downstream information product and is not synonymous with the underlying signaling observations.

Passive Observation. Obtaining signaling observations from signaling activity arising independently of an inquiry initiated for the purpose of obtaining those observations.

Active Observation. Obtaining signaling observations by initiating or causing an authorized signaling inquiry, test, probe, poll, call, message, stimulus, or other signaling transaction intended to obtain a machine observable response or response characteristic.

Signaling Inquiry. An authorized signaling transaction used to obtain machine observable information from or concerning one or more endpoints, network elements, geographic areas, groups, or other targets.

Sweep. One or more signaling inquiries directed to a target population, sample, geographic area, endpoint class, network element, or other selected scope. A sweep may be serial, parallel, periodic, on demand, sampled, adaptive, or otherwise implemented.

Artificial Intelligence (AI). One or more computational systems, processors, models, algorithms, machine learning systems, neural networks, generative systems, statistical learning systems, pattern recognition systems, expert systems, reasoning systems, autonomous systems, agents, or future computational intelligence technologies.

External Phenomenon. An event, cause, condition, relationship, behavior, activity, impact, risk, prediction, or other subject of intelligence whose object is outside the signaling function itself.

Operational Recipient. A person, organization, system, facility, agency, enterprise, carrier, emergency communications center, regulator, or other authorized recipient of an observation, alert, Synthetic Data, report, recommendation, or action.

Authorized Agent. An AI, software agent, automated system, human supervised system, or other system permitted to request information, perform analysis, communicate results, initiate workflows, or take authorized action.

GLOSSARY

AI: Artificial intelligence as defined in the preceding Definitions and Terminology section.

CDR: Call Detail Record, a downstream record assembled from selected communications or signaling information for conventional carrier purposes.

ECC: Emergency communications center or other authorized center receiving emergency communications or related operational information.

Event Record: A purpose specific machine readable representation assembled or derived from signaling observations, optionally with external information, for AI processing, external correlation, reporting, analysis, storage, or action.

External Information: Information not native to the signaling function being analyzed and used by AI to provide context, correlation, explanation, classification, prediction, or other intelligence.

External Phenomenon: The event, cause, condition, relationship, behavior, activity, impact, risk, prediction, or other object of intelligence outside the signaling function itself.

Semantic Content: The substantive words, sounds, images, video, text, media, or communicated meaning exchanged between endpoints, as distinguished from signaling observations about the communication.

Signaling Inquiry: An authorized signaling transaction used to obtain machine observable information from or concerning selected endpoints, network elements, geographic areas, groups, or other targets.

Signaling Observation: A message, field, response, characteristic, relationship, measurement, derived feature, aggregation, or other machine observable information obtained from or based upon intelligent signaling network data.

Sweep: One or more signaling inquiries directed to a selected population, sample, geographic area, endpoint class, network element, or other scope.

Synthetic Data: New machine generated information produced at least in part from processing signaling observations with external information to characterize something outside the signaling function.

REPRESENTATIVE DATA PATHS

Business intelligence. Signaling observations may reveal changes in call volume, geography, timing, mobility, endpoint relationships, or other patterns. AI may correlate those observations with external advertising schedules, retail events, market information, transaction information, geographic information, or other commercial data. Synthetic Data may measure or predict demand, market response, commercial activity, or another external behavior.

Disaster response. Signaling observations may reveal abrupt changes in communications attempts, failures, geographic concentrations, movement, or endpoint availability. AI may correlate those observations with weather, seismic, utility, transportation, sensor, infrastructure, or public safety information. Synthetic Data may identify, classify, locate, measure, or predict an external event before or in addition to independent reporting.

Behavioral and predictive analysis. AI may derive associations, clusters, sequences, trends, and representations describing relationships among endpoints, groups, locations, times, or activities. Historical signaling information associated with known outcomes may train or validate a model, while current activity may be compared with learned patterns to identify precursor conditions or predict an external event, demand, risk, activity, or relationship.

EMERGENCY COMMUNICATIONS AS A REPRESENTATIVE EMBODIMENT

FIG. 11 shows a successful emergency communication through origin 1100, provider network 1102, ESInet 1104, ECC 1106, and response 1108. FIG. 12 contrasts an upstream failure involving origin 1200, originating network 1202, transit or interconnection network 1204, failure condition 1206, and ECC 1208. FIGS. 13 and 14 further illustrate signaling based emergency awareness and AI generated supplemental intelligence.

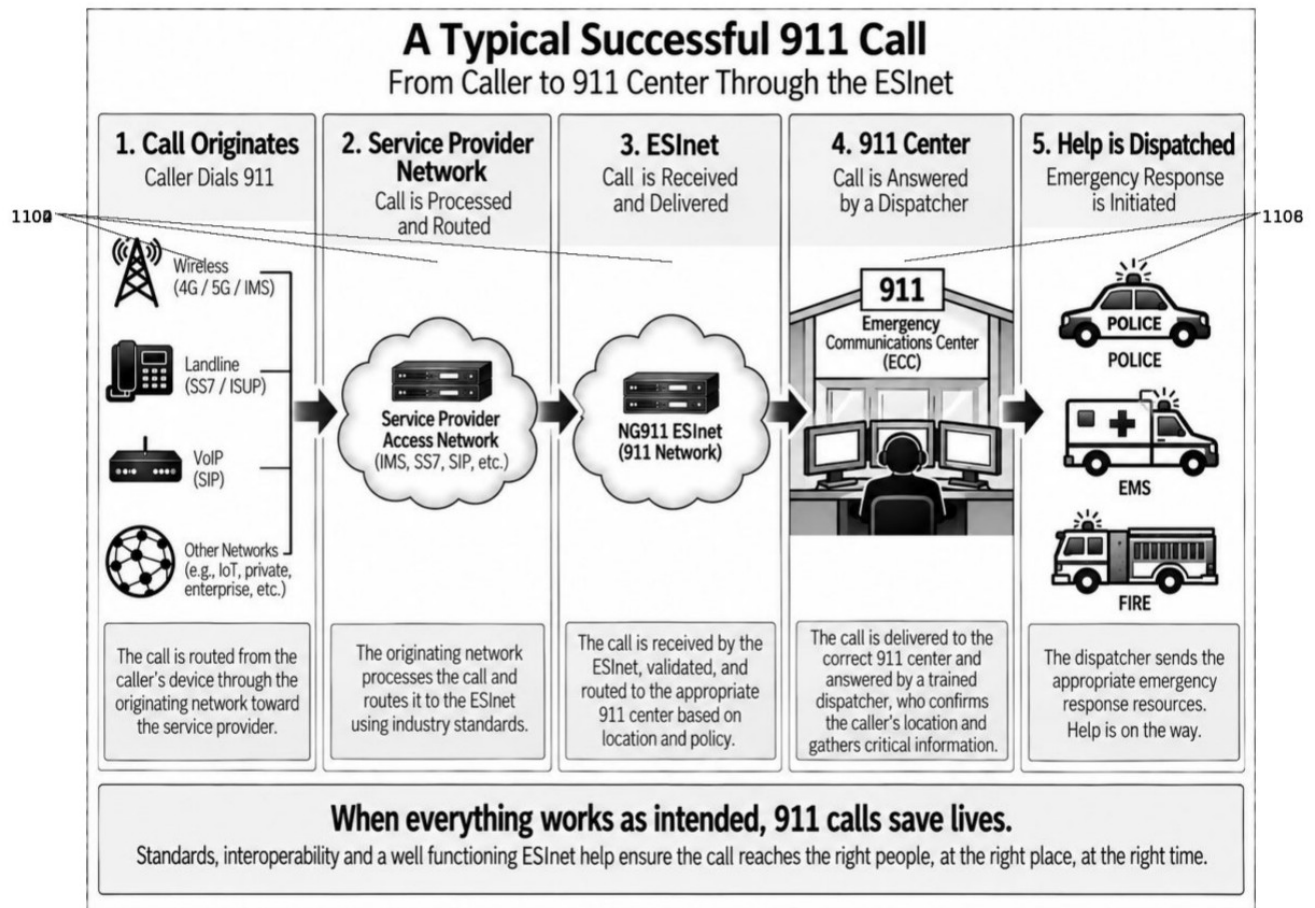


FIG. 11

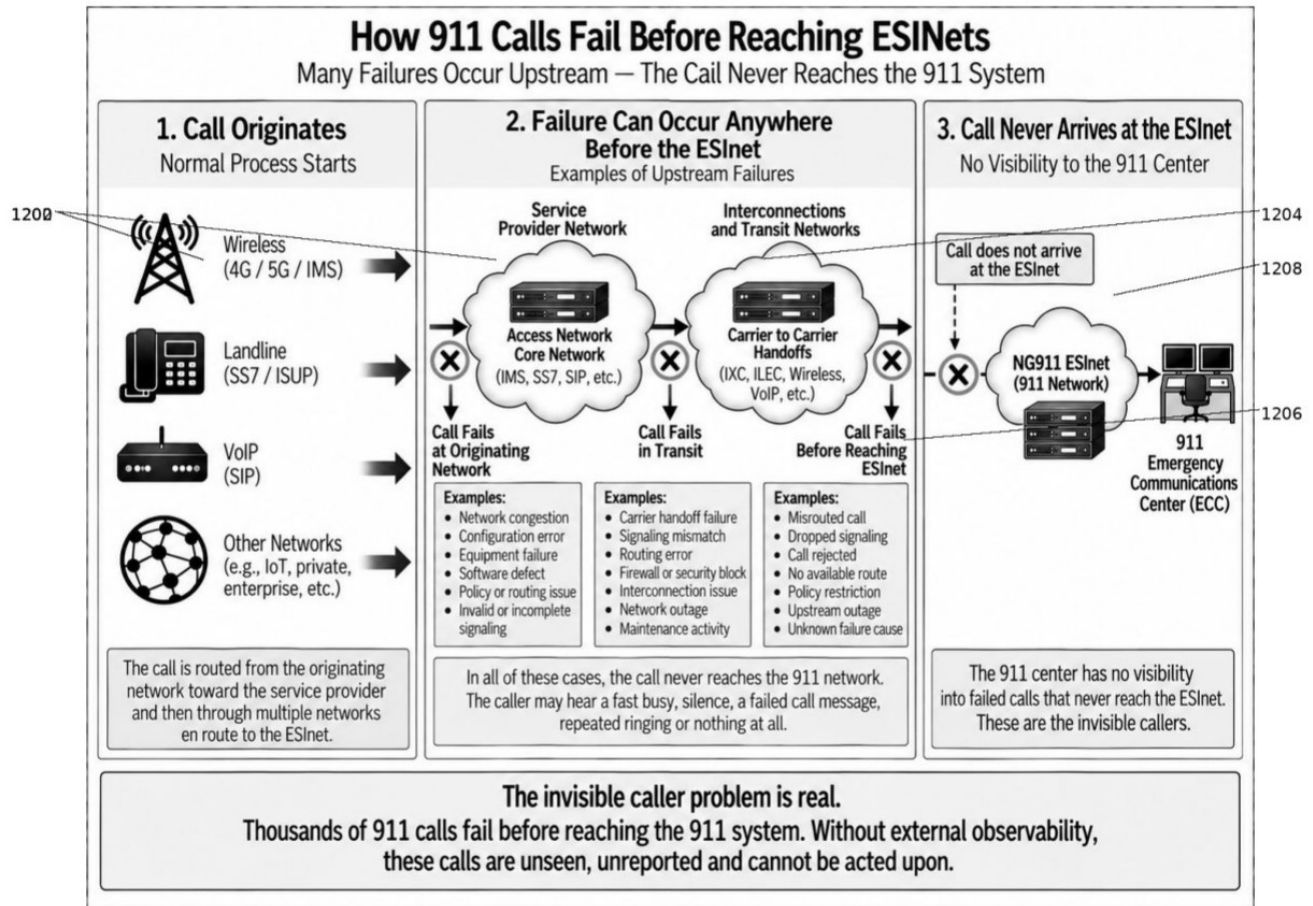


FIG. 12

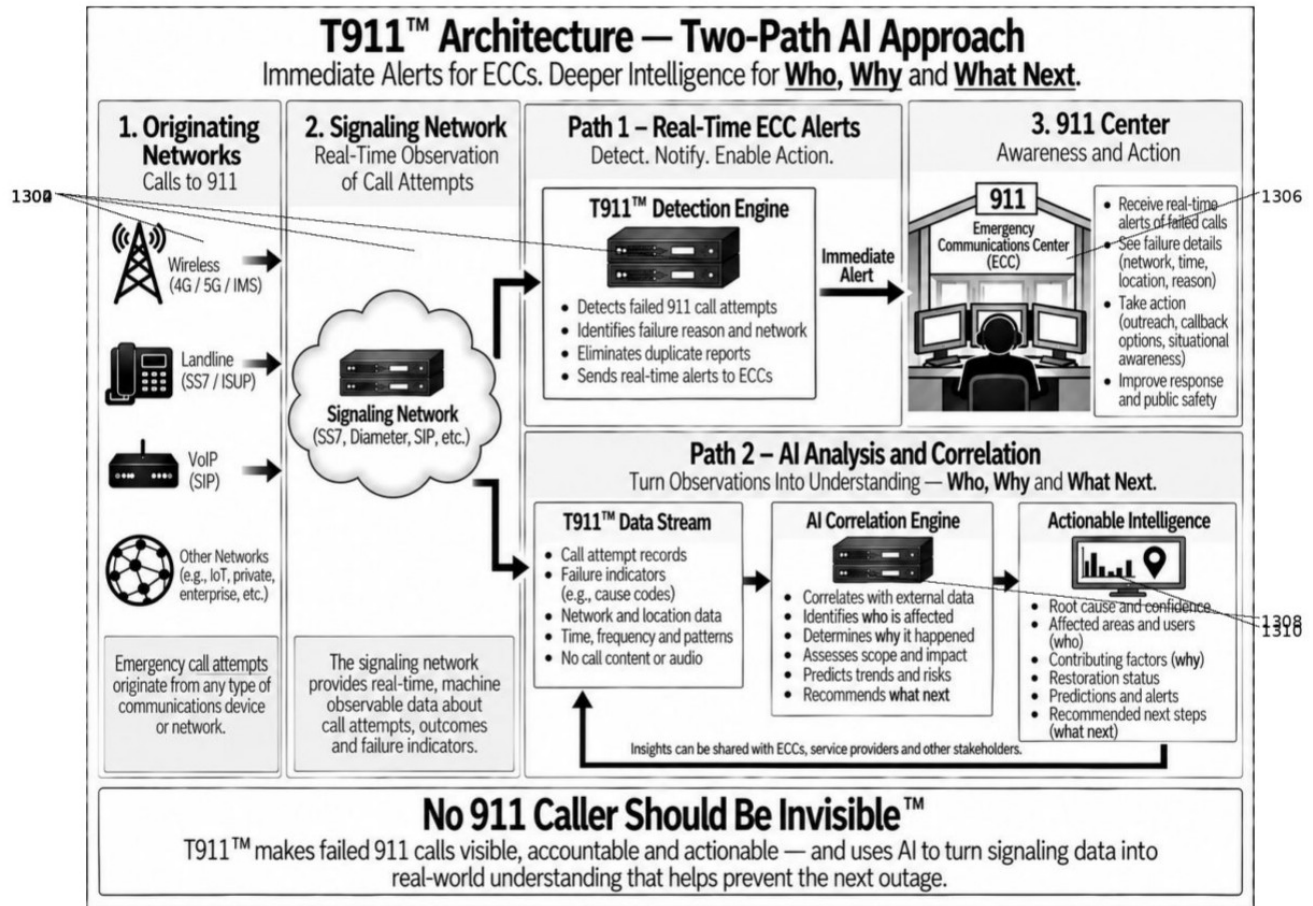


FIG. 13

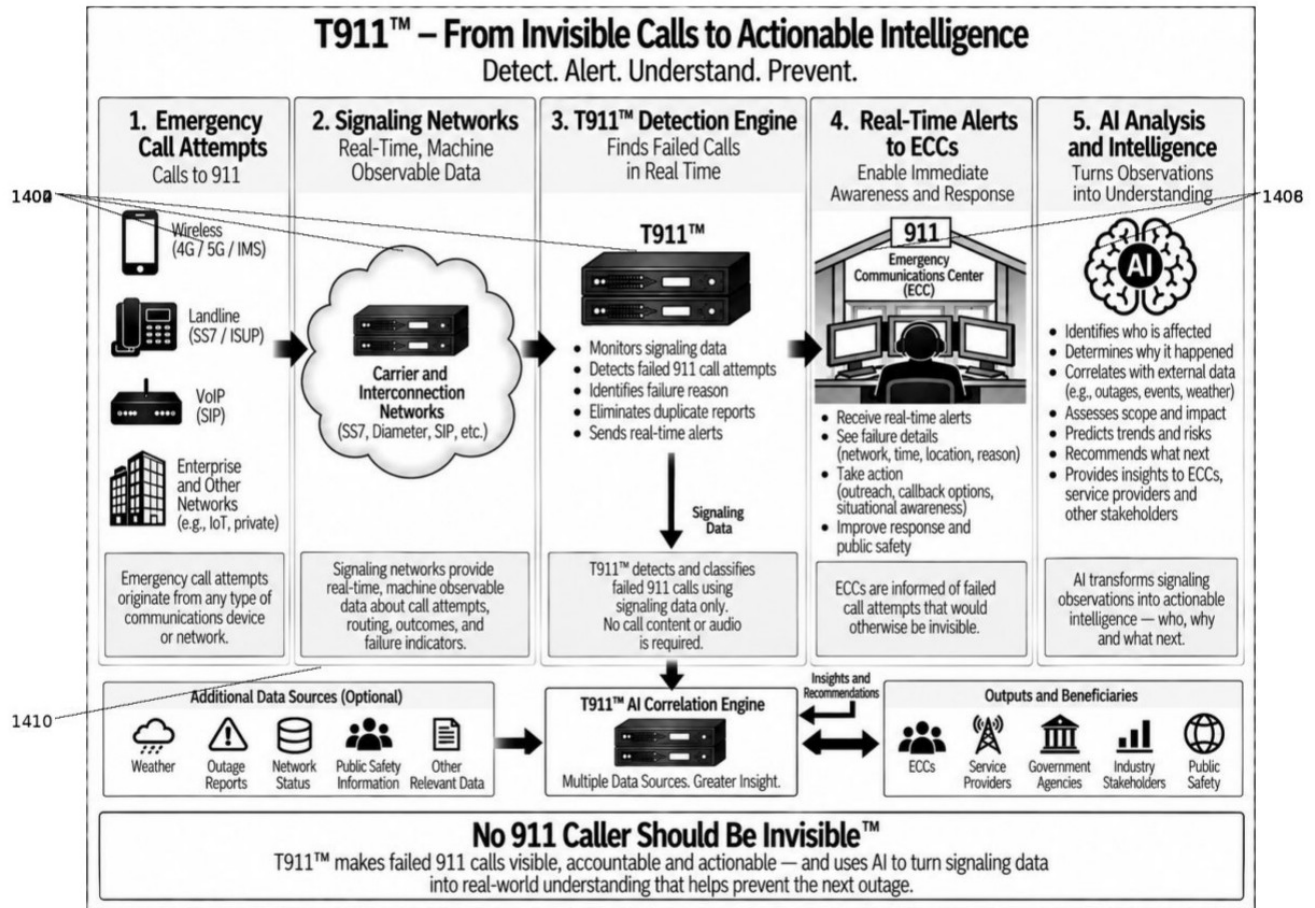


FIG. 14

Emergency communications are one representative application of the broader architecture. Signaling associated with an unsuccessful emergency communication attempt may identify a failed attempt, time, location related information, routing characteristics, network information, cause information, or geographic concentration even when the voice communication does not reach the emergency communications center.

The next two drawings provide context for that embodiment. They are not intended to redefine the invention as a 911 system. Their purpose is to show why a signaling observation can exist when the operational recipient never receives the underlying communication.

T911™ is one implementation that can use this architecture. Detection of a failed emergency call attempt may produce an immediate operational notification to the responsible ECC while information concerning the same event is also supplied to AI. The ECC can act on the immediate alert while AI independently investigates external information to determine who is affected, why the failure may have occurred, what the impact may be, and what may happen next.

The AI generated supplemental information may include a probable external cause, confidence value, affected carrier or service area, geographic condition, repair status, restoration estimate, prediction, recommendation, or other context not contained in the original signaling observation. A common event identifier, signaling attribute, endpoint, time, location, or other association may connect the operational alert and the later Synthetic Data.

FIGS. 13 and 14 illustrate representative T911 embodiments in which signaling observations support immediate operational awareness and AI generated supplemental intelligence.

CONTENT INDEPENDENT INTELLIGENCE

An important embodiment is the ability to derive intelligence without analyzing semantic communication content. The system may determine that communications were attempted, completed, failed, repeated, redirected, geographically concentrated, temporally concentrated, associated with particular endpoints, or otherwise exhibited machine detectable patterns without determining what communicating parties said, wrote, displayed, or otherwise communicated.

Information sometimes characterized as telecommunications metadata may therefore become an AI input. The invention does not depend on a particular statutory definition of metadata. The relevant information is defined by its technical origin and relationship to communications signaling.

EXTERNAL DATA AND DATA FUSION

External information may include weather, seismic, traffic, geographic, infrastructure, utility, emergency incident, sensor, public record, commercial, transaction, market, financial, news, Internet, satellite, imagery, historical, calendar, population, demographic, and event information. AI may use such information to explain a signaling pattern, classify an external condition, estimate location or magnitude, identify relationships, generate confidence values, or predict future development.

SIGNALING AS A TRIGGER FOR AI INVESTIGATION

A signaling observation may establish that a machine observable event occurred and simultaneously trigger an AI inquiry into meaning, cause, context, consequences, or likely future development. The signaling system may establish what occurred, while AI investigates why it occurred, what external condition most likely explains it, what additional facts are relevant, what may happen next, or what action should be considered.

The AI output may be returned to the same operational recipient, delivered to another recipient, supplied to another machine system, or used to initiate an authorized automated action. A first message may establish an event and a later supplemental message may explain or contextualize it.

SYSTEM ARCHITECTURE

A representative system includes signaling information interfaces, preprocessing or feature extraction components, one or more AI systems, external data interfaces, storage systems, and output or action interfaces. Signaling information may be received from signaling links, signaling transfer points, switches, softswitches, session border controllers, IMS elements, carrier systems, probes, databases, logs, call detail systems, signaling archives, or other authorized sources.

Acquisition may be streaming, batch, real time, near real time, historical, centralized, distributed, cloud based, edge based, or hybrid. Preprocessing may select fields, normalize formats, correlate related messages, derive features, establish temporal windows, construct relationship graphs, calculate rates or changes, identify geographic concentrations, compare current behavior with historical behavior, create Event Records, or prepare other representations.

AI may use supervised, unsupervised, semi supervised, self supervised, reinforcement, transfer, federated, online, continual, generative, reasoning, or other present or future computational intelligence techniques.

AI DISCOVERY WITHOUT A PREDETERMINED QUESTION

FIG. 15 illustrates signaling observations 1500 and external information 1502 supplied to AI discovery engine 1504. The engine may identify unknown pattern 1506, associate the pattern with external phenomenon 1508, and generate actionable intelligence 1510.

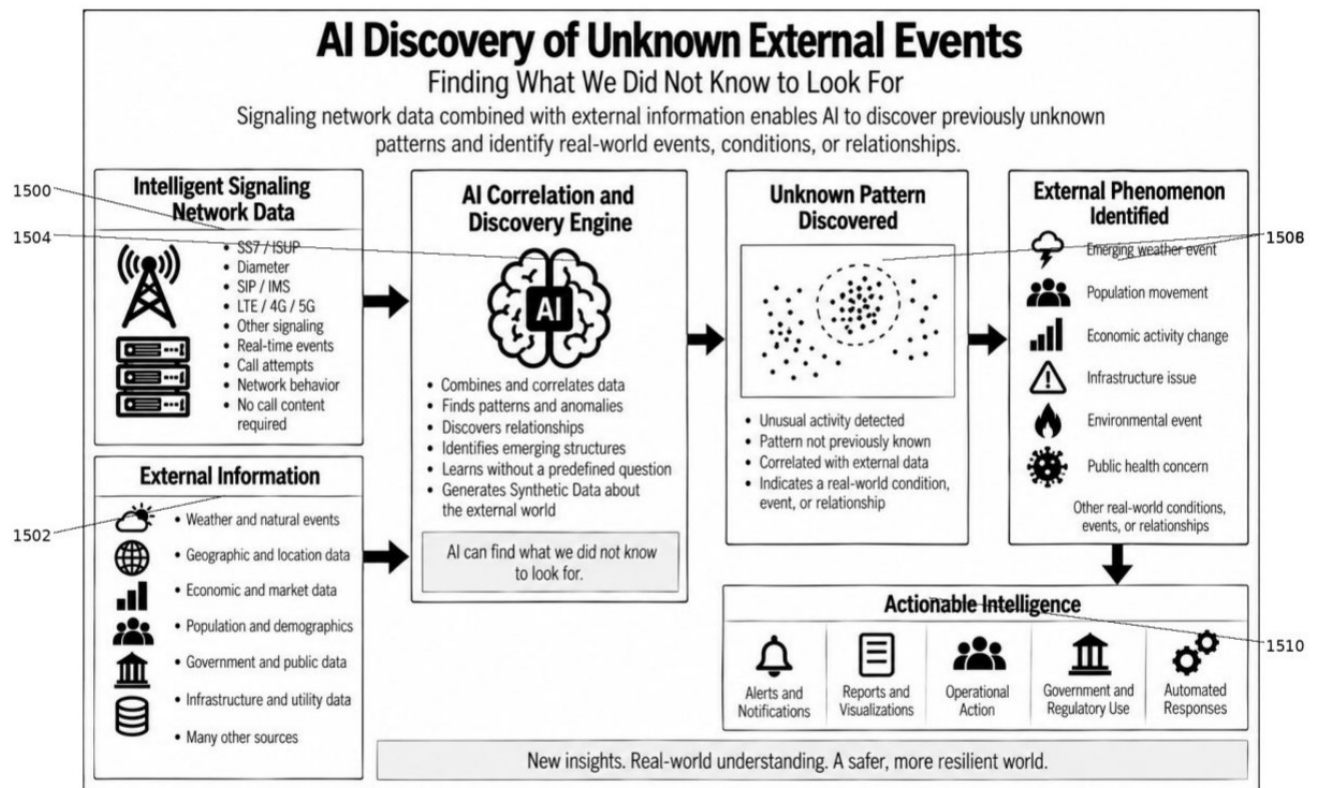


FIG. 15

AI processing may be directed to a known question or may discover information without a predetermined external event definition. Models may identify clusters, relationships, deviations, anomalies, correlations, or emerging structures and subsequently associate them with external conditions. This allows the system to discover phenomena that were not expressly defined by a predetermined rule.

ITERATIVE AI PROCESSING AND COLLABORATIVE ACTION

FIG. 16 illustrates signaling observations 1600 and external information 1602 supplied to primary AI 1604. Synthetic Data 1606 may be supplied to secondary AI or authorized agent 1608 for action 1610, with results returned through iterative refinement 1612.

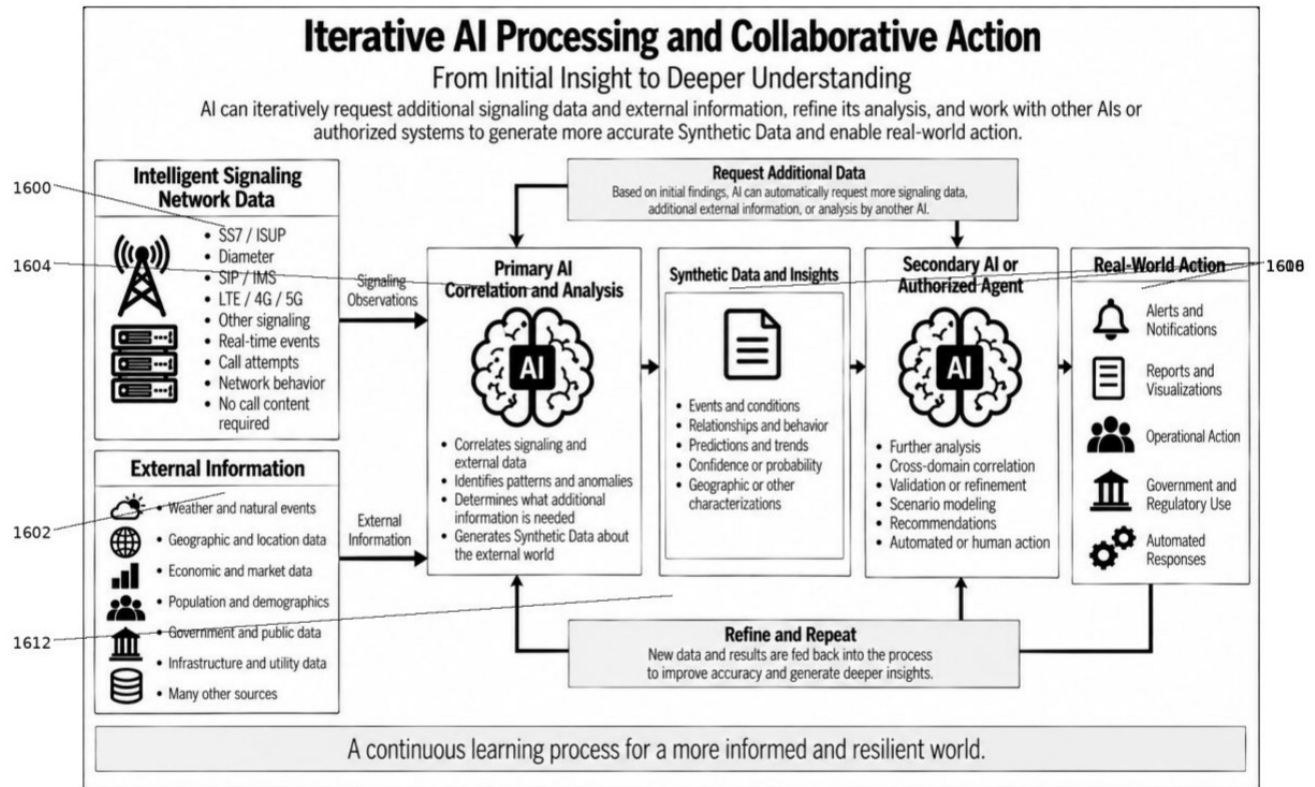


FIG. 16

An initial inference may cause an authorized system or agent to request additional signaling observations, obtain additional external information, compare additional geographic regions or time periods, invoke another model, seek human confirmation, or initiate an authorized response. New observations and results may then be returned to the process for refinement.

Synthetic Data may also be supplied to another AI system or autonomous agent for further analysis or authorized action. This architecture supports repeated observation, inference, validation, refinement, and action rather than requiring a single pass through a fixed analytical pipeline.

REGULATORY ALERT GENERATION AND REPORTING

FIG. 17 illustrates signaling information 1700 and external information 1702 supplied to collection and correlation processing 1704. The system may determine a potentially reportable condition 1706, prepare or route a regulatory notice 1708, communicate with authorized regulatory recipients 1710, and provide status, review, or approval through operational user interface 1712.

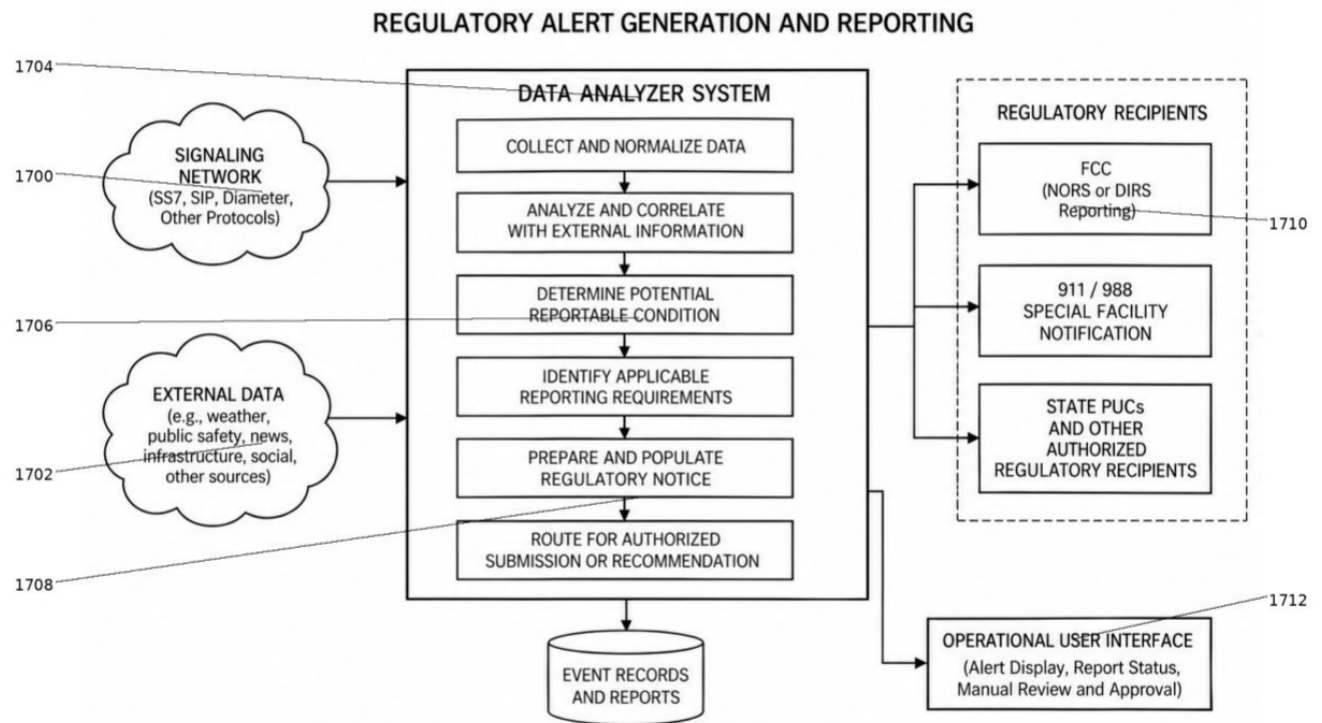


FIG. 17

In another embodiment, signaling observations and external information may be used to identify a condition that is reportable, potentially reportable, or otherwise relevant to an authorized regulatory or governmental recipient. The condition may concern an outage, degradation, emergency communications impairment, geographic impact, service availability, infrastructure event, or another matter for which notification, reporting, escalation, or documentation may be required or useful.

AI may correlate signaling observations with external information to determine the nature, scope, affected area, affected population, probable cause, duration, confidence, restoration status, or other facts relevant to a regulatory notice. The system may identify an applicable reporting regime or recipient and may prepare, populate, update, recommend, route, or, where authorized, submit a regulatory notice or related report.

The system may also correlate signaling observations across carriers, facilities, routes, service areas, and reporting sources to reduce duplicate alerts concerning the same underlying event. Multiple observations or notices that share time, geography, routing characteristics, point codes, facility information, cause information, fiber route information, or other common attributes may be associated with a common Event Record or incident identifier. AI may determine that multiple apparent outages or alerts are manifestations of one external condition and may suppress, consolidate, associate, prioritize, or update redundant notifications while preserving the underlying observations.

Carrier responsibility may also be inferred or qualified where communications traverse backhaul providers, intermediate carriers, shared transport facilities, leased facilities, common fiber routes, or other multi-entity arrangements. By correlating signaling observations with external carrier, routing, facility, fiber, maintenance, outage, geographic, ownership, or operational information, AI may identify a responsible, affected, originating, intermediate, backhaul, or facilities based carrier; distinguish the carrier serving the endpoint from the carrier associated with the underlying failure; or assign a confidence value to that determination. This information may improve the accuracy of regulatory notices, reduce duplicate reporting, and direct alerts or follow-up inquiries to the entity most likely to possess relevant operational information.

A reporting workflow may include human review or approval. Alternatively, an authorized automated system or agent may transmit an initial notice, update a previously submitted notice, request additional observations, preserve an Event Record, or provide status information to an operational user interface. The invention

is not limited to a particular agency, form, reporting threshold, rule, or present day regulatory program.

Representative recipients may include the Federal Communications Commission, 911 or 988 special facilities, state public utility commissions, emergency management organizations, or other authorized governmental or regulatory entities. References to NORS, DIRS, or other present reporting mechanisms are illustrative examples and do not limit the disclosed process.

FIG. 17 illustrates this embodiment. Signaling observations and external information enter the analysis process; AI may correlate multiple observations to identify a common incident, reduce duplicate alerts, distinguish endpoint-serving carriers from backhaul or facilities based carriers, and determine whether a potentially reportable condition exists. Applicable reporting requirements or recipients may then be identified and a notice prepared and routed for authorized submission, recommendation, review, update, or approval.

RELATIONSHIP TO PRIOR INVENTIONS

The inventor's earlier patents demonstrated that signaling information can have evidentiary value beyond conventional network control and expressly contemplated artificial intelligence, machine learning, neural networks, pattern recognition, external data, data fusion, and Synthetic Data. The present disclosure generalizes that architecture so signaling information can become a broad machine readable intelligence source from which AI may discover, infer, classify, predict, or act upon external phenomena.

The earlier patents are technological antecedents to the present disclosure. Nothing herein is intended to disclaim or narrow subject matter disclosed or claimed in those patents.

PRIOR ART DISTINCTION

FIG. 18 contrasts conventional signaling uses 1800 and network directed outputs 1802 with signaling and external information 1804 processed through AI correlation 1806 to produce external world uses 1808 and a different information product 1810.

SIGNaling DATA APPLICATIONS CONVENTIONAL USES VERSUS PRESENT INVENTION

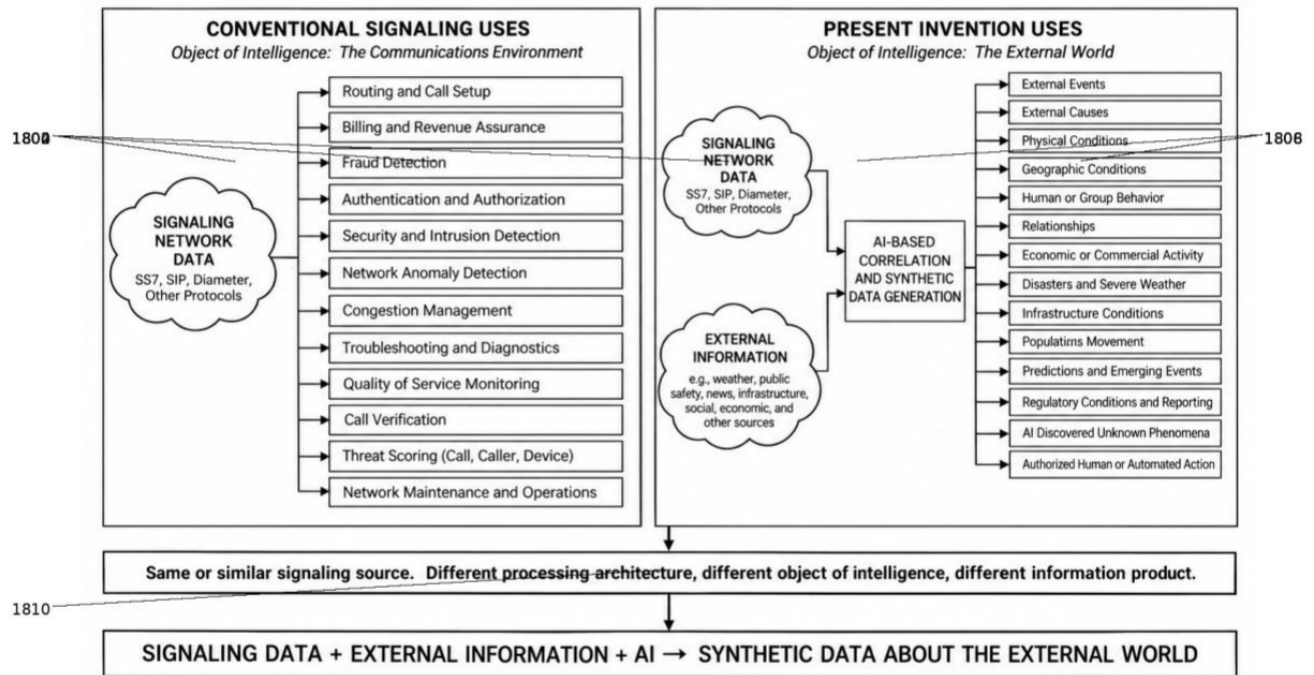


FIG. 18

The closest prior art confirms that signaling data can be analyzed by analytics and AI. The distinction is what those systems are trying to learn and what they produce. Oracle U.S. Patent No. 11,451,670 uses granular SS7 fields and machine learning for signaling network anomaly and intrusion detection. Caller verification, JIP and CLLI matching, and communications threat identification families use signaling or carrier metadata, probability models, machine learning, and sometimes external or historical information to evaluate a call, caller, device, facility, authenticity, fraud risk, threat, or communications transaction.

Those references remain directed to the communications environment. The present architecture uses signaling observations with external information to create Synthetic Data concerning an event, cause, condition, relationship, behavior, activity, prediction, or other phenomenon external to the signaling function. Similarity in the source of data does not by itself establish that the claimed method of using that data would have been obvious. The claimed processing architecture, correlation with external information, object of intelligence, and resulting Synthetic Data must be considered as part of the claimed method as a whole. See 35 U.S.C. § 103; MPEP § 2141.02. See also MPEP § 2116.01, discussing *In re Ochiai*, 71 F.3d 1565 (Fed. Cir. 1995), and *In re Brouwer*, 77 F.3d 422 (Fed. Cir. 1996), and rejecting per se treatment of process claims in favor of a fact specific analysis of the claimed subject matter as a whole.

FIG. 18 closes the prior art discussion by placing the two technological purposes side by side. Conventional signaling applications use signaling information to understand, operate, secure, authenticate, bill, troubleshoot, or otherwise manage the communications environment. The present invention uses signaling observations with external information and AI to create Synthetic Data concerning the external world.

The distinction shown in FIG. 18 is not based on ownership of SS7, SIP, Diameter, or any other signaling protocol. It lies in the claimed methodology: the processing architecture, external correlation, object of intelligence, resulting information product, and associated actions. The same or similar signaling source can therefore participate in materially different processes.

CONCLUSIONS

FIG. 19 summarizes signaling sources 1900, AI correlation 1902, representative external applications 1904, and actionable intelligence 1906.

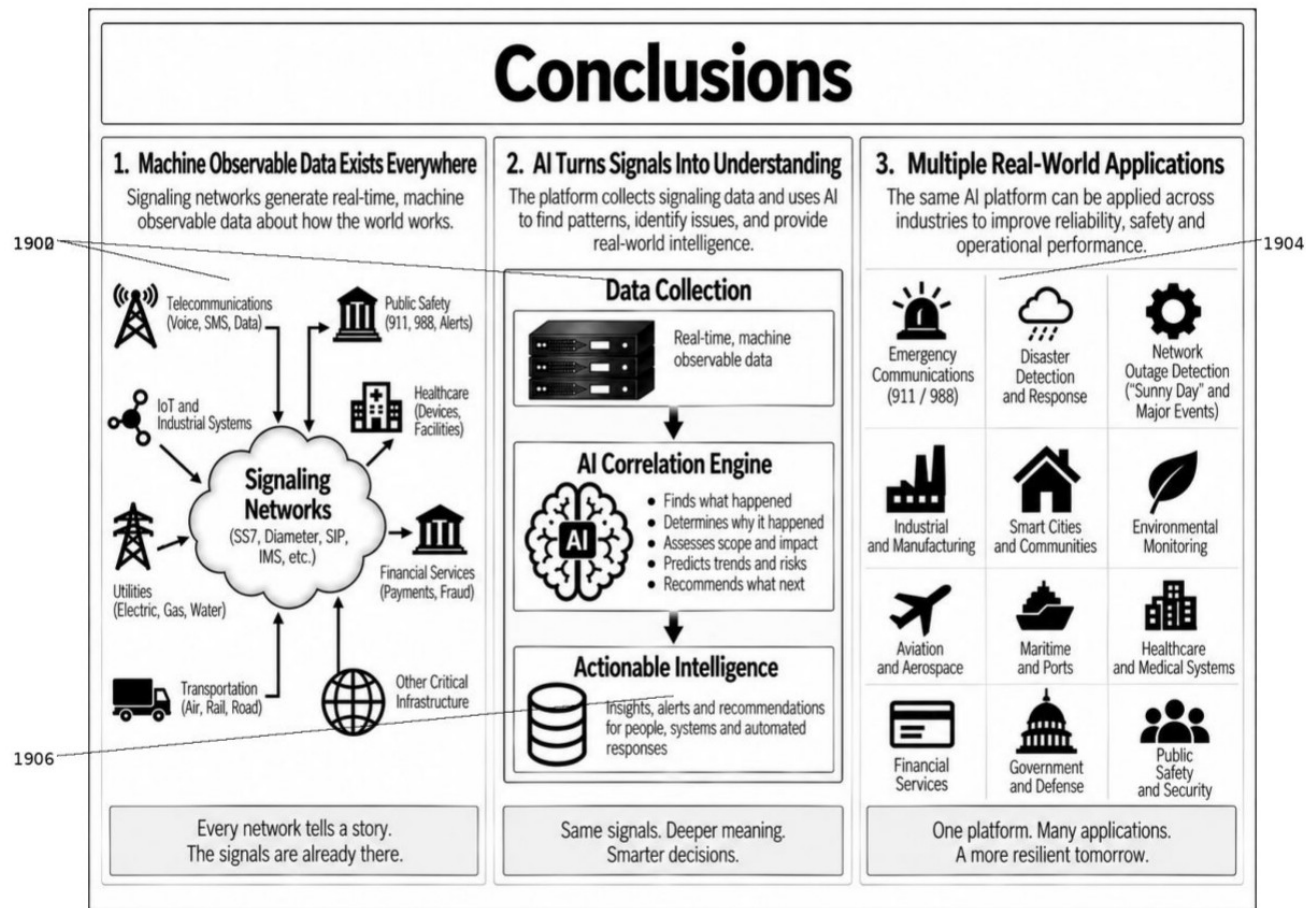


FIG. 19

The signaling network is a source of machine observable observations. AI can correlate those observations with information from the external world, discover patterns that were not predetermined, request additional observations when useful, create purpose specific Event Records, and generate Synthetic Data supporting human or automated action.

DETAILED DESCRIPTION OF REPRESENTATIVE IMPLEMENTATIONS

The AI system may receive signaling derived features directly or through intermediate services and may operate on premises, in a carrier network, in a cloud environment, at an edge location, in a governmental or enterprise environment, or in a distributed architecture. The AI need not be owned or operated by the carrier that generated the signaling information.

A principal technical distinction is that the information sought from AI need not be a telecommunications network condition. The signaling network is the source of observations, while the object of analysis may exist outside the signaling function. Signaling information generated for setting up, routing, managing, completing, failing, or terminating communications may acquire a second technological use as input data for AI concerning the external world.

The invention is not limited to SS7. SS7 is a useful example because it demonstrates an intelligent signaling environment separate from bearer content. The broader invention applies to present and future signaling architectures capable of producing machine observable information about communications activity.

CLAIMS

1. A computer-implemented method comprising: obtaining intelligent signaling network data generated in connection with one or more communication activities or communication attempts; obtaining information external to the intelligent signaling network; providing at least a portion of the intelligent signaling network data and the external information to an artificial intelligence system; correlating, combining, fusing, comparing, or otherwise processing, by the artificial intelligence system, the intelligent signaling network data with the external information; determining, from the processing, information concerning at least one subject, relationship, behavior, activity, condition, cause, prediction, or event external to the intelligent signaling network; and generating Synthetic Data based at least in part upon the determined information.
2. The method of claim 1 wherein determining the information is performed without analyzing semantic content communicated between originating and terminating endpoints, and wherein the intelligent signaling network data comprises data associated with one or more of SS7, ISUP, TCAP, MAP, SIP, Diameter, IMS, LTE, 4G, 5G, 6G, VoIP, wireless, landline, satellite, cable telephony, or another present or future signaling protocol or architecture.
3. The method of claim 1 wherein the artificial intelligence system identifies a pattern, relationship, cluster, anomaly, correlation, trend, cause, predictive indicator, or external phenomenon not expressly defined by a predetermined rule or predetermined external event definition.
4. The method of claim 1 wherein the Synthetic Data identifies, describes, measures, classifies, locates, explains, predicts, or assigns a confidence value to an external event, probable external cause, relationship, behavior, activity, condition, demand, risk, geographic area, affected population, or future external phenomenon.
5. The method of claim 1 further comprising selecting, assembling, deriving, correlating, enriching, summarizing, or otherwise constructing from one or more signaling observations a purpose-specific Event Record for artificial intelligence processing or external correlation, wherein the Event Record includes signaling information omitted from, differently represented in, or independent of a conventional Call Detail Record.
6. The method of claim 1 wherein the intelligent signaling network data is obtained before, independently of, or in addition to creation of a Call Detail Record or other downstream record and is parsed, filtered, normalized, encoded, vectorized, summarized, aggregated, anonymized, pseudonymized, hashed, enriched,

transformed into an intermediate representation, or otherwise preprocessed before being provided to the artificial intelligence system.

7. The method of claim 1 wherein receipt or detection of an intelligent signaling network observation triggers acquisition by the artificial intelligence system or an authorized agent of at least a portion of the external information, and the artificial intelligence system correlates the observation with the acquired external information to determine a probable external cause and a confidence value or probability associated with the probable external cause.
8. The method of claim 1 further comprising providing information concerning an intelligent signaling network event to an operational recipient and to an artificial intelligence system, and subsequently providing Synthetic Data generated by the artificial intelligence system to the operational recipient, wherein the intelligent signaling network event optionally comprises an unsuccessful emergency communication attempt and the operational recipient optionally comprises an emergency communications center.
9. The method of claim 1 wherein the Synthetic Data is supplied to another artificial intelligence system, autonomous agent, human recipient, or automated system for further analysis, recommendation, notification, workflow initiation, resource allocation, verification, or authorized action.
10. The method of claim 1 further comprising actively obtaining signaling observations by causing an authorized signaling inquiry, test, probe, poll, call, message, stimulus, or sweep directed to one or more endpoints, network elements, geographic areas, groups, or other selected targets.
11. The method of claim 10 wherein the artificial intelligence system selects at least one of a target population, geographic area, endpoint class, number of endpoints, sampling method, inquiry frequency, or signaling inquiry based on an objective, prior observation, historical information, current condition, risk factor, or confidence criterion.
12. The method of claim 11 wherein the artificial intelligence system evaluates responses from a sample of endpoints, determines a confidence associated with a condition of a geographic area or target population, and increases, decreases, redirects, or repeats signaling inquiries based at least in part on the confidence or observed condition.
13. The method of claim 10 wherein signaling observations obtained by active observation are combined with signaling observations obtained passively from independently arising signaling activity, and an initial inference causes the artificial

intelligence system or an authorized agent to request or obtain additional signaling observations or additional external information and iteratively refine the Synthetic Data.

14. The method of claim 1 further comprising determining, based at least in part on the intelligent signaling network data, external information, or Synthetic Data, a reportable or potentially reportable condition; identifying an authorized regulatory or governmental recipient or applicable reporting requirement; and preparing, populating, updating, recommending, routing, or, when authorized, submitting a regulatory notice or report concerning the condition.
15. The method of claim 14 wherein the artificial intelligence system correlates multiple signaling observations, alerts, notices, or Event Records associated with a common underlying event and suppresses, consolidates, associates, prioritizes, or updates duplicate or redundant regulatory notifications.
16. The method of claim 14 wherein the artificial intelligence system correlates signaling observations with external carrier, routing, facility, fiber, geographic, ownership, maintenance, outage, or operational information to identify or assign a confidence value to a responsible, affected, originating, intermediate, backhaul, or facilities-based carrier associated with the reportable or potentially reportable condition.
17. The method of claim 1 wherein the intelligent signaling network data and the external information are obtained from systems operated by different entities and the Synthetic Data causes, recommends, or supports a human or automated action.
18. A system comprising: an intelligent signaling network data interface configured to obtain intelligent signaling network data generated in connection with communication activities or communication attempts; an external information interface configured to obtain information external to the intelligent signaling network; one or more processors; an artificial intelligence system; and memory containing instructions which, when executed by the one or more processors, cause the system to correlate, combine, fuse, compare, or otherwise process at least a portion of the intelligent signaling network data with the external information, determine information concerning at least one subject, relationship, behavior, activity, condition, cause, prediction, or event external to the intelligent signaling network, and generate Synthetic Data based at least in part upon the determined information.
19. The system of claim 18 wherein the instructions further cause the system to perform at least one of: construct a purpose-specific Event Record; initiate an active

signaling inquiry or sweep; select or modify a sampling strategy; request additional signaling observations or external information in response to an initial inference; supply Synthetic Data to another artificial intelligence system or authorized agent; generate an emergency communication alert; or prepare, route, update, recommend, or, when authorized, submit a regulatory notice or report.

- 20.** A nontransitory computer-readable medium containing instructions which, when executed by one or more processors, cause the one or more processors to obtain intelligent signaling network data and information external to the intelligent signaling network, process by an artificial intelligence system at least a portion of the intelligent signaling network data with the external information, determine information concerning an external subject, relationship, behavior, activity, condition, cause, prediction, or event, and generate Synthetic Data based at least in part upon the determined information.
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ABSTRACT

Systems and methods use intelligent signaling network data as a machine observable information source for artificial intelligence. Signaling observations associated with communication attempts, routing, completion, failure, endpoint status, network behavior, or active signaling inquiries are obtained and processed with information external to the signaling network. Artificial intelligence correlates, combines, fuses, compares, or otherwise evaluates the signaling observations and external information to generate Synthetic Data concerning an external event, cause, condition, relationship, behavior, activity, location, impact, risk, or prediction. Signaling observations may be obtained passively, actively, or iteratively and may be assembled into purpose specific Event Records. Artificial intelligence may select sampling sweeps, request additional observations, discover previously undefined patterns, support emergency communications, generate regulatory notices, reduce duplicate alerts, identify affected or responsible carriers, and provide results to human recipients, automated systems, or other artificial intelligence agents.