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SYSTEMS AND METHODS FOR PERFORMING AI-DRIVEN RELEVANCY SEARCH

Abstract

Computerized systems and methods are described for enhancing search capabilities and user engagement within technology distribution platforms. The system integrates components including Real-Time Data Mesh, Single Pane of Glass User Interface, Advanced Analytics and Machine-Learning Module, and Relevancy Search Engine Module, Embodiments aggregate real-time data from multiple sources, standardize it for efficient processing, and utilize advanced analytics and machine learning models to optimize search results. A Relevancy Search Engine prioritizes search results based on relevancy scores using machine learning models and natural language processing. A Dynamic SKU Search Engine enables dynamic and responsive search functionalities personalized to user needs. A Personalization Engine provides personalized recommendations based on user profiles and interactions. A Real-Time Relevancy Adjustment Module ensures continuous optimization of search relevancy. Methods include initiating enhancement processes, analyzing search queries, processing data, and adjusting relevancy in real-time. Impact is measured using performance indicators.

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Background/Summary

CROSS REFERENCE TO RELATED APPLICATIONS [0001] This application is a Continuation-in-Part (CIP) of U.S. patent application Ser. No. 18/341,714, filed on Jun. 26, 2023. This application is also a Continuation-in-Part (CIP) of U.S. patent application Ser. No. 18/349,836, filed on Jul. 10, 2023. Each of these applications is incorporated herein by reference in its entirety.

BACKGROUND
[0002] Traditional ordering processes in distribution and supply-chain platforms are marred with inefficiencies, delays, and inaccuracies. In the conventional landscape, multiple systems and vendors usually perform each activity independently, from creating a bill of materials to registering deals, applying pricing, generating quotes, and submitting orders. This approach leads to operational inefficiencies and a heightened likelihood of errors.
[0003] Enterprise Resource Planning (ERP) systems have served as the mainstay in managing business processes, including distribution and supply chain. These systems act as central repositories where different departments such as finance, human resources, and inventory management can access and share real-time data. While ERPs are comprehensive, they present several challenges in today's complex distribution and supply chain environment. One of the primary challenges is data fragmentation. Data silos across different departments or even separate ERP systems make real-time visibility difficult to achieve. Users lack a comprehensive view of key distribution and supply chain metrics, which adversely affects decision-making processes.
[0004] Moreover, ERP systems often do not offer effective data integration capabilities. Traditional ERP systems are not designed to integrate efficiently with external systems or even between different modules within the same ERP suite. This design results in a cumbersome and error-prone manual process to transfer data between systems and affects the flow of information throughout the supply chain. Data inconsistencies occur when information exists in different formats across systems, hindering accurate data analysis and leading to uninformed decision-making. Conventional data normalization techniques are time-intensive and error-prone when applied to heterogeneous and fragmented data sources. There remains a need for systems capable of interpreting and extracting value from inconsistent data without prior cleansing.
[0005] Data inconsistency presents another challenge. When data exists in different formats or units across departments or ERPs, standardizing this data for meaningful analysis becomes a painstaking process. Businesses often resort to time-consuming manual processes for data transformation and validation, which further delays decision-making. Additionally, traditional ERP systems often lack the capabilities to handle large volumes of data effectively. These systems struggle to provide timely insights for operational improvements, particularly problematic for businesses dealing with complex and expansive distribution and supply chain networks.
[0006] Data security is another concern, especially considering the sensitive nature of supply chain data, which includes customer details, pricing, and contracts. Ensuring compliance with global

regulations on data security and governance adds an additional layer of complexity. Traditional ERP systems often lack robust security features agile enough to adapt to the continually evolving landscape of cybersecurity threats and compliance requirements.

BRIEF SUMMARY OF THE INVENTION

[0007] Automated Relevancy Search processes are designed to address deficiencies in search capabilities within technology distribution platforms by integrating various systems and activities into a unified interface, enabling enhanced search experiences and efficient navigation of products and services. This transformation enhances the search experience, facilitates efficient product discovery, and ensures personalized recommendations tailored to individual user preferences and requirements. The platform ensures data integrity and relevance while effectively integrating and optimizing search processes.

[0008] In the global distribution industry, challenges such as inefficient search capabilities, SKU management, and the need for real-time relevancy adjustments necessitate innovative solutions. Traditional search methods are increasingly insufficient, particularly with shifts in consumer expectations and market dynamics. By integrating functionalities for real-time data mesh integration, dynamic SKU searches, and personalized recommendations, the platform supports a shift from traditional search methods to a flexible, AI-powered search model. The platform further eliminates the need for manual or rule-based data preparation by employing AI-powered relevance detection across unstructured and inconsistent data formats, enabling meaningful search operations without traditional cleansing or normalization steps.

[0009] According to some embodiments, a search optimization module can be configured to incorporate algorithms to optimize search results based on real-time data and user preferences. The system includes a search optimization module that, integrated with Real-Time Data Mesh (RTDM) and Single Pane of Glass User Interface (SPoG UI), optimizes the relevancy of search results. Using advanced algorithms, it adapts search results based on real-time data and user interactions, enhancing the relevance and accuracy of search options.

[0010] In a non-limiting example, a Search Recommendation Engine employs sophisticated algorithms to offer dynamic, personalized search options to users. A Real-Time Relevancy Adjustment Module, using models like neural networks or decision trees, dynamically adjusts search relevancy based on real-time market data, user feedback, and historical interactions.

[0011] In an embodiment, a Dynamic SKU Search Engine operably connected with the RTDM and SPoG UI conducts dynamic and static SKU searches to retrieve comprehensive search results. The engine optimizes search results based on relevancy scores, considering factors such as product attributes, user preferences, and real-time market dynamics. The system includes a real-time data mesh integration for efficient data retrieval, ensuring comprehensive coverage and accuracy.

[0012] In some embodiments, the system enables users to refine their search queries and explore additional options through an intuitive user interface. It includes a module for capturing user feedback and behavior, facilitating continuous improvement and optimization of search results. Additionally, the system employs validation algorithms to ensure the accuracy of search queries, synchronizing real-time data to provide consistent and up-to-date search options.

[0013] Embodiments disclosed herein integrate multiple systems, automate processes, and validate to enhance search capabilities within technology distribution platforms. By implementing intelligent rules and algorithms, the system efficiently delivers relevant and accurate search results, reducing search time and improving user satisfaction. The system's adaptability ensures it remains current and evolves to meet market and user demands.

[0014] The system uses data-driven methods to optimize search experiences based on user preferences and real-time market data. This includes analyzing user interactions and historical search patterns to discern preferences and anticipate needs. Automated search optimization integrates various factors such as product specifications, user feedback, and market trends to deliver personalized and relevant search options tailored to individual user requirements.

[0015] In this process, user profiles are automatically generated based on comprehensive data analysis, encompassing aspects like search history and interaction patterns. This data informs the creation of search options that meet specific user needs in areas such as technology products and services. The system employs advanced algorithms to analyze user data and deliver search options that align with individual preferences and requirements.

[0016] The system incorporates advanced algorithms to analyze user data, including historical search patterns and user interactions, to optimize search experiences. This facilitates the delivery of search options that are highly relevant and tailored to individual user preferences. Automated search optimization integrates various factors such as product specifications, user feedback, and real-time market data to deliver accurate and personalized search options.

Single Pane of Glass

[0017] The Single Pane of Glass (SPoG) can provide a comprehensive solution that is configured to address these multifaceted challenges. It can be configured to provide a holistic, user-friendly, and efficient platform that facilitates the distribution process.

[0018] According to some embodiments, SPoG can be configured to address supply chain and distribution management by enhancing visibility and control over the supply chain process. Through real-time tracking and analytics, SPoG can deliver valuable insights into inventory levels and the status of goods, ensuring that the process of supply chain and distribution management is handled efficiently.

[0019] According to some embodiments, SPoG can integrate multiple touchpoints into a single platform to emulate a direct consumer channel into a distribution platform. This integration provides a unified direct channel for consumers to interact with distributors, significantly reducing the complexity of the supply chain and enhancing the overall customer experience.

[0020] SPoG offers an innovative solution for improved inventory management through advanced forecasting capabilities. These predictive analytics can highlight demand trends, guiding companies in managing their inventory more effectively and mitigating the risks of stockouts or overstocks.

[0021] According to some embodiments, SPoG can include a global compliance database. Updated in real-time, this database enables distributors to stay abreast with the latest international laws and regulations. This feature significantly reduces the burden of manual tracking, ensuring smooth and compliant cross-border transactions.

[0022] According to some embodiments, SPoG integrates data from various sources into a single platform, ensuring data consistency and reducing the potential for errors. This integrated data facilitates efficient management of products and enhances automated search relevancy, aligning with specific market needs and requirements.

[0023] According to some embodiments, SPoG is its highly configurable and user-friendly platform. Its intuitive interface allows users to easily access and purchase technology, thereby aligning with the expectations of the new generation of tech buyers.

[0024] Moreover, SPoG's advanced analytics capabilities offer invaluable insights that can drive strategy and decision-making. It can track and analyze trends in real-time, allowing companies to stay ahead of the curve and adapt to changing market conditions.

[0025] SPoG's flexibility and scalability make it a future-proof solution. It can adapt to changing business needs, allowing companies to expand or contract their operations as needed without significant infrastructural changes.

[0026] SPoG's innovative approach to resolving the challenges in the distribution industry makes it an invaluable tool. By enhancing supply chain visibility, facilitating inventory management, ensuring compliance, and improving automated search relevancy, it offers a comprehensive solution to the complex problems that have long plagued the distribution sector. Through its implementation, distributors can look forward to increased efficiency, reduced errors, and improved customer satisfaction, leading to sustained growth in the ever-evolving global market.

Real-Time Data Mesh (RTDM)

[0027] The platform can be include implementation(s) of a Real-Time Data Mesh (RTDM), according to some embodiments. RTDS offers an innovative solution to address these challenges. RTDM, a distributed data architecture, enables real-time data availability across multiple sources and touchpoints. This feature enhances supply chain visibility, allowing for efficient management and enabling distributors to handle disruptions more effectively.
[0028] RTDM's predictive analytics capability offers a solution for efficient inventory control. By providing insights into demand trends, it aids companies in managing inventory, reducing risks of overstocking or stockouts.
[0029] RTDM's global compliance database, updated in real-time, ensures distributors are current with international regulations. It significantly reduces the manual tracking burden, enabling cross-border transactions.
[0030] The RTDM simplifies data integration from various sources, ensuring data consistency and reducing error potential. Its capabilities for managing products and market data efficiently align with specific market needs and enhance automated search relevancy.
[0031] The RTDM enhances customer experience with its intuitive interface, allowing easy access and purchase of technology, meeting the expectations of the new generation of tech buyers.
Advantages of SPoG and RTDM Integration
[0032] Integrating the SPoG platform with RTDM provides numerous advantages. Firstly, it offers a holistic solution to longstanding distribution industry challenges. With RTDM's capabilities, SPoG enhances supply chain visibility, facilitates data integration, and improves automated search relevancy.
[0033] The real-time tracking and analytics offered by RTDM improve SPoG's ability to manage the supply chain and inventory effectively. It provides accurate and current information, enabling distributors to make informed decisions quickly.
[0034] Integrating SPoG with RTDM also ensures data consistency and reduces errors in data management. By providing a centralized platform for managing data from various sources, it simplifies product localization and helps to align with market needs and improve automated search relevancy.
[0035] The global compliance database of RTDM, integrated with SPoG, facilitates and compliant cross-border transactions. It also reduces the burden of manual tracking, saving significant time and resources.
[0036] In some embodiments, a distribution platform incorporates SPoG and RTDM to provide an improved and comprehensive distribution system. The platform can leverage the advantages of a distribution model, addresses its existing challenges, and positions it for sustained growth in the ever-evolving global market.

Description

BRIEF DESCRIPTION OF THE DRAWINGS/FIGURES
[0037] FIG. **1** illustrates one embodiment of an operating environment of a distribution platform, referred to as System in this embodiment.
[0038] FIG. **2** illustrates one embodiment of an operating environment of the distribution platform, which builds upon the elements introduced in FIG. **1**.
[0039] FIG. **3** illustrates an embodiment of a system for distribution management.
[0040] FIG. **4** depicts a system for automated relevancy search processes, according to an embodiment.
[0041] FIG. **5** illustrates an RTDM module, according to an embodiment.
[0042] FIG. **6** illustrates a SPoG UI, according to an embodiment.
[0043] FIG. **7** illustrates a system for automated relevancy search, according to an embodiment.

[0044] FIG. **8** is a flow diagram of a method for integrating Generative AI and Large Language Models in an automated relevancy search system, according to some embodiments of the present disclosure.
[0045] FIG. **9** is a flow diagram of a method for implementing Fuzzy Logic and Natural Language Processing (NLP) Enhancement in an automated relevancy search system, according to some embodiments of the present disclosure.
[0046] FIG. **9** is a flow diagram of a method for implementing Real-Time Data Mesh Integration and Dynamic SKU Searches, according to some embodiments of the present disclosure.
[0047] FIG. **11** is a block diagram of example components of device, according to some embodiments of the present disclosure.
[0048] FIGS. **12**A to **12**Q depict various screens and functionalities of the SPoG UI, according to some embodiments.

DETAILED DESCRIPTION OF THE INVENTION

[0049] Embodiments may be implemented in hardware, firmware, software, or any combination thereof. Embodiments may also be implemented as instructions stored on a machine-readable medium, which may be read and executed by one or more processors. A machine-readable medium may include any mechanism for storing or transmitting information in a form readable by a machine (e.g., a computing device). For example, a machine-readable medium may include read only memory (ROM); random access memory (RAM); magnetic disk storage media; optical storage media; flash memory devices, and others. Further, firmware, software, routines, instructions may be described herein as performing certain actions. However, it should be appreciated that such descriptions are merely for convenience and that such actions in fact result from computing devices, processors, controllers, or other devices executing the firmware, software, routines, instructions, etc.
[0050] It should be understood that the operations shown in the exemplary methods are not exhaustive and that other operations can be performed as well before, after, or between any of the illustrated operations. In some embodiments of the present disclosure, the operations can be performed in a different order and/or vary.
[0051] FIG. **1** illustrates an operating environment **100** of a distribution platform, referred to as System **110** in this embodiment. System **110** operates within the context of an information technology (IT) distribution model, catering to various users such as customers **120**, end customers **130**, vendors **140**, resellers **150**, and other entities involved in the distribution process. This operating environment encompasses a broad range of characteristics and dynamics that contribute to the success and efficiency of the distribution platform.
[0052] Customers **120** within the operating environment of System **110** represent businesses or individuals seeking IT solutions to meet their specific needs. These customers may require a diverse range of IT products such as hardware components, software applications, networking equipment, or cloud-based services. System **110** provides customers with a user-friendly interface, allowing them to browse, search, and select the most suitable IT solutions based on their requirements. Customers can also access real-time data and analytics through System **110**, empowering them to make informed decisions and optimize their IT infrastructure.
[0053] End customers **130** can be the ultimate beneficiaries of the IT solutions provided by System **110**. They may include businesses or individuals who utilize IT products and services to enhance their operations, productivity, or daily activities. End customers rely on System **110** to access a wide array of IT solutions, ensuring they have access to the latest technologies and innovations in the market. System **110** enables end customers to track their orders, receive updates on delivery status, and access customer support services, thereby enhancing their overall experience.
[0054] Vendors **140** play a crucial role within the operating environment of System **110**. These vendors encompass manufacturers, distributors, and suppliers who offer a diverse range of IT products and services. System **110** acts as a centralized platform for vendors to showcase their

offerings, manage inventory, and facilitate transactions with customers and resellers. Vendors can leverage System **110** to facilitate their supply chain operations, manage pricing and promotions, and gain insights into customer preferences and market trends. By integrating with System **110**, vendors can expand their reach, access new markets, and enhance their overall visibility and competitiveness.

[0055] Resellers **150** can be intermediaries within the distribution model who bridge the gap between vendors and customers. They play a vital role in the IT distribution ecosystem by connecting customers with the right IT solutions from various vendors. Resellers may include retailers, value-added resellers (VARs), system integrators, or managed service providers. System **110** enables resellers to access a comprehensive catalog of IT solutions, manage their sales pipeline, and provide value-added services to customers. By leveraging System **110**, resellers can enhance their customer relationships, optimize their product offerings, and increase their revenue streams.

[0056] Within the operating environment of System **110**, there can be various dynamics and characteristics that contribute to its effectiveness. These dynamics include real-time data exchange, integration with existing enterprise systems, scalability, and flexibility. System **110** ensures that relevant data can be exchanged in real-time between users, enabling accurate decision-making and timely actions. Integration with existing enterprise systems such as enterprise resource planning (ERP) systems, customer relationship management (CRM) systems, and warehouse management systems allows for communication and interoperability, eliminating data silos and enabling end-to-end visibility.

[0057] System **110** can achieve scalability and flexibility. It can accommodate the growing demands of the IT distribution model, whether it involves an expanding customer base, an increasing number of vendors, or a wider range of IT products and services. System **110** can be configured to handle large-scale data processing, storage, and analysis, ensuring that it can support the evolving needs of the distribution platform. Additionally, System **110** leverages a technology stack that includes .NET, Java, and other suitable technologies, providing a robust foundation for its operations.

[0058] In summary, the operating environment of System **110** within the IT distribution model encompasses customers **120**, end customers **130**, vendors **140**, resellers **150**, and other entities involved in the distribution process. System **110** serves as a centralized platform that facilitates efficient collaboration, communication, and transactional processes between these users. By leveraging real-time data exchange, integration, scalability, and flexibility, System **110** empowers users to optimize their operations, enhance customer experiences, and drive business success within the IT distribution ecosystem.

[0059] FIG. **2** depicts the operating environment **200** of the distribution platform, expanding upon elements introduced in FIG. **1**. This environment features integration points **210**, which enable data flow and connectivity among various systems like customer systems **220**, vendor systems **240**, reseller systems **260**, and other entities within the Relevancy Search process. FIG. **2** illustrates the network's interconnectedness and mechanisms that facilitate collaborative and data-driven decision-making for Relevancy Search. Operating environment **200** configures to automate Relevancy Search processes using AI and ML technologies, processing and analyzing data for search enhancement.

[0060] Some embodiments of the Relevancy Search process involve a systematic approach to enhance search capabilities and user engagement within the distribution platform. This process encompasses several technological components: Collection of diverse data including user search queries, product specifications, and historical search patterns. This data, aggregated from sources like search logs and product databases, feeds into the Real-Time Data Mesh (RTDM). RTDM processes and standardizes this data, serving as a centralized repository for real-time data updating and retrieval. The AAML Module analyzes this aggregated data to identify optimal strategies for

enhancing search relevancy. It segments search queries based on data-driven insights and predicted user preferences. The Relevancy Search Engine Module, informed by AAML Module insights, configures search algorithms for each user or market segment. It applies predictive models and heuristic algorithms to determine search results that align with specific user requirements. Users interact with these search results through the SPoG UI, exploring and selecting relevant products or services. The system includes a feedback loop where user interactions with search results are collected and analyzed, continually refining the search experience.

[0061] AI algorithms in the Relevancy Search process address search relevancy, user preferences, and optimization of search results. Machine learning models, such as neural networks and decision trees, refine search algorithms. The Relevancy Search process uses ML-based algorithms for real-time search optimization. Advanced analytics, like ensemble learning or reinforcement learning, continuously improve the Relevancy Search process. AI and ML technologies in operating environment **200** employ supervised and unsupervised learning algorithms, including convolutional neural networks for pattern recognition and logistic regression for decision-making. These components adapt dynamically to changing data inputs like user search behavior and market conditions, optimizing search pathways through reinforcement learning. ML components leverage predictive analytics, continuously refining outputs by assimilating new data to enhance search relevancy and user engagement.

[0062] Operating environment **200** includes System **110** as the central hub for managing the Relevancy Search process. System **110** functions as a bridge among customer systems **220**, vendor systems **240**, reseller systems **260**, and other entities. It integrates communication, data exchange, and transactional processes, offering a cohesive experience. Moreover, environment **200** features integration points **210**, using a hybrid architecture that combines RESTful APIs and WebSockets for real-time data exchange and synchronization. This architecture secures with SSL/TLS protocols, safeguarding data during transit.

[0063] Customer System Integration: Integration point **210** enables System **110** to connect with customer systems **220**, facilitating efficient data exchange and synchronization. Customer systems **220** may include entities like customer system **221**, customer system **222**, and customer system **223**. These systems represent internal systems used by customers, such as ERP or CRM systems. Integration with customer systems **220** allows customers to access real-time information on search results, including personalized recommendations, pricing details, and other relevant data, enhancing their search experience. This integration offers an automated, real-time solution for optimizing search relevancy and user engagement.

[0064] Data exchange among customer systems **220**, vendor systems **240**, and reseller systems **260** is enabled by a robust ETL (Extract, Transform, Load) described below in reference to the real-time data mesh architecture, in ensuring data consistency and reliability. This interaction can be governed by predefined business rules and logic, which dictate the data flow and processing methodologies. Advanced mapping and transformation tools are employed to harmonize disparate data formats, allowing for integration and utilization of data across these systems. Orchestrated data exchange supports synchronized operations, enabling efficient and informed decision-making across the distribution network.

[0065] Associate System Integration: Integration point **210** enables System **110** to connect with associate systems **230**, facilitating efficient data exchange and synchronization. These systems contribute to the overall efficiency of Relevancy Search processing by providing relevant market and product data.

[0066] Vendor System Integration: Integration point **210** facilitates the connection between System **110** and vendor systems **240**. Vendor systems **240** may include entities like vendor system **241**, vendor system **242**, and vendor system **243**, representing inventory management, pricing systems, and product catalogs. Integration with vendor systems **240** ensures vendors can efficiently update their offerings and receive real-time notifications, to facilitate the Relevancy Search process.

[0067] Reseller System Integration: Integration point **210** allows reseller systems **260** to connect with System **110**. Reseller systems **260** encompass entities such as reseller system **261**, reseller system **262**, and reseller system **263**, handling sales, customer management, and service delivery.
[0068] Other Entity System Integration: Integration point **210** also connects other entities involved in the distribution process, facilitating collaboration and efficient distribution. This integration ensures real-time data exchange for Relevancy Search processing and decision-making in the distribution ecosystem.
[0069] System **110**'s configuration includes sophisticated AI and ML capabilities to optimize Relevancy Search processing according to individual preferences, ensuring relevance and optimization in the distribution process.
[0070] Integration points **210** also enable connectivity with System of Records **280**, for additional data management and integration. Representing System of Records **280** can represent enterprise resource planning (ERP) systems or customer relationship management (CRM) systems, including both future systems as well as legacy ERP systems such as SAP, Impulse, META, I-SCALA, and others. System of Records can include one or more storage repositories of critical and legacy business data. It facilitates integration of data exchange and synchronization between the distribution platform, System **110**, and the ERPs, enabling real-time updates and ensuring the availability of accurate and up-to-date information. Integration points **210** establish connectivity between the System of Records **280** and the distribution platform, allowing stakeholders to leverage rich data stored in the ERPs for efficient collaboration, data-driven decision-making, and streamlined distribution processes. These systems represent the internal systems utilized by customers, vendors, and others.
[0071] Integration points **210** within the operating environment **200** can be facilitated through standardized protocols, APIs, and data connectors. These mechanisms ensure compatibility, interoperability, and secure data transfer between the distribution platform and the connected systems. System **110** employs industry-standard protocols, such as RESTful APIs, SOAP, or GraphQL, to establish communication channels and enable data exchange.
[0072] In some embodiments, System **110** can incorporate authentication and authorization mechanisms to ensure secure access and data protection. Technologies such as OAuth or JSON Web Tokens (JWT) can be employed to authenticate users, authorize data access, and maintain the integrity and confidentiality of the exchanged information.
[0073] In some embodiments, integration points **210** and data flow within the operating environment **200** enable users to operate within a connected ecosystem. Data generated at various stages of the Relevancy Search process, including user search queries, product information, and search interactions, flows between customer systems **220**, vendor systems **240**, reseller systems **260**, and other entities. This data exchange facilitates real-time visibility, enables data-driven decision-making, and enhances operational efficiency throughout the distribution platform.
[0074] In some embodiments, System **110** leverages advanced technologies such as Typescript, NodeJS, ReactJS, .NET Core, C#, and other suitable technologies to support the integration points **210** and enable communication within the operating environment **200**. These technologies provide a robust foundation for System **110**, ensuring scalability, flexibility, and efficient data processing capabilities. Moreover, the integration points **210** may also employ algorithms, data analytics, and machine learning techniques to derive valuable insights, optimize distribution processes, and personalize customer experiences. Integration points **210** and data flow within the operating environment **200** enable users to operate within a connected ecosystem. Data generated at various touchpoints, including customer orders, inventory updates, pricing changes, or delivery status, flows between the different entities, systems, and components. The integrated data can be processed, harmonized, and made available in real-time to relevant users through System **110**. This real-time access to accurate and current information empowers users to make informed decisions, optimize supply chain operations, and enhance customer experiences.

[0075] Several elements in the operating environment depicted in FIG. **2** can include conventional, well-known elements that are explained only briefly here. For example, each of the customer systems, such as customer systems **220**, could include a desktop personal computer, workstation, laptop, PDA, cell phone, or any wireless access protocol (WAP) enabled device, or any other computing device capable of interfacing directly or indirectly with the Internet or other network connection. Each of the customer systems typically can run an HTTP client, such as Microsoft's Edge browser, Google's Chrome browser, Opera's browser, or a WAP-enabled browser for mobile devices, allowing customer systems to access, process, and view information, pages, and applications available from the distribution platform over the network.
[0076] Moreover, each of the customer systems can typically be equipped with user interface devices such as keyboards, mice, trackballs, touchpads, touch screens, pens, or similar devices for interacting with a graphical user interface (GUI) provided by the browser. These user interface devices enable users of customer systems to navigate the GUI, interact with pages, forms, and applications, and access data and applications hosted by the distribution platform.
[0077] The customer systems and their components can be operator-configurable using applications, including web browsers, which run on central processing units such as Intel Pentium processors or similar processors. Similarly, the distribution platform (System **110**) and its components can be operator-configurable using applications that run on central processing units, such as the processor system, which may include Intel Pentium processors or similar processors, and/or multiple processor units.
[0078] Computer program product embodiments include machine-readable storage media containing instructions to program computers to perform the processes described herein. The computer code for operating and configuring the distribution platform and the customer systems, vendor systems, reseller systems, and other entities' systems to intercommunicate, process webpages, applications, and other data, can be downloaded and stored on hard disks or any other volatile or non-volatile memory medium or device, such as ROM, RAM, floppy disks, optical discs, DVDs, CDs, micro-drives, magneto-optical disks, magnetic or optical cards, nano-systems, or any suitable media for storing instructions and data.
[0079] Furthermore, the computer code for implementing the embodiments can be transmitted and downloaded from a software source over the Internet or any other conventional network connection using communication mediums and protocols such as TCP/IP, HTTP, HTTPS, Ethernet, etc. The code can also be transmitted over extranets, VPNs, LANs, or other networks, and executed on client systems, servers, or server systems using programming languages such as C, C++, HTML, Java, JavaScript, ActiveX, VBScript, and others.
[0080] It will be appreciated that the embodiments can be implemented in various programming languages executed on client systems, servers, or server systems, and the choice of language may depend on the specific requirements and environment of the distribution platform.
[0081] Thereby, operating environment **200** can couple a distribution platform with one or more integration points **210** and data flow to enable efficient collaboration and streamlined distribution processes.
[0082] FIG. **3** illustrates a system **300** for supply chain and distribution management. System **300** (FIG. **3**) is a supply chain and distribution management solution configured to address the challenges faced by fragmented distribution ecosystems in the global distribution industry. System **300** can include several interconnected components and modules that work in harmony to optimize supply chain and distribution operations, enhance collaboration, and drive business efficiency.
[0083] The Single Pane of Glass (SPoG) UI **305** serves as a centralized user interface, providing users with a unified view of the entire supply chain. It consolidates information from various sources and presents real-time data, analytics, and functionalities tailored to the specific roles and responsibilities of users. By offering a customizable and intuitive dashboard-style layout, the SPoG UI enables users to access relevant information and tools, empowering them to make data-driven

decisions and efficiently manage their supply chain and distribution activities.
[0084] For example, a logistics manager can use the SPoG UI to monitor the status of shipments, track delivery routes, and view real-time inventory levels across multiple warehouses. They can visualize data through interactive charts and graphs, such as a map displaying the current location of each shipment or a bar chart showing inventory levels by product category. By having a unified view of the supply chain, the logistics manager can identify bottlenecks, optimize routes, and ensure timely delivery of goods.
[0085] The SPoG UI **305** integrates with other modules of System **300**, facilitating real-time data exchange, synchronized operations, and workflows. Through API integrations, data synchronization mechanisms, and event-driven architectures, SPoG UI **305** ensures smooth information flow and enables collaborative decision-making across the distribution ecosystem. SPoG UI **305** is designed with a user-centric approach, featuring an intuitive and responsive layout. It utilizes front-end technologies to render dynamic and interactive data visualizations. Customizable dashboards allow users to tailor their views based on specific roles and requirements. The UI supports drag-and-drop functionality for ease of use, and its adaptive design ensures compatibility across various devices and platforms. Advanced filtering and search capabilities enable users to efficiently navigate and access relevant supply chain data and insights.
[0086] For instance, when a purchase order is generated in the SPoG UI, the system automatically updates the inventory levels, triggers a notification to the warehouse management system, and initiates the shipping process. This integration enables efficient order fulfillment, reduces manual errors, and enhances overall supply chain visibility.
[0087] The Real-Time Data Mesh (RTDM) module **310** is another component of System **300**, responsible for ensuring the flow of data within the distribution ecosystem. It aggregates data from multiple sources, harmonizes it, and ensures its availability in real-time.
[0088] In a distribution network, the RTDM module collects data from various systems, including inventory management systems, point-of-sale terminals, and customer relationship management systems. It harmonizes this data by aligning formats, standardizing units of measurement, and reconciling any discrepancies. The harmonized data can be then made available in real-time, allowing users to access accurate and current information across the distribution and supply chain.
[0089] The RTDM module **310** can be configured to capture changes in data across multiple transactional systems in real-time. It employs a sophisticated Change Data Capture (CDC) mechanism that constantly monitors the transactional systems, detecting any updates or modifications. The CDC component can be specifically configured to work with various transactional systems, including legacy ERP systems, Customer Relationship Management (CRM) systems, and other enterprise-wide systems, ensuring compatibility and flexibility for businesses operating in diverse environments.
[0090] By having access to real-time data, users can make timely decisions and respond quickly to changing market conditions. For example, if the RTDM module detects a sudden spike in demand for a particular product, it can trigger alerts to the production team, enabling them to adjust manufacturing schedules and prevent stockouts.
[0091] The RTDM module **310** facilitates data management within supply chain operations. It enables real-time harmonization of data from multiple sources, freeing vendors, resellers, customers, and end customers from constraints imposed by legacy ERP systems. This enhanced flexibility supports improved efficiency, customer service, and innovation.
[0092] Another component of System **300** is the Advanced Analytics and Machine Learning (AAML) module **315**. Leveraging powerful analytics tools and algorithms such as Apache Spark, TensorFlow, or scikit-learn, the AAML module extracts valuable insights from the collected data. It enables advanced analytics, predictive modeling, anomaly detection, and other machine learning capabilities.
[0093] For instance, the AAML module can analyze historical sales data to identify seasonal

patterns and predict future demand. It can generate forecasts that help optimize inventory levels, ensure stock availability during peak seasons, and minimize excess inventory costs. By leveraging machine learning algorithms, the AAML module automates repetitive tasks, predicts customer preferences, and optimizes supply chain processes.

[0094] In addition to demand forecasting, the AAML module can provide insights into customer behavior, enabling targeted marketing campaigns and personalized customer experiences. For example, by analyzing customer data, the module can identify cross-selling or upselling opportunities and recommend relevant products to individual customers.

[0095] Furthermore, the AAML module can analyze data from various sources, such as social media feeds, customer reviews, and market trends, to gain a deeper understanding of consumer sentiment and preferences. This information can be used to inform product development decisions, identify emerging market trends, and adapt business strategies to meet evolving consumer expectations.

[0096] System **300** emphasizes integration and interoperability to connect with existing enterprise systems such as ERP systems, warehouse management systems, and customer relationship management systems. By establishing connections and data flows between these systems, System **300** enables smooth data exchange, process automation, and end-to-end visibility across the supply chain. Integration protocols, APIs, and data connectors facilitate communication and interoperability among different modules and components, creating a holistic and connected distribution ecosystem.

[0097] The implementation and deployment of System **300** can be tailored to meet specific business needs. It can be deployed as a cloud-native solution using containerization technologies like Docker and orchestration frameworks like Kubernetes. This approach ensures scalability, easy management, and efficient updates across different environments. The implementation process involves configuring the system to align with specific supply chain requirements, integrating with existing systems, and customizing the modules and components based on the business's needs and preferences.

[0098] System **300** for supply chain and distribution management is a comprehensive and innovative solution that addresses the challenges faced by fragmented distribution ecosystems. It combines the power of the SPoG UI **305**, the RTDM module **310**, and the AAML module **315**, along with integration with existing systems. By leveraging a diverse technology stack, scalable architecture, and robust integration capabilities, System **300** provides end-to-end visibility, data-driven decision-making, and optimized supply chain operations. The examples and options provided in this description are non-limiting and can be customized to meet specific industry requirements, driving efficiency and success in supply chain and distribution management.

[0099] FIG. **4** depicts an embodiment of System **400** for an AI-driven relevancy search model, incorporating the SPoG UI, RTDM, and AI/ML technologies, with interactions to achieve a comprehensive relevancy search system. System **400** is configured for integration with existing reseller systems, ensuring efficient data exchange and system synchronization.

[0100] The SPoG UI **405** serves as the primary user interface. Users interact with this interface to perform various tasks provides straightforward interaction and customization. It displays information and options that are relevant to the distinct business models and customer demographics of the resellers. It displays real-time data from the Data Mesh **410** and provides controls for initiating actions in System **400**. For example, a user can interact with a dynamic display for service options, interactive elements for search customization, and tools for real-time feedback on user selections, directly from the SPoG UI **405**. It integrates with other system components to reflect accurate service information and user customization options. The SPoG UI is developed using web-based technologies, allowing it to be accessed from various types of devices such as desktop computers, laptops, tablets, and smartphones. SPoG UI **405** provides a comprehensive view of the entire distribution ecosystem, consolidating data and functionalities

from various modules into a centralized, easy-to-navigate platform. SPoG UI **405** simplifies the management of complex distribution tasks, offering a streamlined experience for resellers. In some embodiments, SPoG **405** comprises dynamic pricing tools, displaying variable costs based on individual user consumption patterns.

[0101] Data Mesh **410** is a sophisticated data management layer. It aggregates and harmonizes data from various sources, including ERPs, Vendor platforms, third-party databases, etc. This component ensures that all operational modules in System **400** access consistent and up-to-date information. System **400** can synchronize with existing reseller systems, ensuring efficient data exchange and system functionality

[0102] Data mesh **410** aggregates, harmonizes, and ensures the real-time availability of data from various systems like inventory management, point-of-sale, and CRM. It employs Change Data Capture (CDC) to track real-time changes in transactional systems. This module standardizes data formats and units, ensuring data consistency and accuracy for decision-making processes related to service offerings.

[0103] AI Module **460** uses machine learning algorithms and predictive modeling to automate relevancy search models. AI Module **460** analyzes market trends, user preferences, and consumption data to dynamically adjust search experiences. AI Module **460** is configured to dynamically adjust automated search models based on real-time usage data. This allows for a flexible search model that adapts to changing user needs and consumption habits.

[0104] AI Module **460** includes decision support systems for personalizing relevancy search criteria based on sophisticated data analysis. In some embodiments, AI Module **460** employs deep learning neural networks, specifically convolutional neural networks (CNNs) and recurrent neural networks (RNNs), for pattern recognition and time-series analysis. For example, CNNs can be used to identify trends and patterns in market data, while RNNs, particularly LSTM (Long Short-Term Memory) networks, can analyze sequential data, such as time-based user interaction patterns. In some embodiments, AI module **460** can use decision trees for classification and regression tasks. These trees analyze user data and market conditions to segment users into different categories based on their service preferences. Random forest and gradient boosting algorithms, ensemble methods of decision trees, provide improved accuracy and stability in predictions. In some embodiments, clustering, particularly K-means and hierarchical clustering, is employed to segment the market and user base into distinct groups. Market/user segmentation assists AI Module **460** in understanding varied user preferences and customizing relevancy search models for different market segments. In some embodiments, these models can be configured to extract semantic meaning and relational patterns even from fragmented or inconsistently formatted input data, reducing dependency on conventional data preparation workflows.

[0105] In some embodiments, AI Module **460** can use reinforcement learning (RL) to adapt service offerings based on user feedback. RL algorithms, particularly Q-learning and policy gradient methods, can adjust models to maximize user satisfaction, learning from each interaction to improve recommendation accuracy. I The module integrates reinforcement learning algorithms to continually adapt service offerings based on user feedback, enhancing the accuracy and relevance of customized search models over time. Further, NLP techniques can be employed to analyze user feedback and queries. Utilizing tokenization, sentiment analysis, and named entity recognition, AI Module **460** interprets user feedback, enhancing the service customization process.

[0106] Real-time processing based on Data Mesh **410** enables AI module **460** to dynamically adjust service offerings based on current usage patterns and immediate market feedback. Data Mesh **410** also enables precise tracking of real-time usage data for implementing a usage-based pricing strategy. Data Mesh **410** can include collaborative filtering and content-based recommendation systems to analyze user behavior and preferences, comparing them with similar user profiles or content characteristics to suggest appropriate service adjustments.

[0107] In some embodiments, AI Module **460** can integrate predictive analytics tools, employing

time series forecasting methods (e.g., AutoRegressive Integrated Moving Average, exponential smoothing, etc.) for predicting future service demand. Optimization algorithms, such as linear programming and genetic algorithms, can facilitate optimal relevancy search configurations, considering various factors like cost, user preferences, and resource availability to recommend the most effective service bundles. AI Module **460** can employ Monte Carlo simulations and scenario analysis for risk assessment and strategic planning, simulating different market scenarios, evaluating the potential impacts of relevancy search configurations and models under different conditions.

[0108] Relevancy Integration (RI) Module **420** is configured to generate AI-powered relevancy search, incorporating the SPoG UI, Data Mesh, and AI technologies, with interactions to achieve a comprehensive search solution. In some embodiments, RI Module **420** is configured via data mesh for integration with existing distribution systems, ensuring efficient data exchange and system synchronization.

[0109] In some embodiments, RI Module **420** is integrated with AI Module **460** to enhance search experiences using machine learning algorithms and predictive modeling. RI Module **420** can leverage historical search data, user preferences, and market trends to dynamically adjust search relevancy and optimize search results, moving away from a pull model, where customers query what they are interested in, to a push model where the system intelligently determines insights and recommendations based on relevancy to the user. RI Module **420** can invoke AI Module **460** to analyze user interactions with search results to continually improve relevancy and engagement. For example, RI Module **420** can integrate with AI Module **460** to provide decision support systems for personalizing search results based on sophisticated data analysis. Deep learning neural networks, such as convolutional neural networks (CNNs) and recurrent neural networks (RNNs), can be employed via AI Module **460** for pattern recognition and analysis of search queries and results. Reinforcement learning algorithms, such as Q-learning and policy gradient methods, can be integrated via AI Module **460** to adapt search results based on user feedback. In another non-limiting example, NLP algorithms can be utilized to analyze user queries and feedback, for enhancing the search customization process.

[0110] RI Module **420** can leverage real-time processing based on Data Mesh **410** and AI Module **460** to dynamically adjust search results based on current usage patterns and immediate feedback. Collaborative filtering and content-based recommendation systems can be employed to analyze user behavior and preferences, suggesting relevant search adjustments.

[0111] In some embodiments, RI Module **420** can utilize predictive analytics tools, including time series forecasting methods and optimization algorithms, via AI Module **460**, for predicting future search trends and optimizing search results. Monte Carlo simulations and scenario analysis can be utilized for risk assessment and strategic planning related to search relevancy and engagement.

[0112] RI Module **420** is thereby configured for managing search operations, analyzing search metrics, personalizing search experiences, and optimizing search resources within the distribution ecosystem. AI-powered relevancy search provides a comprehensive solution that addresses challenges faced by distribution ecosystems. System **400** provides personalized and optimized search experiences, driving engagement and efficiency in distribution operations. The examples and options provided in this description are non-limiting and can be customized to meet specific industry requirements, enhancing the search functionality in distribution environments.

[0113] FIG. **5** depicts an embodiment of an advanced distribution platform including System **500** for managing a complex distribution network, which can be an embodiment of System **300**, and provides a technology distribution platform for optimizing the management and operation of distribution networks. System **500** includes several interconnected modules, each serving specific functions and contributing to the overall efficiency of supply chain operations. In some embodiments, these modules can include SPoG UI **505**, CIM **510**, RTDM module **515**, AI module **520**, Interface Display Module **525**, Personalized Interaction Module **530**, Document Hub **535**,

Catalog Management Module **540**, Performance and Insight Markers Display **545**, Predictive Analytics Module **550**, Recommendation System Module **555**, Notification Module **560**, Self-Onboarding Module **565**, and Communication Module **570**.

[0114] System **500**, as an embodiment of System **300**, can use a range of technologies and algorithms to enable supply chain and distribution management. These technologies and algorithms facilitate efficient data processing, personalized interactions, real-time analytics, secure communication, and effective management of documents, catalogs, and performance metrics.

[0115] The SPoG UI **505**, in some embodiments, serves as the central interface within System **500**, providing users with a unified view of the entire distribution network. It utilizes frontend technologies such as ReactJS, TypeScript, and Node.js to create interactive and responsive user interfaces. These technologies enable the SPoG UI **505** to deliver a user-friendly experience, allowing users to access relevant information, navigate through different modules, and perform tasks efficiently.

[0116] The CIM **510**, or Customer Interaction Module, employs algorithms and technologies such as Oracle Eloqua, Adobe Target, and Okta to manage customer relationships within the distribution network. These technologies enable the module to handle customer data securely, personalize customer experiences, and provide access control for users.

[0117] The RTDM module **515**, or Real-Time Data Mesh module, is a component of System **500** that ensures the smooth flow of data across the distribution ecosystem. It utilizes technologies such as Apache Kafka, Apache Flink, or Apache Pulsar for data ingestion, processing, and stream management. These technologies enable the RTDM module **515** to handle real-time data streams, process large volumes of data, and ensure low-latency data processing. Additionally, the module employs Change Data Capture (CDC) mechanisms to capture real-time data updates from various transactional systems, such as legacy ERP systems and CRM systems. This capability allows users to access current and accurate information for informed decision-making.

[0118] The AI module **520** within System **500** can use advanced analytics and machine learning algorithms, including Apache Spark, TensorFlow, and scikit-learn, to extract valuable insights from data. These algorithms enable the module to automate repetitive tasks, predict demand patterns, optimize inventory levels, and improve overall supply chain efficiency. For example, the AI module **520** can utilize predictive models to forecast demand, allowing users to optimize inventory management and minimize stockouts or overstock situations.

[0119] The Interface Display Module **525** focuses on presenting data and information in a clear and user-friendly manner. It utilizes technologies such as HTML, CSS, and JavaScript frameworks like ReactJS to create interactive and responsive user interfaces. These technologies allow users to visualize data using various data visualization techniques, such as graphs, charts, and tables, enabling efficient data comprehension, comparison, and trend analysis.

[0120] The Personalized Interaction Module **530** utilizes customer data, historical trends, and machine learning algorithms to generate personalized recommendations for products or services. It employs technologies like Adobe Target, Apache Spark, and TensorFlow for data analysis, modeling, and delivering targeted recommendations. For example, the module can analyze customer preferences and purchase history to provide personalized product recommendations, enhancing customer satisfaction and driving sales.

[0121] The Document Hub **535** serves as a centralized repository for storing and managing documents within System **500**. It utilizes technologies like SeeBurger and Elastic Cloud for efficient document management, storage, and retrieval. For instance, the Document Hub **535** can employ SeeBurger's document management capabilities to categorize and organize documents based on their types, such as contracts, invoices, product specifications, or compliance documents, allowing users to easily access and retrieve relevant documents when needed.

[0122] The Catalog Management Module **540** enables the creation, management, and distribution of current product catalogs. It ensures that users have access to the latest product information,

including specifications, pricing, availability, and promotions. Technologies like Kentico and Akamai can be employed to facilitate catalog updates, content delivery, and caching. For example, the module can use Akamai's content delivery network (CDN) to deliver catalog information to users quickly and efficiently, regardless of their geographical location.

[0123] The Performance and Insight Markers Display **545** collects, analyzes, and visualizes real-time performance metrics and insights related to supply chain operations. It utilizes tools like Splunk and Datadog to enable effective performance monitoring and provide actionable insights. For instance, the module can utilize Splunk's log analysis capabilities to identify performance bottlenecks in the supply chain, enabling users to take proactive measures to optimize operations.

[0124] The Predictive Analytics Module **550** employs machine learning algorithms and predictive models to forecast demand patterns, optimize inventory levels, and enhance overall supply chain efficiency. It utilizes technologies such as Apache Spark and TensorFlow for data analysis, modeling, and prediction. For example, the module can utilize TensorFlow's deep learning capabilities to analyze historical sales data and predict future demand, allowing users to optimize inventory levels and minimize costs.

[0125] The Recommendation System Module **555** focuses on providing intelligent recommendations to users within the distribution network. It generates personalized recommendations for products or services based on customer data, historical trends, and machine learning algorithms. Technologies like Adobe Target and Apache Spark can be employed for data analysis, modeling, and delivering targeted recommendations. For instance, the module can use Adobe Target's recommendation engine to analyze customer preferences and behavior, and deliver personalized product recommendations across various channels, enhancing customer engagement and driving sales.

[0126] The Notification Module **560** enables the distribution of real-time notifications to users regarding important events, updates, or alerts within the supply chain. It utilizes technologies like Apigee X and TIBCO for message queues, event-driven architectures, and notification delivery. For example, the module can utilize TIBCO's messaging infrastructure to send real-time notifications to users' devices, ensuring timely and relevant information dissemination.

[0127] The Self-Onboarding Module **565** facilitates the onboarding process for new users entering the distribution network. It provides guided steps, tutorials, or documentation to help users become familiar with the system and its functionalities. Technologies such as Okta and Kentico can be employed to ensure secure user authentication, access control, and self-learning resources. For instance, the module can utilize Okta's identity and access management capabilities to securely onboard new users, providing them with appropriate access permissions and guiding them through the system's functionalities.

[0128] The Communication Module **570** enables communication and collaboration within System **500**. It provides channels for users to interact, exchange messages, share documents, and collaborate on projects. Technologies like Apigee Edge and Adobe Launch can be employed to facilitate secure and efficient communication, document sharing, and version control. For example, the module can utilize Apigee Edge's API management capabilities to ensure secure and reliable communication between users, enabling them to collaborate effectively.

[0129] Thereby, System **500** can incorporate various modules that utilize a diverse range of technologies and algorithms to optimize supply chain and distribution management. These modules, including SPoG UI **505**, CIM **510**, RTDM module **515**, AI module **520**, Interface Display Module **525**, Personalized Interaction Module **530**, Document Hub **535**, Catalog Management Module **540**, Performance and Insight Markers Display **545**, Predictive Analytics Module **550**, Recommendation System Module **555**, Notification Module **560**, Self-Onboarding Module **565**, and Communication Module **570**, work together to provide end-to-end visibility, data-driven decision-making, personalized interactions, real-time analytics, and streamlined communication within the distribution network. The incorporation of specific technologies and algorithms enables

efficient data management, secure communication, personalized experiences, and effective performance monitoring, contributing to enhanced operational efficiency and success in supply chain and distribution management.

Real Time Data Mesh

[0130] FIG. **6** illustrates RTDM module **600**, according to an embodiment. RTDM module **600**, which can be an embodiment of RTDM module **310**, can include interconnected components, processes, and sub-systems configured to enable real-time data management and analysis.

[0131] The RTDM module **600**, as depicted in FIG. **5**, represents an effective data mesh and change capture component within the overall system architecture. The module can be configured to provide real-time data management and standardization capabilities, enabling efficient operations within the supply chain and distribution management domain.

[0132] RTDM module **600** can include an integration layer **610** (also referred to as a "system of records") that integrates with various enterprise systems. These enterprise systems can include ERPs such as SAP, Impulse, META, and I-SCALA, among others, and other data sources. Integration layer **610** can process data exchange and synchronization between RTDM module **600** and these systems. Data feeds can be established to retrieve relevant information from the system of records, such as sales orders, purchase orders, inventory data, and customer information. These feeds enable real-time data updates and ensure that the RTDM module operates with the most current and accurate data.

[0133] RTDM module **600** can include data layer **620** configured to process and translate data for retrieval and analysis. Data layer **620** includes data mesh, a cloud-based infrastructure configured to provide scalable and fault-tolerant data storage capabilities. Within the data mesh, multiple Purposive Datastores (PDS) can be deployed to store specific types of data, such as customer data, product data, or inventory data. Each PDS can be optimized for efficient data retrieval based on specific use cases and requirements. The PDSes can be configured to store specific types of data, such as customer data, product data, finance data, and more. These PDS serve as repositories for canonized and/or standardized data, ensuring data consistency and integrity across the system.

[0134] In some embodiments, RTDM module **600** implements a data replication mechanism to capture real-time changes from multiple data sources, including transactional systems like ERPs (e.g., SAP, Impulse, META, I-SCALA). The captured data can then be processed and standardized on-the-fly, transforming it into a standardized format suitable for analysis and integration. This process ensures that the data is readily available and current within the data mesh, facilitating real-time insights and decision-making.

[0135] More specifically, data layer **620** within the RTDM module **600** can be configured as a powerful and flexible foundation for managing and processing data within the distribution ecosystem. In some embodiments, data layer **620** can encompasses a highly scalable and robust data lake, which can be referred to as data lake **622**, along with a set of purposive datastores (PDSes), which can be denoted as PDSes **624**.**1** to **624**.N. These components integrate to ensure efficient data management, standardization, and real-time availability. In some embodiments, AI-powered relevancy detection operates directly on the ingested heterogeneous data, minimizing the need for prior cleansing or structural harmonization while enabling real-time semantic interpretation across inconsistent data formats.

[0136] Data layer **620** incudes data lake **622**, a state-of-the-art storage and processing infrastructure configured to handle the ever-increasing volume, variety, and velocity of data generated within the supply chain. Built upon a scalable distributed file system, such as Apache Hadoop Distributed File System (HDFS) or Amazon S3, the data lake provides a unified and scalable platform for storing both structured and unstructured data. Leveraging the elasticity and fault-tolerance of cloud-based storage, data lake **622** can accommodate the influx of data from diverse sources.

[0137] Associated with data lake **622**, a population of purposive datastores, PDSes **624**.**1** to **624**.N, can be employed. Each PDS **624** can function as a purpose-built repository optimized for storing

and retrieving specific types of data relevant to the supply chain domain. In some non-limiting examples, PDS **624.1** may be dedicated to customer data, storing information such as customer profiles, preferences, and transaction history. PDS **624.2** may be focused on product data, encompassing details about SKU codes, descriptions, pricing, and inventory levels. These purposive datastores allow for efficient data retrieval, analysis, and processing, catering to the diverse needs of supply chain users.

[0138] To ensure real-time data synchronization, data layer **620** can be configured to employ one or more change data capture (CDC) mechanisms. These CDC mechanisms can be integrated with the transactional systems, such as legacy ERPs like SAP, Impulse, META, and I-SCALA, as well as other enterprise-wide systems. CDC constantly monitors these systems for any updates, modifications, or new transactions and captures them in real-time. By capturing these changes, data layer **620** ensures that the data within the data lake **622** and PDSes **624** remains current, providing users with real-time insights into the distribution ecosystem.

[0139] In some embodiments, data layer **620** can be implemented to facilitate integration with existing enterprise systems using one or more frameworks, such as .NET or Java, ensuring compatibility with a wide range of existing systems and providing flexibility for customization and extensibility. For example, data layer **620** can utilize the Java technology stack, including frameworks like Spring and Hibernate, to facilitate integration with a system of records having a population of diverse ERP systems and other enterprise-wide solutions. This can facilitate smooth data exchange, process automation, and end-to-end visibility across the supply chain.

[0140] In terms of data processing and analytics, data layer **620** can use the capabilities of distributed computing frameworks, such as Apache Spark or Apache Flink in some non-limiting examples. These frameworks can enable parallel processing and distributed computing across large-scale datasets stored in the data lake and PDSes. By leveraging these frameworks, supply chain users can perform complex analytical tasks, apply machine learning algorithms, and derive valuable insights from the data. For instance, data layer **620** can use Apache Spark's machine learning libraries to develop predictive models for demand forecasting, optimize inventory levels, and identify potential supply chain risks.

[0141] In some embodiments, data layer **620** can incorporate robust data governance and security measures. Fine-grained access control mechanisms and authentication protocols ensure that only authorized users can access and modify the data within the data lake and PDSes. Data encryption techniques, both at rest and in transit, safeguard the sensitive supply chain information against unauthorized access. Additionally, data layer **620** can implement data lineage and audit trail mechanisms, allowing users to trace the origin and history of data, ensuring data integrity and compliance with regulatory requirements.

[0142] In some embodiments, data layer **620** can be deployed in a cloud-native environment, leveraging containerization technologies such as Docker and orchestration frameworks like Kubernetes. This approach ensures scalability, resilience, and efficient resource allocation. For example, data layer **620** can be deployed on cloud infrastructure provided by AWS, Azure, or Google Cloud, utilizing their managed services and scalable storage options. This allows for scaling of resources based on demand, minimizing operational overhead and providing an elastic infrastructure for managing supply chain data.

[0143] Data layer **620** of RTDM module **600** can incorporate a highly scalable data lake, data lake **622**, along with purpose-built PDSes, PDSes **624.1** to **624**.N, and employing CDC mechanisms, data layer **620** ensures efficient data management, standardization, and real-time availability. In a non-limiting example, Data Layer **620** can be implemented utilizing any appropriate technology, such as .NET or Java, and/or distributed computing frameworks like Apache Spark, enables powerful data processing, advanced analytics, and machine learning capabilities. With robust data governance and security measures, data layer **620** ensures data integrity, confidentiality, and compliance. Through its scalable infrastructure and integration with existing systems, data layer

620 enables supply chain users to make data-driven decisions, optimize operations, and drive business success in the dynamic and complex distribution environment.

[0144] RTDM module **600** can include an AI module **630** configured to implement one or more algorithms and machine learning models to analyze the stored data in data layer **620** and derive meaningful insights. In some non-limiting examples, AI module **630** can apply predictive analytics, anomaly detection, and optimization algorithms to identify patterns, trends, and potential risks within the supply chain. AI module **630** can continuously learns from new data inputs and adapts its models to provide accurate and current insights. AI module **630** can generate predictions, recommendations, and alerts and publish such insights to dedicated data feeds.

[0145] Data engine layer **640** comprises a set of interconnected systems responsible for data ingestion, processing, transformation, and integration. Data engine layer **640** of RTDM module **600** can include a collection of headless engines **640**.**1** to **640**.N that operate autonomously. These engines represent distinct functionalities within the system and can include, for example, one or more recommendation engines, insights engines, and subscription management engines. Engines **640**.**1** to **640**.N can use the standardized data stored in the data mesh to deliver specific business logic and services. Each engine can be configured to be pluggable, allowing for flexibility and future expansion of the module's capabilities. Exemplary engines are shorn in FIG. **5**, which are not intended to be limiting. Any additional headless engine can be included in data engine layer **640** or in other exemplary layers of the disclosed system.

[0146] These systems can be configured to receive data from multiple sources, such as transactional systems, IoT devices, and external data providers. The data ingestion process involves extracting data from these sources and transforming it into a standardized format. Data processing algorithms can be applied to cleanse, aggregate, and enrich the data, making it ready for further analysis and integration.

[0147] Further, to facilitate integration and access to RTDM module **600**, a data distribution mechanism can be employed. Data distribution mechanism **645** can be configured to include one or more APIs to facilitate distribution of data from the data mesh and engines to various endpoints, including user interfaces, micro front ends, and external systems.

[0148] Experience layer **650** focuses on delivering an intuitive and user-friendly interface for interacting with supply chain data. Experience layer **650** can include data visualization tools, interactive dashboards, and user-centric functionalities. Through this layer, users can retrieve and analyze real-time data related to various supply chain metrics such as inventory levels, sales performance, and customer demand. The user experience layer supports personalized data feeds, allowing users to customize their views and receive relevant updates based on their roles and responsibilities. Users can subscribe to specific data updates, such as inventory changes, pricing updates, or new SKU notifications, tailored to their preferences and roles.

[0149] Thereby, in some embodiments, RTDM module **600** for supply chain and distribution management can include an integration with a system of records and include one or more of a data layer with a data mesh and purposive datastores, an AI component, a data engine layer, and a user experience layer. These components work together to provide users with intuitive access to real-time supply chain data, efficient data processing and analysis, and integration with existing enterprise systems. The technical feeds and retrievals within the module ensure that users can retrieve relevant, current information and insights to make informed decisions and optimize supply chain operations. Accordingly, RTDM module **600** facilitates supply chain and distribution management by providing a scalable, real-time data management solution. Its innovative architecture allows for the rich integration of disparate data sources, efficient data standardization, and advanced analytics capabilities. The module's ability to replicate and standardize data from diverse ERPs, while maintaining auditable and repeatable transactions, provides a distinct advantage in enabling a unified view for vendors, resellers, customers, end customers, and other entities in a distribution system, including an IT distribution system.

Automated Relevancy Search System

[0150] In an embodiment, FIG. **7** depicts System **700** to enhance search capabilities within technology distribution platforms. System **700** includes the Real-Time Data Mesh **710**, Single Pane of Glass User Interface (SPoG UI) **705**, Advanced Analytics and Machine-Learning (AAML) Module **715**, and the Relevancy Search Engine Module **720**.

[0151] In some embodiments, SPoG UI **705**, which can be an embodiment of SPoG UIs described above, can be enhanced with a push model integrating advanced search functionalities, enabling users to access relevant products and services, thereby improving the search experience and facilitating efficient navigation and discovery of products personalized to user preferences and requirement.

[0152] RTDM **710** aggregates and standardizes real-time data from various sources, enabling the efficient operation of the AI-driven relevancy search (AIRS) processes. This includes data on product specifications, subscription usage patterns, and market trends. RTDM **710** establishes a centralized, unified data hub, aggregating and standardizing data from multiple sources such as ERPs, CRM systems, and market intelligence. It utilizes a blend of data warehousing and data lakes to handle both structured and unstructured data efficiently. RTDM **710** employs ETL processes and data normalization techniques to ensure uniformity and accessibility of data. This standardized data is essential for the functioning of the Relevancy Search Engine Module **720**. RTDM **710** maintains data integrity and relevance, optimizing search relevancy and user experience. In some embodiments, RTDM **710** is configured to interface with asset management systems, supporting efficient inventory management and product discovery.

[0153] AAML Module **715** functions as the central processing unit for the AIRS processes. It contains specialized rules and algorithms specialized algorithms and analytics tools to analyze search queries, product compatibility, and market trends. AAML Module **715** employs analytics tools for big data processing and deep learning capabilities. It conducts sentiment analysis, trend forecasting, and behavioral analytics to understand and anticipate market and user demands. AAML Module **715** integrates and trains machine learning models to understand user intent, predict search behavior, and optimize search results accordingly. It integrates sentiment analysis, trend forecasting, and behavioral analytics to deliver personalized search experiences tailored to individual user preferences. The module adapts its algorithms based on continuous feedback loops and real-time data updates, ensuring search results align with evolving user needs and market conditions. This module plays a pivotal role in enhancing the overall search experience within distribution platforms, driving increased user engagement and satisfaction.

[0154] In an embodiment, The AI-Powered Relevancy Search (AIRS) Module **720** is a critical component within System **700**, designed to revolutionize search capabilities in the distribution environment. It employs advanced algorithms and techniques to prioritize search results based on relevancy scores, thereby enhancing user experience and engagement. The module utilizes a combination of machine learning models, natural language processing (NLP) algorithms, and real-time data processing to deliver accurate and personalized search results tailored to individual user preferences and requirements.

[0155] One of the primary use cases for the AIRS Module **720** is to optimize search results within distribution channels by analyzing various factors such as product specifications, customer preferences, and historical search patterns. For example, consider a scenario where a user searches for a specific product within a distribution platform. The AIRS Module **720** analyzes the search query, interprets user intent, and prioritizes search results based on relevancy scores generated through machine learning algorithms.

[0156] Furthermore, the AIRS Module **720** incorporates fuzzy logic and NLP techniques to improve search query interpretation and result relevance. This allows the system to handle vague or fuzzy search queries effectively, ensuring accurate and comprehensive search results for users. For instance, if a user enters a generic search query such as “high-performance laptop,” the module

utilizes NLP algorithms to understand the underlying intent and retrieve relevant products based on features, specifications, and user preferences.
[0157] Additionally, the AIRS Module **720** enables real-time adjustments to search relevancy based on dynamic factors such as market trends, inventory availability, and user feedback. For example, if a particular product becomes popular due to a sudden surge in demand, the module can prioritize search results for that product accordingly, ensuring users have access to the most relevant and up-to-date information.
[0158] In terms of implementation, the AIRS Module **720** consists of several components, including data ingestion pipelines, machine learning models, and real-time processing engines. Data from various sources such as distribution channels, inventory systems, and customer interactions is ingested into the module and processed in real-time to generate relevancy scores for search results.
[0159] The module employs machine learning models, including neural networks and decision trees, to analyze and prioritize search results based on relevancy scores. These models are trained using historical data sets and continuously updated using feedback loops to improve accuracy and performance over time.
[0160] Furthermore, the AIRS Module **720** is designed to be highly scalable and adaptable, enabling integration with existing systems and workflows within the distribution environment. It offers flexibility in terms of customization, allowing organizations to tailor search algorithms and relevancy scoring criteria based on specific business requirements and objectives.
[0161] Overall, the AIRS Module **720** represents a significant advancement in search technology within the distribution industry, enabling organizations to deliver personalized, efficient, and relevant search experiences for users, thereby enhancing engagement and conversion rates.
[0162] In some embodiments, the system is configured to process heterogeneous data sources without requiring manual data normalization or rule-based cleansing. The system applies AI-based relevance detection techniques to identify patterns, attributes, and relationships across unstructured or inconsistent vendor data formats. This enables the execution of meaningful search and matching operations across disparate data schemas, supporting scalability and adaptability in dynamic distribution environments.
[0163] Unlike traditional systems that require full data normalization and cleansing prior to processing, embodiments disclosed herein apply machine learning techniques to operate directly on raw, unprocessed data. The system utilizes real-time pattern recognition and semantic analysis to extract relevant insights from inconsistent or fragmented inputs. This approach eliminates pre-processing delays and enables efficient relevancy scoring and search optimization without requiring intermediate data transformation steps.
[0164] In some embodiments, system **700** can include additional functionality modules configured for elevating search capabilities and user engagement within the distribution platform. Embodiments can include Dynamic SKU Search Engine **725** configured to implement algorithms and data processing methodologies to enable dynamic and responsive search functionalities personalized to users' specific needs and preferences.
[0165] Dynamic SKU Search Engine **725** operates on a data layer of RTDM **710** configured to handle complexities of SKU (Stock Keeping Unit) data management within a distribution environment. Dynamic SKU Search Engine **725** can include and/or integrate one or more data ingestion pipelines integrated with indexing mechanisms, search algorithms, and real-time processing engines. Dynamic SKU Search Engine **725** retrieves and indexes both static and dynamic SKU data from various sources, such as inventory systems, product databases, and external APIs. This involves implementing data connectors and integration points to gather and consolidate SKU information from disparate sources, ensuring comprehensive coverage and accuracy.
[0166] After SKU data is ingested, Dynamic SKU Search Engine **725** employs indexing techniques

to organize and structure data for efficient search operations. This may involve utilizing inverted indexing methods, trie data structures, or other indexing mechanisms optimized for fast and scalable search queries. The search algorithms employed by the Dynamic SKU Search Engine **725** can prioritize search results based on relevancy scores, considering factors such as product attributes, user preferences, historical interactions, and real-time market dynamics. These algorithms can be configured to implement machine learning models, natural language processing methodologies, and contextual analysis to deliver accurate and personalized search results personalized to each user's unique context and intent.

[0167] Further, Dynamic SKU Search Engine **725** can incorporate real-time processing capabilities to adapt search results dynamically based on changing conditions such as inventory availability, pricing updates, and user feedback. This involves implementing event-driven architectures and stream processing frameworks to handle real-time data updates and ensure timely adjustments to search relevancy.

[0168] Personalization Engine **730** complements Dynamic SKU Search Engine **725**. In some embodiments, Personalization Engine **730** provides personalized recommendations and personalized search experiences based on user profiles, preferences, and historical interactions. Embodiments of Personalization Engine **730** can employ collaborative filtering algorithms, content-based filtering techniques, and reinforcement learning models to understand user behavior and deliver relevant suggestions and insights.

[0169] Real-Time Relevancy Adjustment Module **735** enables continuous optimization of search relevancy based on evolving market trends, user feedback, and performance metrics. In some embodiments, Real-Time Relevancy Adjustment Module **735** can implement one or more feedback loops, A/B testing frameworks, and experimentation platforms to gather insights and refine search algorithms iteratively.

[0170] System **700** integrates the above modules and components to perform AI-powered relevancy search to promote expectations and engagement of users within the distribution environment. System **700** efficiently performs efficient and relevant search experiences personalized in real-time to drive increased engagement and conversion rates across global distribution networks.

[0171] FIG. **8** illustrates a flow diagram of method **800** for integrating Generative AI and Large Language Models, according to embodiments of the present disclosure. This methodology includes operations from initiation to completion, describing the integration process within System **700**, which includes SPoG UI **705**, RTDM **710**, AAML Module **715**, AIRS Module **720**, Dynamic SKU Search Engine **725**, Personalization Engine **730**, and Real-Time Relevancy Adjustment Module **735**.

[0172] At Operation **801**, the user initiates the integration process through SPoG UI **705**, providing minimal input requirements to expedite the commencement of integration. SPoG UI **705** interacts with AAML Module **715** to gather initial user preferences and system requirements, initializing the integrating process based on a trigger in the user input or other aspects, such as based on a specific time period or other factor.

[0173] At Operation **802**, AAML Module **715** executes preliminary analytics to identify specific requirements for integrating Generative AI and Large Language Models. Leveraging data structures within RTDM **710**, AAML Module **715** employs algorithms such as decision trees and neural networks to assess the compatibility of the system with Generative AI and Large Language Models. For example, decision trees can determine the best integration strategy based on historical usage patterns and prevailing market conditions.

[0174] At Operation **803**, RTDM **710** efficiently gathers relevant data for integration from various sources, including real-time data streams and historical databases. Using techniques such as data warehousing and data lakes described above, RTDM **710** continuously performs comprehensive aggregation and standardization of data, for perpetual integration with Generative AI and Large Language Models.

[0175] At Operation **804**, an Integration Engine within AIRS Module **720** processes users' requests, incorporating tools such as Dynamic SKU Search Engine **725** and Personalization Engine **730**. AIRS Module **720** can utilize a Model Compatibility Assessment Sub-Module to assess the compatibility of existing data structures with Generative AI and Large Language Models. The Integration Engine, implementing algorithms such as clustering and association rule mining, facilitates a technical integration process by identifying patterns and dependencies within the data.
[0176] At Operation **805**, Real-Time Relevancy Adjustment Module **735** validates the proposed integration plan, ensuring accuracy and feasibility with advanced error-checking mechanisms. Real-Time Relevancy Adjustment Module **735** can use anomaly detection and outlier analysis, for example, to ensure the integrity and coherence of the integration process, minimizing the risk of errors or inconsistencies.
[0177] At Operation **806**, the proposed integration plan is presented back to the user through SPoG UI **705** for review and approval, fostering user involvement throughout the process. SPoG UI **705** provides intuitive visualization of the integration plan, allowing users to make informed decisions based on clear, concise information.
[0178] At Operation **807**, machine learning models within AAML Module **715** analyze the integration process post-implementation, applying predictive analytics to refine the integration mechanism based on real-time data from RTDM **710**. Utilizing techniques such as regression analysis and time series forecasting, these models continuously monitor the performance of the integrated Generative AI and Large Language Models, identifying areas for improvement and optimization.
[0179] At Operation **808**, a logging mechanism records integration details for ongoing enhancement of the system, facilitated by Real-Time Relevancy Adjustment Module **735**. This logging mechanism captures comprehensive information about the integration process, including user inputs, system configurations, and integration outcomes, providing valuable insights for future iterations and refinements.
[0180] At Operation **809**, the user confirms the integration plan through SPoG UI **705**, marking the completion of the integration process. This final step ensures user satisfaction and validation of the integrated Generative AI and Large Language Models within System **700**, optimizing search relevancy and user engagement. The confirmation process may involve interactive elements within SPoG UI **705**, such as prompts for user feedback and suggestions for further improvements, fostering continuous collaboration between users and the system.
[0181] FIG. **9** illustrates a flow diagram of method **900** for implementing Fuzzy Logic and Natural Language Processing (NLP) Enhancement within System **700**, according to embodiments of the present disclosure. This flowchart delineates operations aimed at improving search relevancy and enhancing user experience through the integration of fuzzy logic and NLP algorithms.
[0182] At Operation **901**, the system initiates the enhancement process by receiving user queries through SPoG UI **705**, which serves as the primary interface for user interaction. These queries may include vague or ambiguous search terms such as “long cable” or “laptop battery life,” requiring interpretation using fuzzy logic and NLP techniques.
[0183] At Operation **902**, AAML Module **715** analyzes the incoming search queries using advanced NLP algorithms, which can include techniques such as natural language understanding (NLU) and semantic analysis. These algorithms enable the system to interpret the user's intent behind vague or ambiguous search queries, extracting relevant keywords and context to refine the search process.
[0184] At Operation **903**, the interpreted search queries are processed through the Fuzzy Logic and NLP Enhancement Module within AIRS Module **720**. This module utilizes fuzzy logic algorithms to handle imprecise or uncertain information inherent in vague search queries, allowing for flexible and adaptive search behavior.
[0185] At Operation **904**, Dynamic SKU Search Engine **725** and Personalization Engine **730** collaborate to optimize search results based on the interpreted queries. Dynamic SKU Search

Engine **725** retrieves relevant products or services from the database, considering factors such as product attributes, user preferences, and historical interactions. Personalization Engine **730** further refines the search results based on user profiles and past behavior, ensuring personalized recommendations tailored to individual preferences.

[0186] At Operation **905**, Real-Time Relevancy Adjustment Module **735** continuously monitors user interactions and feedback to adapt search results dynamically. By analyzing user behavior in real-time, this module identifies patterns and trends, allowing for proactive adjustments to search relevancy and user experience.

[0187] At Operation **906**, the optimized search results are presented to the user through SPoG UI **705**, providing an intuitive browsing experience. The system ensures that relevant products or services aligned with the user's intent are prominently featured, enhancing user satisfaction and engagement.

[0188] At Operation **907**, the user interacts with the search results, potentially refining their queries or exploring additional options. SPoG UI **705** captures user feedback and behavior, which is fed back into the system for continuous improvement and optimization.

[0189] At Operation **908**, the system measures the impact of the fuzzy logic and NLP enhancement on search relevancy and user engagement metrics. Key performance indicators such as click-through rates, time spent on the platform, and conversion rates are analyzed to assess the effectiveness of the enhancement.

[0190] At Operation **909**, based on the impact assessment results, the system iteratively refines its algorithms and strategies to further enhance search relevancy and user experience. This iterative process ensures continuous improvement and adaptation to evolving user needs and preferences.

[0191] This operational flow leverages the architecture of System **700** to integrate fuzzy logic and NLP enhancements, ultimately enhancing the search experience and driving increased user engagement and satisfaction within the distribution environment. Method **900** integrates SPoG UI **705**, Service Configuration Engine **735**, and Error-Check Integrator **780** in a structured flow. This integration facilitates user-centric relevancy search optimization, enhancing the overall user experience within System **700**. Alternative embodiments may involve different user interface layouts, configuration algorithms, and validation mechanisms to adapt to diverse user needs and preferences.

[0192] FIG. **10** illustrates a flow diagram of method **1000** for implementing Real-Time Data Mesh Integration and Dynamic SKU Searches within System **700**, according to embodiments of the present disclosure. This flowchart delineates operations aimed at accessing real-time data and optimizing search results through dynamic SKU searches.

[0193] At Operation **1001**, the system initiates the integration process by establishing connections with a real-time data mesh, facilitated by RTDM **710**. This data mesh serves as a centralized hub for accessing and analyzing data from various sources, including SKUs, inventory systems, and market intelligence platforms.

[0194] At Operation **1002**, RTDM **710** aggregates and standardizes real-time data streams, ensuring the availability of up-to-date information for analysis. This includes data on product specifications, inventory levels, pricing, and customer interactions, among others, optimizing search relevancy and user experience.

[0195] At Operation **1003**, AAML Module **715** utilizes advanced analytics and machine learning techniques to analyze the real-time data streams. By processing data from multiple sources, including SKUs and customer interactions, AAML Module **715** identifies patterns and trends that influence search relevancy and user engagement.

[0196] At Operation **1004**, based on the analysis conducted by AAML Module **715**, Real-Time Relevancy Adjustment Module **735** dynamically adjusts search relevancy in response to changing conditions. This includes factors such as customer segment, personalization preferences, and historical interactions, ensuring that search results remain relevant and up-to-date.

[0197] At Operation **1005**, Dynamic SKU Search Engine **725** conducts dynamic and static SKU searches to retrieve comprehensive search results. This engine addresses the complexities of SKU standardization across different regions and vendors, ensuring that users have access to relevant products regardless of how SKUs are defined or updated.
[0198] At Operation **1006**, Dynamic SKU Search Engine **725** retrieves and indexes both dynamic and static SKU data from various sources, such as inventory systems, product databases, and external APIs. This involves implementing data connectors and integration points to gather and consolidate SKU information from disparate sources.
[0199] At Operation **1007**, the search algorithms employed by Dynamic SKU Search Engine **725** prioritize search results based on relevancy scores, considering factors such as product attributes, user preferences, historical interactions, and real-time market dynamics. These algorithms leverage machine learning models, natural language processing methodologies, and contextual analysis to deliver accurate and personalized search results.
[0200] At Operation **1008**, the optimized search results are presented to the user through SPoG UI **705**, providing a comprehensive and intuitive browsing experience. The system ensures that relevant products or services aligned with the user's intent are prominently featured, enhancing user satisfaction and engagement.
[0201] At Operation **1009**, the user interacts with the search results, potentially refining their queries or exploring additional options. SPoG UI **705** captures user feedback and behavior, which is fed back into the system for continuous improvement and optimization.
[0202] At Operation **1010**, the system measures the impact of real-time data mesh integration and dynamic SKU searches on search relevancy and user engagement metrics. Key performance indicators such as click-through rates, time spent on the platform, and conversion rates are analyzed to assess the effectiveness of the enhancements.
[0203] At Operation **1011**, based on the impact assessment results, the system iteratively refines its algorithms and strategies to further enhance search relevancy and user experience. This iterative process ensures continuous improvement and adaptation to evolving user needs and preferences.
[0204] This operational flow leverages the architecture of System **700** to integrate real-time data mesh integration and dynamic SKU searches, ultimately enhancing the search experience and driving increased user engagement and satisfaction within the distribution environment.
[0205] FIG. **11** depicts a block diagram of example components of device **1100**. One or more computer systems **1100** may be used, for example, to implement any of the embodiments discussed herein, as well as combinations and sub-combinations thereof. Computer system **1100** may include one or more processors (also called central processing units, or CPUs), such as a processor **1104**. Processor **1104** may be connected to a communication infrastructure or bus **1106**.
[0206] Computer system **1100** may also include user input/output device(s) **1103**, such as monitors, keyboards, pointing devices, etc., which may communicate with communication infrastructure **1106** through user input/output interface(s) **1102**.
[0207] One or more processors **1104** may be a graphics processing unit (GPU). In an embodiment, a GPU may be a processor that can be a specialized electronic circuit configured to process mathematically intensive applications. The GPU may have a parallel structure that can be efficient for parallel processing of large blocks of data, such as mathematically intensive data common to computer graphics applications, images, videos, etc.
[0208] Computer system **1100** may also include a main or primary memory **1108**, such as random access memory (RAM). Main memory **1108** may include one or more levels of cache. Main memory **1108** may have stored therein control logic (i.e., computer software) and/or data.
[0209] Computer system **1100** may also include one or more secondary storage devices or memory **1110**. Secondary memory **1110** may include, for example, a hard disk drive **1112** and/or a removable storage device or drive **1114**.
[0210] Removable storage drive **1114** may interact with a removable storage unit **1118**. Removable

storage unit **1118** may include a computer-usable or readable storage device having stored thereon computer software (control logic) and/or data. Removable storage unit **1118** may be program cartridge and cartridge interface (such as that found in video game devices), a removable memory chip (such as an EPROM or PROM) and associated socket, a memory stick and USB port, a memory card and associated memory card slot, and/or any other removable storage unit and associated interface. Removable storage drive **1114** may read from and/or write to removable storage unit **1118**.

[0211] Secondary memory **1110** may include other means, devices, components, instrumentalities or other approaches for allowing computer programs and/or other instructions and/or data to be accessed by computer system **1100**. Such means, devices, components, instrumentalities or other approaches may include, for example, a removable storage unit **1122** and an interface **1120**. Examples of the removable storage unit **1122** and the interface **1120** may include a program cartridge and cartridge interface (such as that found in video game devices), a removable memory chip (such as an EPROM or PROM) and associated socket, a memory stick and USB port, a memory card and associated memory card slot, and/or any other removable storage unit and associated interface.

[0212] Computer system **1100** may further include a communication or network interface **1124**. Communication interface **1124** may enable computer system **1100** to communicate and interact with any combination of external devices, external networks, external entities, etc. (individually and collectively referenced by reference number **1128**). For example, communication interface **1124** may allow computer system **1100** to communicate with external or remote devices **1128** over communications path **1126**, which may be wired and/or wireless (or a combination thereof), and which may include any combination of LANs, WANs, the Internet, etc. Control logic and/or data may be transmitted to and from computer system **1100** via communication path **1126**.

[0213] Computer system **1100** may also be any of a personal digital assistant (PDA), desktop workstation, laptop or notebook computer, netbook, tablet, smartphone, smartwatch or other wearables, appliance, part of the Internet-of-Things, and/or embedded system, to name a few non-limiting examples, or any combination thereof.

[0214] Computer system **1100** may be a client or server, accessing or hosting any applications and/or data through any delivery paradigm, including but not limited to remote or distributed cloud computing solutions; local or on-premises software (“on-premise” cloud-based solutions); “as a service” models (e.g., content as a service (CaaS), digital content as a service (DCaaS), software as a service (SaaS), managed software as a service (MSaaS), platform as a service (PaaS), desktop as a service (DaaS), framework as a service (FaaS), backend as a service (BaaS), mobile backend as a service (MBaaS), infrastructure as a service (IaaS), etc.); and/or a hybrid model including any combination of the foregoing examples or other services or delivery paradigms.

[0215] Any applicable data structures, file formats, and schemas in computer system **1100** may be derived from standards including but not limited to JavaScript Object Notation (JSON), Extensible Markup Language (XML), Yet Another Markup Language (YAML), Extensible Hypertext Markup Language (XHTML), Wireless Markup Language (WML), MessagePack, XML User Interface Language (XUL), or any other functionally similar representations alone or in combination. Alternatively, proprietary data structures, formats or schemas may be used, either exclusively or in combination with known or open standards.

[0216] In some embodiments, a tangible, non-transitory apparatus or article of manufacture comprising a tangible, non-transitory computer useable or readable medium having control logic (software) stored thereon may also be referred to herein as a computer program product or program storage device. This includes, but is not limited to, computer system **1100**, main memory **1108**, secondary memory **1110**, and removable storage units **1118** and **1122**, as well as tangible articles of manufacture embodying any combination of the foregoing. Such control logic, when executed by one or more data processing devices (such as computer system **1100**), may cause such data

processing devices to operate as described herein.
[0217] FIGS. **12**A to **12**Q depict various screens and functionalities of the SPoG UI related to vendor onboarding, partner dashboard, customer carts, order summary, SKU generation, order tracking, shipment tracking, subscription history, and subscription modifications. A detailed description of each figure is provided below:
[0218] FIG. **12**A depicts a Vendor Onboarding Initiation screen that represents the initial step of the vendor onboarding process. It provides a form or interface where vendors can express their interest in joining the distribution ecosystem. Vendors can enter their basic information, such as company details, contact information, and product catalogs.
[0219] FIG. **12**B depicts a Vendor Onboarding Guide that displays a step-by-step guide or checklist for vendors to follow during the onboarding process. It outlines the necessary tasks and requirements, ensuring that vendors have a clear understanding of the onboarding process and can progress smoothly.
[0220] FIG. **12**C depicts a Vendor Onboarding Call Scheduler that facilitates scheduling calls or meetings between vendors and platform associates or representatives responsible for guiding them through the onboarding process. Vendors can select suitable time slots or request a call, ensuring effective communication and assistance throughout the onboarding journey.
[0221] FIG. **12**D depicts a Vendor Onboarding Task List that presents a comprehensive task list or dashboard that outlines the specific steps and actions required for successful vendor onboarding. It provides an overview of pending tasks, completed tasks, and upcoming deadlines, helping vendors track their progress and ensure timely completion of each onboarding task.
[0222] FIG. **12**E depicts a Vendor Onboarding Completion Screen that confirms the successful completion of the vendor onboarding process. It may display a congratulatory message or summary of the completed tasks, indicating that the vendor is now officially onboarded into the distribution ecosystem.
[0223] FIG. **12**F depicts a Partner Dashboard that offers partners or users a centralized view of relevant information and metrics related to their partnership with the distribution ecosystem. It provides an overview of performance indicators, key data points, and actionable insights to facilitate effective collaboration and decision-making.
[0224] FIG. **12**G depicts a Customer Product Cart that represents the customer's product cart, where they can add items they wish to purchase. It displays a list of selected products, quantities, prices, and other relevant details. Customers can review and modify their cart contents before proceeding to the checkout process.
[0225] FIG. **12**H depicts a Customer Subscription Cart that allows customers to manage their subscription-based purchases. It displays the selected subscription plans, pricing, and duration. Customers can review and modify their subscription details before finalizing their choices.
[0226] FIG. **12**I depicts a Customer Order Summary that provides a summary of the customer's order, including details such as the products or subscriptions purchased, quantities, pricing, and any applied discounts or promotions. It allows customers to review their order before confirming the purchase.
[0227] FIG. **12**J depicts a Vendor SKU Generation screen for generating unique Stock Keeping Unit (SKU) codes for vendor products. It may include fields or options where vendors can specify the product details, attributes, and pricing, and the system automatically generates the corresponding SKU code.
[0228] FIGS. **12**K and **12**L depicts Dashboard Order Summary to display summarized information about orders placed within the distribution ecosystem. They present key order details, such as order number, customer name, product or subscription information, quantity, and order status. The dashboard provides an overview of order activity, enabling users to track and manage orders efficiently.
[0229] FIG. **12**M depicts a Customer Subscription Cart that permits a customer to add, modify, or

remove subscription plans. It can display a list of selected subscriptions, pricing, and renewal dates. Customers can manage their subscriptions and make changes according to their preferences and requirements.
[0230] FIG. **12**N depicts a Customer Order Tracking screen that enables customers to track the status and progress of their orders within the supply chain. It displays real-time updates on order fulfillment, including processing, packaging, and shipping. Customers can monitor the movement of their orders and anticipate delivery times.
[0231] FIG. **12**O depicts a Customer Shipment Tracking that provides customers with real-time tracking information about their shipments. It may include details such as the carrier, tracking number, current location, and estimated delivery date. Customers can stay informed about the whereabouts of their shipments.
[0232] FIG. **12**P depicts a Customer Subscription History, that presents a historical record of the customer's subscription activities. It displays a list of previous subscriptions, including the subscription plan, duration, and status. Customers can review their subscription history, track past payments, and refer to previous subscription details.
[0233] FIG. **12**Q depicts a Customer Subscription Modifications dialog, that allows customers to modify their existing subscriptions. It offers options to upgrade or downgrade subscription plans, change billing details, or adjust other subscription-related preferences. Customers can manage their subscriptions according to their evolving needs or preferences.
[0234] The depicted UI screens are not limiting. In some embodiments the UI screens of FIGS. **12**A to **12**Q collectively represent the diverse functionalities and features offered by the SPoG UI, providing users with a comprehensive and user-friendly interface for vendor onboarding, partnership management, customer interaction, order management, subscription management, and tracking within the distribution ecosystem.
[0235] It is to be appreciated that the Detailed Description section, and not the Summary and Abstract sections, is intended to be used to interpret the claims. The Summary and Abstract sections may set forth one or more but not all exemplary embodiments of the present invention as contemplated by the inventor(s), and thus, are not intended to limit the present invention and the appended claims in any way.
[0236] The present invention has been described above with the aid of functional building blocks illustrating the implementation of specified functions and relationships thereof. The boundaries of these functional building blocks have been arbitrarily defined herein for the convenience of the description. Alternate boundaries can be defined so long as the specified functions and relationships thereof are appropriately performed.
[0237] The foregoing description of the specific embodiments will so fully reveal the general nature of the invention that others can, by applying knowledge within the skill of the art, readily modify and/or adapt for various applications such specific embodiments, without undue experimentation, without departing from the general concept of the present invention. Therefore, such adaptations and modifications are intended to be within the meaning and range of equivalents of the disclosed embodiments, based on the teaching and guidance presented herein. It is to be understood that the phraseology or terminology herein is for the purpose of description and not of limitation, such that the terminology or phraseology of the present specification is to be interpreted by the skilled artisan in light of the teachings and guidance.
[0238] The breadth and scope of the present invention should not be limited by any of the above-described exemplary embodiments, but should be defined only in accordance with the following claims and their equivalents.

Claims

1. A system configured to enhance search capabilities within technology distribution platforms, comprising: a Real-Time Data Mesh (RTDM) module configured to aggregate and standardize real-time data from various sources, including product specifications, subscription usage patterns, and market trends, wherein the RTDM is configured to establish a centralized, unified data hub; a Single Pane of Glass User Interface (SPoG UI) module enhanced with a push model integrating advanced search functionalities, wherein the SPoG UI is configured to enable users to access relevant products and services, improve search experience and facilitate efficient navigation and discovery of products personalized to user preferences and requirements; an Advanced Analytics and Machine-Learning (AAML) module containing specialized rules and algorithms for analyzing search queries, product compatibility, and market trends, wherein the AAML module is configured to employ analytics tools for big data processing and deep learning; a Relevancy Search Engine Module employing algorithms via the AAML module to prioritize search results based on relevancy scores, wherein the Relevancy Search Engine Module delivers personalized search results based on individual user preferences and requirements, wherein the Relevancy Search Engine Module is configured to perform relevance detection across unstructured or inconsistent data formats without requiring prior normalization or rule-based cleansing.

2. The system of claim 1, wherein the Real-Time Data Mesh (RTDM) module interfaces with asset management systems to support efficient inventory management and product discovery.

3. The system of claim 1, wherein the Advanced Analytics and Machine-Learning (AAML) module employs sentiment analysis, trend forecasting, and behavioral analytics to understand and anticipate market and user demands.

4. The system of claim 1, wherein the Relevancy Search Engine Module incorporates fuzzy logic and Natural Language Processing (NLP) techniques to improve search query interpretation and result relevance.

5. The system of claim 1, further comprising a Dynamic SKU Search Engine module configured to implement algorithms and data processing methodologies to enable dynamic and responsive search functionalities personalized to users' specific needs and preferences.

6. The system of claim 5, wherein the Dynamic SKU Search Engine module retrieves and indexes both static and dynamic SKU data from various sources, ensuring comprehensive coverage and accuracy.

7. The system of claim 1, further comprising a Personalization Engine module providing personalized recommendations and search experiences based on user profiles, preferences, and historical interactions.

8. A computerized method for integrating Generative AI and Large Language Models within a technology distribution platform, comprising: initiating the integration process through the Single Pane of Glass User Interface (SPoG UI) module, gathering initial user preferences and system requirements; executing preliminary analytics using the Advanced Analytics and Machine-Learning (AAML) module to identify specific requirements for integration, leveraging data structures within the Real-Time Data Mesh (RTDM); efficiently gathering relevant data for integration from various sources using the RTDM module, employing data warehousing and data lakes to handle both structured and unstructured data efficiently; processing users' requests through an Integration Engine within the Relevancy Search Engine Module, via a Dynamic SKU Search Engine and Personalization Engine, wherein the Relevancy Search Engine Module is configured to perform relevance detection across unstructured or inconsistent data formats without requiring prior normalization or rule-based cleansing; validating the proposed integration plan using Real-Time Relevancy Adjustment Module, ensuring accuracy and feasibility with advanced error-checking mechanisms; presenting the proposed integration plan back to the user through SPoG UI for review and approval; analyzing the integration process post-implementation using machine learning models within AAML Module and continuously monitoring the performance of the integrated

Generative AI and Large Language Models.
9. The computerized method of claim 8, wherein the preliminary analytics executed by the Advanced Analytics and Machine-Learning (AAML) module include assessing the compatibility of existing data structures with Generative AI and Large Language Models.
10. The computerized method of claim 8, wherein the relevant data for integration is continuously aggregated and standardized from various sources using the Real-Time Data Mesh (RTDM) module, ensuring perpetual integration with Generative AI and Large Language Models.
11. The computerized method of claim 8, wherein the Integration Engine within the Relevancy Search Engine Module employs algorithms such as clustering and association rule mining to facilitate a technical integration process by identifying patterns and dependencies within the data.
12. The computerized method of claim 8, further comprising validating the proposed integration plan using anomaly detection and outlier analysis conducted by the Real-Time Relevancy Adjustment Module to minimize the risk of errors or inconsistencies.
13. The computerized method of claim 8, wherein the integration plan is presented back to the user through the Single Pane of Glass User Interface (SPoG UI) module for review and approval, fostering continuous collaboration between users and the system.
14. The computerized method of claim 8, wherein machine learning models within the Advanced Analytics and Machine-Learning (AAML) module continuously monitor the performance of the integrated Generative AI and Large Language Models, identifying areas for improvement and optimization based on real-time data updates.
15. A computerized method for implementing enhanced relevancy searches within a technology distribution platform, the computerized method comprising: initiating an enhancement process by queries from a user through a Single Pane of Glass User Interface (SPoG UI) module; analyzing the incoming search queries using one or more Natural Language Processing (NLP) algorithms within the Advanced Analytics and Machine-Learning (AAML) module; processing the interpreted search queries via a Fuzzy Logic and NLP Enhancement Module within a Relevancy Search Engine Module, wherein the Relevancy Search Engine Module is configured to perform relevance detection across unstructured or inconsistent data formats without requiring prior normalization or rule-based cleansing; optimizing search results, by a dynamic SKU search engine and/or a personalization engine based on the interpreted queries; continuously monitoring, by a real-Time Relevancy Adjustment Modul, feedback to adapt search results dynamically; presenting, by the SPoG UI, the optimized search results to the user to facilitate an intuitive browsing experience; measuring performance of the enhancements on one or more search relevancy and/or user engagement metrics, analyzing performance indicators to assess effectiveness; iteratively refining one or more algorithms based on the effectiveness assessment to further enhance search relevancy and user experience.
16. The method of claim 15, wherein the enhancement process initiated by the system comprises receiving user queries through the Single Pane of Glass User Interface (SPoG UI) module, which serves as the primary interface for user interaction.
17. The method of claim 15, wherein the interpreted search queries are processed through the Fuzzy Logic and Natural Language Processing (NLP) Enhancement Module within the Relevancy Search Engine Module, utilizing fuzzy logic algorithms to handle imprecise or uncertain information inherent in vague search queries.
18. The method of claim 15, further comprising dynamically adjusting search relevancy in response to one or more changing conditions selected from customer segment, personalization preferences, and historical interactions, enabling current search results.
19. The method of claim 15, wherein the dynamic SKU search engine retrieves and indexes dynamic and static SKU data from one or more sources selected from inventory systems, product databases, and external APIs, ensuring comprehensive accuracy for search queries.
20. The method of claim 15, wherein the measuring the performance of real-time data mesh

integration and dynamic SKU searches on search relevancy and user engagement metrics is measured based on key performance indicators selected from click-through rates, time spent on the platform, and/or conversion rates, to assess the effectiveness of the enhancements.