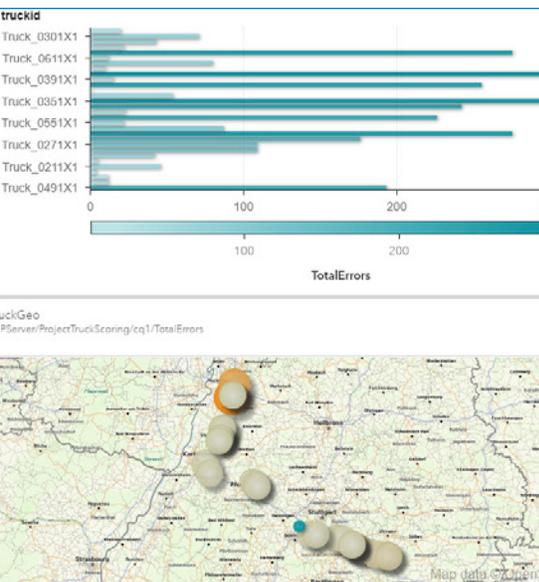


SAS® Event Stream Processing

Act on data while it's in motion to keep a real-time pulse on your business



Staying competitive in a data-driven world means working and making decisions incredibly fast. You need to assess continuously changing conditions, monitor for events of interest as they happen and follow through with contextually relevant action. With event stream processing, the data doesn't stop. Continuous queries constantly analyze live data to detect patterns of interest so you can respond in real time.

SAS Event Stream Processing helps you understand events while they're in motion (known as event streams). Instead of the traditional "stream, store and score" model, queries are stored and data is streamed through them - introducing a "stream, score, then store" business model. Data is analyzed continually as it's received, updating situational intelligence as new events take place. This model captures the business value of information immediately rather than losing it to information lag. Designed for optimal performance with a flexible processing model, the solution provides submillisecond response for high-volume throughput.

What does SAS® Event Stream Processing do?

SAS Event Stream Processing analyzes and understands millions of events per second, detecting patterns of interest as they occur. The results show the correct actions to take, what alerts to issue, which data to store and which events to ignore.

Why is SAS® Event Stream Processing important?

Get value out of streaming data from sensors, devices, transmissions, operational transactions, etc. - while the data is in motion. With submillisecond response times, the software assesses data streams using a suite of prebuilt operators, functions, routines and advanced analytics. So you can derive insight into events and take appropriate actions.

For whom is SAS® Event Stream Processing designed?

A configurable, embeddable engine, the software is designed for application developers, IT engineers and system architects. The web-based interface makes it easy to manipulate data and build projects, while a dashboard delivers information visually so you can test and validate results.

Benefits

- **Get instant information, take immediate action.** Streaming data from operations, transactions, existing systems, and Internet of Things (IoT) sensors and devices is valuable when you can act upon key insights in real time. Regardless of data or format, SAS immediately enhances the value of streaming data for information-driven applications, including customer experience, asset and IT performance, fraud, risk, security and more.
- **Store the right data.** Faster, better and more powerful analysis of streaming data ensures data transformations are made before high-volume data is stored - reducing data management processing and storage costs. Continuous queries run faster in the flexible threaded-processing model to dynamically and intelligently filter, detect, update, delete and insert the data most important to the business - all while the data is in motion.
- **Make sound decisions based on sound analyses.** Having accurate data at your disposal means you can take the right action. SAS Event Stream Processing provides in-stream, continuous analytical model updates, prebuilt data quality operators, natural language text-processing functions and a wealth of advanced analytics algorithms to score and detect even the most complex event stream patterns.
- **Take full control and adapt to changes quickly.** No matter how fast your data moves, how much data you have, or how many data sources you're connecting to, it's all streamlined and under your control from a single, intuitive interface. Consolidated event stream data instructions defined in SAS and other programming languages ensure streamlined, governed pattern detection, which makes it easier to evolve with changing data conditions.

Product Overview

SAS Event Stream Processing ingests large volumes of streaming data quickly – millions of events per second – so you can understand events in the data while it's in motion. No data stream is too big or fast. You can integrate, visualize, transform and analyze IoT data across the entire ecosystem – edge devices, data centers or the cloud. The solution's processing speed is bounded only by the hardware environment's limitations.

Incoming data is read through adapters and connectors, which are part of a publish-and-subscribe architecture. Event data publishes into a source window of an event stream processor. A visual interface makes it easy to define the windows, procedures and operators. In turn, it's simple to define continuous queries through which the data will stream. Streaming data is examined for patterns and can be intelligently filtered to store anomalies that demand deeper investigation. Or, if no relevancy is detected, the data can be discarded. Downstream applications

subscribe to receive streaming analysis results with prescribed actions. This approach allows you to respond quickly to changing conditions and position your business for new IoT market opportunities.

Consume and connect streaming data from the edge or the cloud

Is your data center prepared to handle the rapid growth projected for IoT data? Are you prepared to collect data from the edge, the fog and the cloud? Most are not. Even data streams generated from current web transactions, sensor devices and operational systems can be challenging to consolidate and fully exploit.

SAS Event Stream Processing can consume a wide array of data stream formats and can easily integrate results into existing systems and applications. An extensive suite of prebuilt adapters and connectors enables you to ingest and manipulate live data streams to detect, filter, aggregate, correlate and delineate patterns of interest. Actions are applied to both structured and unstructured text data, with results sent to other systems to improve efficiency and lower costs. Your organization can consume the data sources it needs today with assurance that the same technology will work tomorrow.

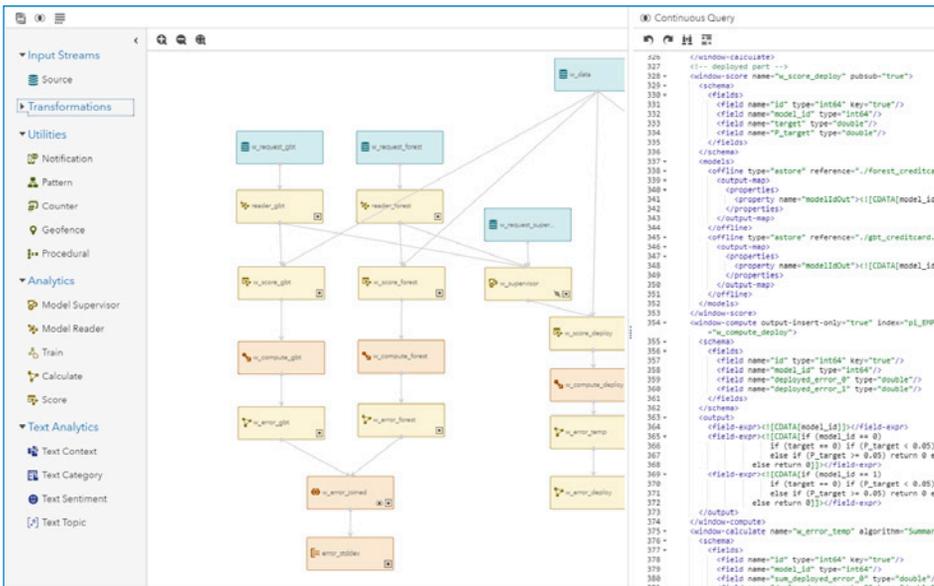


Figure 1: The design interface in SAS Event Stream Processing provides access to all advanced analytics and stream processing windows.

| Name | Type | Tags | Modified Date | Modified Time | Modified By |
|--------------------|-------------|---------------------------------|---------------|---------------|-------------|
| PMU_Transpose | ESP Project | | 2017-11-30 | 11:46 | anonymous |
| Sample_Cluster_Mod | ESP Project | | 2017-11-29 | 13:24 | anonymous |
| Truck | ESP Project | TruckFleet; Monitoring; IOT | 2017-11-28 | 15:15 | anonymous |
| pg_usecase2 | ESP Project | | 2017-11-27 | 15:04 | anonymous |
| project | ESP Project | kmeans; demo | 2017-11-15 | 12:37 | anonymous |
| project | ESP Project | Demo; DBSCAN | 2017-11-15 | 12:34 | anonymous |
| Sample_PMU | ESP Project | | 2017-11-09 | 11:33 | anonymous |
| ScoringComparison | ESP Project | RandomForest; GradientBoost; ML | 2017-11-01 | 10:29 | anonymous |
| Clustering_Model | ESP Project | | 2017-11-01 | 10:28 | anonymous |
| annotationProject | ESP Project | image | 2017-10-18 | 18:22 | anonymous |
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| project | ESP Project | kmeans | 2017-09-28 | 09:46 | anonymous |
| project | ESP Project | dbscan | 2017-09-28 | 09:46 | anonymous |
| HealthMonitoring | ESP Project | health; wearables | 2017-09-28 | 09:44 | anonymous |
| SocialMedia | ESP Project | sentiment; social | 2017-09-28 | 09:33 | anonymous |

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| Solace03 | | 2017-11-01 | 10:47 | anonymous |

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Figure 2: SAS Event Stream Processing studio provides an easy-to-navigate repository of projects.

Advanced streaming analytics, flexible, visual development environment

SAS Event Stream Processing provides a highly visual, interactive interface for building modular, continuous queries that use SAS advanced analytics algorithms and rules to pinpoint event relevance. System architects and application developers have point-and-click access to the palette of windows and connectors, making it easy to design complex streaming analytical models. An interactive test mode lets users evaluate logic and validate results before deployment. Events can be shared across projects and historic activity can be compared to current events from the visual drag-and-drop environment. This makes it easy to define, update and revise data in motion to address quickly emerging events.

Real-time, advanced analytics provides high-frequency calculations as well as advanced clustering algorithms. These algorithms can be trained on data at rest and then deployed on streaming data. Real-time streaming algorithm support includes: support vector data description, robust principal component analysis, convolutional neural networks, recurrent neural networks, random forest, gradient boosting and streaming regression analysis, streaming summary univariate statistics, streaming Pearson's correlation, streaming segmented correlation, Weibull distribution fitting, short-time Fourier transform, streaming text tokenization, streaming text vectorization and moving relative range. Analytical models can be retrained on streaming data to update model coefficients as new data arrives, for continuously updated analytical models.

Key Features

In-stream learning model windows

- In-stream learning model windows allow you to use different window types to specify data stream input sources, patterns of interest and derived output actions. Learning model windows include:
 - Train. Develop an advanced analytical model in stream and pass the resulting model updates to a score window.
 - Score. Apply the trained model to current events in stream to produce score output, as well as support for learning models that use both training and scoring together.
 - Calculate. Use with offline ASTORE models, Python code, data normalization and transformation methods, as well as learning models that bundle training and scoring together.
 - Model supervisor. Control what model to deploy, and when and where to deploy it (for example, to the score window).
 - Model reader. Integrate offline ASTORE models and publish a model to another streaming analytics window, such as the score window.
- With unified project and server management via SAS Event Stream Manager, you can:
 - Construct and manage repeatable deployment plans with an easy-to-use interface, for projects executing on SAS Event Stream Processing servers.
 - Quickly create deployments to monitor collections of servers and to simplify management.
 - Identify deployment errors and retry operations only on servers that need attention.
 - Create filtered lists of SAS Event Stream Processing servers to apply deployment operations.
 - Create repeatable deployment scripts for rapid automation and user prompts, simplifying SAS Event Stream Processing project activation.
 - Monitor events consumed with metering server displays to identify event usage patterns per license.
 - Easily add new SAS Event Stream Processing servers for improved monitoring.

Ability to consume and connect streaming data

- Extensive suite of data adapters and connectors for publishing and subscribing to live data streams of both structured and unstructured data, including videos and images.
- Predefined adapters include read and write (i.e., publish and subscribe): BACNET, Hadoop (HDFS Yarn), Kafka, MQTT, OPC-UA, Cassandra, MapR, Apache Camel, REST (HTTP POST requests to a configured REST service), Nurego, OSIsoft PI, Axeda, RabbitMQ, Solace, Tervela Data Fabric, UVC camera, XML/JSON file socket adapter, SAS Cloud Analytic Services, SAS® LASR™ Analytic Server, IBM DB2, IBM Netezza, IBM WebSphere MQ, SAP Sybase ASE, TIBCO Rendezvous, JMS, file/socket, database ODBC and SAS data sets.
- Customized publish/subscribe APIs can also be written in C or Java.
- Adapter connector makes it easier to manage adapters from within a SAS Event Stream Processing project, simplifying adapter orchestration (similar to connector orchestration).
- Publish only to SAS Event Stream Processing from the following: BoardReader, Twitter, log sniffers (Oracle, Greenplum), network sniffer, SYSLOG, HTTP RESTful interfaces; subscribe only from SAS Event Stream Processing to SOAP and SMTP.

Advanced pattern-matching algorithms

Right out of the box, SAS Event Stream Processing provides parsing, filters, joins, field calculations and pattern-matching functions. This includes prebuilt functions designed for routine data management tasks like transformations, normalization, matching, identification and more. Unstructured text processing functions provide natural language processing (NLP) extractions of tokens, concepts, entities and facts, as well as classification of text and sentiment identification. In-stream clustering builds homogeneous groups of events on the fly while predictive algorithms estimate future events, creating advanced patterns of interest. You can examine multiple events in a single query, including sequential and time-based (temporal) events.

Dashboard view of live event streams

The streamviewer in SAS Event Stream Processing is a real-time dashboard that lets you monitor live event streams from a single location. Use the dashboard to produce SAS graph visualizations, view multiple models across different SAS Event Stream Processing servers, share dashboards and create embeddable dashboards. Links to SAS Visual Analytics reports can be embedded in the real-time dashboards to provide fast access to deeper historical insights.

Key Features (continued)

Adaptable, in-stream analytics and data manipulation

- Machine learning streaming-algorithm support lets you create scoring and learning procedural windows for various continuous learning algorithms to include streaming linear regression, logistic regression, support vector machine, density-based clustering (DBSCAN) and k-means clustering.
- In-stream analytics packaged with SAS Event Stream Processing include streaming regression analysis, streaming summary (univariate statistics), Pearson's correlation, text vectorization and moving relative range, Weibull distribution fitting, text tokenization, segmented correlation and short-time Fourier transform.
- Algorithms for offline training packaged with SAS Event Stream Processing include robust principal components analysis, Bayesian network, recurrent neural networks, convoluted neural networks and deep neural networks.
- DBSCAN lets you identify clusters in an unsupervised manner. A combination of train and score windows are used to periodically update the DBSCAN model.
- The geofence window type allows you to track the location of objects relative to borders of a geofence. Alert when an object approaches, enters or leaves the defined geofence boundaries - and track entities within the geofence boundaries.
- Model training on historical data (for accurate model development) complements high-performance analytics for at-rest data.
- Integration with SAS model management capabilities provides faster, automated integration of analytical models with SAS Event Stream Processing projects.
- Flexible, modular, window-driven architecture to define complex continuous queries:
 - Based on an extensive suite of interchangeable window types and operators to detect an unlimited number of patterns, correlations, computations and aggregations.
 - Prebuilt, common data quality routines are used to cleanse, standardize and filter livestream data before it's stored, reducing downstream processing.
 - Patterns of interest can include nearly unlimited advanced analytics calculations with in-stream, machine learning k-means clusters and livestream analytical scoring. Analytical models include all SAS DATA step, DS2, Python and third-party code snippets.
- Highly embeddable to gateways, devices and any existing C++ application (with dedicated thread-pool processing).

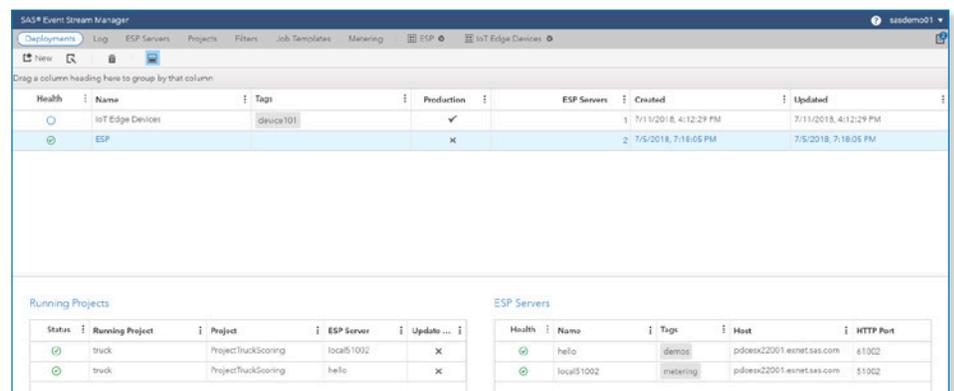


Figure 3: SAS Event Stream Manager supports collaboration between IT and data scientists, speeding time to deployment for operational streaming environments.

Optimized processing that scales

With event stream processing, systems need to be online, all the time. And processing must happen very fast, which demands optimal performance. SAS has patented, instantaneous 1+N way failover, guaranteed delivery without persistence and dynamic updates to ensure consistent, relevant processing. The low latency, high-volume SAS Event Stream Processing software outperforms other stream processing engines with commodity hardware. And the distributed, in-memory grid processing scales linearly as your data grows, optimizing hardware investments.

Enterprise administration and management

Centralized administration and management of event stream processing activities are key to enforcing IT command and control of project handling, processing optimization and maintenance. The solution provides transparent governance that aligns to business requirements and can integrate stream processors and algorithms from SAS and other sources. IT has complete control over deployment of stream processing across distributed SAS Event Stream Processing servers with user-defined deployment scripts as well as server health monitoring. Integration with SAS Model Manager ensures model performance is available to support active alerting when new champion analytical models are ready for deployment. An optional caching store is also available if data sizes exceed the available memory.

Key Features (continued)

Expanded deployments and open data support

- Deploy SAS Event Stream Processing to the edge for IoT applications - SAS Event Stream Processing for Edge Computing provides a smaller, configurable disk footprint for simplified deployment to smaller edge devices.
- SAS Event Stream Processing Python development interface:
 - Speed development time with a familiar, open and flexible Python interface to develop, publish, test and stream events through SAS Event Stream Processing projects.
- Python publish/subscribe API:
 - Publish events and subscribe to SAS Event Stream Processing using Python.
- Use languages in SAS Event Stream Processing (in-process event stream handlers):
 - DS2, Python and C/C++.
- BOSH Cloud Foundry: for large-scale distributed services.
- Data stream support:
 - Hortonworks DataFlow (HDF) NiFi integration: SAS and HDF can provide immediate, streaming and deep intelligence.
 - Teradata integration: Teradata Listener connector sends data from SAS Event Stream Processing to the Teradata Listener application. Teradata Listener ingests high-volume, real-time data streams and persists the data from those streams to Teradata, Aster or Hadoop.
 - MapR streams support: The Kafka adapter is certified to work with the MapR converged data platform for publishing and subscribing.
 - Connectors and adapters for IoT (OPC UA, Twitter, Kafka, MQTT, BACnet, UVC camera, gateways, devices, Cassandra (adapter only), BoardReader.

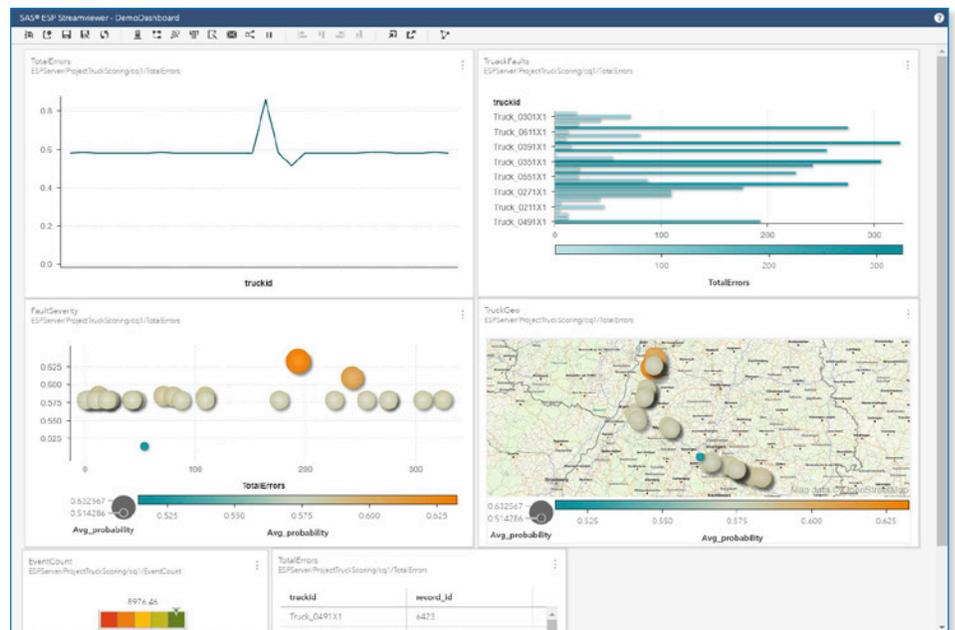


Figure 4: The streamviewer is a real-time dashboard for creating, editing and sharing streaming data insights.

TO LEARN MORE »

To learn more about SAS Event Stream Processing system requirements and see other related material, please visit: sas.com/esp.

Key Features (continued)

- SAS Event Stream Processing for SAS® Viya® and SAS Cloud Analytic Services (CAS):
 - Deploy SAS Viya data management/machine learning models to SAS Event Stream Processing for streaming analytics.
 - Stream, analyze, filter, identify patterns and score data while it moves in/out of SAS CAS.

Visual monitoring of event streams

- Configure the dashboard for customized testing of streaming activity.
- Interactively filter and query livestream activity to examine specific behavior of elements.
- Define and customize notifications by SMS, email and other alerts as part of event stream model workflow.
- Faster response with new web socket support to monitor events from SAS Event Stream Processing server.
- Compare historical activity with current processing using graphical representations.
- Monitor stream processing detail by subscribing to events of interest.

In-memory, distributed and optimized processing that scales

- High-volume processing of millions of events per second. Low-latency response times (millisecond, submillisecond).
- SAS Event Stream Processing metering server monitors and records event consumption for each SAS Event Stream Processing project, input window and production SAS Event Stream Processing server - speeding the collection of event consumption data.
- Retained and aggregated data kept in memory.
- Ability to take advantage of distributed grid architectures.
- Processing speeds can be customized with flexible thread-pool sizing, caching stores and more.
- Includes patented, instantaneous 1+N way failover, native failover, guaranteed delivery without the use of persistence and other fault-tolerance functions to ensure successful event stream processing activity.
- Full and open access to all event metadata.

To contact your local SAS office, please visit: sas.com/offices

