

# Transform invoice anomaly detection with AI smart encoders



ERICSSON

# Executive summary

**Communications service providers (CSPs)** face challenges with billing errors that can lead to revenue loss, customer dissatisfaction, and churn. Traditional rule-based systems for invoice error detection are often limited in their effectiveness.

Recently, generative artificial intelligence (Gen-AI) has emerged as a game-changer, disrupting conventional processes across industries. Gen-AI is often associated with search engines and conversational chatbots powered by large language models (LLMs). However, beyond LLMs and chatbots, Gen-AI offers multiple models and approaches that can be used for various purposes. One such distinct Gen-AI model is the Variational Autoencoder (VAE), which is particularly useful in detecting anomalies. Ericsson has

harnessed the power of the VAE model to revolutionize anomaly detection in telecom invoices, ensuring greater accuracy and efficiency in identifying discrepancies.

Ericsson leverages VAE to offer intelligent invoice anomaly detection that swiftly processes large amounts of invoice data and accurately detects billing errors such as amount variations, incorrect charges, and missing charges. An intuitive dashboard presents these anomalies, enabling billing support and revenue assurance teams to act promptly before the final bill run, thus preventing customer dissatisfaction and mitigating revenue loss.

This document describes how Ericsson is utilizing VAE for faster, scalable, and more precise invoice anomaly detection.

# The crucial role of accurate billing in customer experience and revenue assurance

According to the TM Forum Business Assurance Survey Report, overbilling, underbilling, and bill shock are among the main factors impacting customer experience. The same

survey highlighted that more than 90 percent of CSPs have “revenue losses and/or overcharging” as the main revenue assurance key performance indicator (Figure 1).

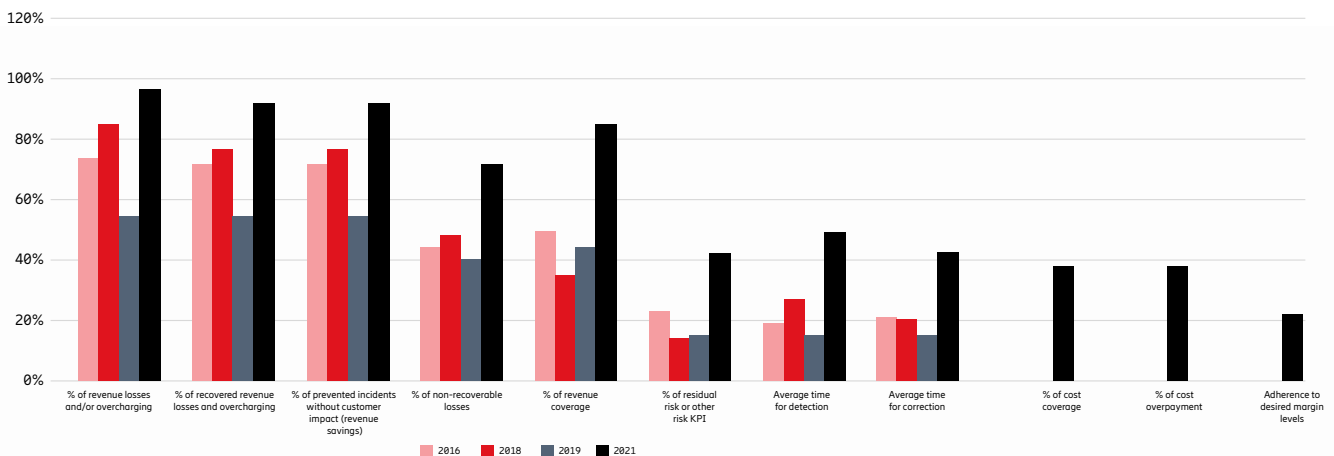


Figure 1: TM Forum Business Assurance Survey

Source: TM Forum

In today's dynamic telecom landscape, powered by 4G and 5G technologies, accurate billing and invoicing play a pivotal role in ensuring the success of CSPs. The diverse range of services enabled by 4G and 5G, including the Internet of Things (IoT), augmented reality, and ultra-high-definition video streaming, necessitates precise billing to reflect the specific usage of these advanced services. As CSPs strive to maximize revenue and minimize loss, accurate billing becomes a cornerstone of revenue assurance. In a competitive market, maintaining customer trust through accurate billing is essential for retaining subscribers and attracting new ones.

Invoices are among the most crucial and complex documents generated by CSPs. They detail the charges incurred by customers for various services, such as voice calls, text messages, data usage, and additional features like roaming, international calls, and value-added services. With the introduction of [differentiated connectivity](#), such as network slicing and advanced 5G services, the complexity of invoices is increasing. As this complexity grows, the risk of invoice anomalies rises, directly impacting revenue collection and customer experience.

Invoice anomalies can occur due to several factors, including:

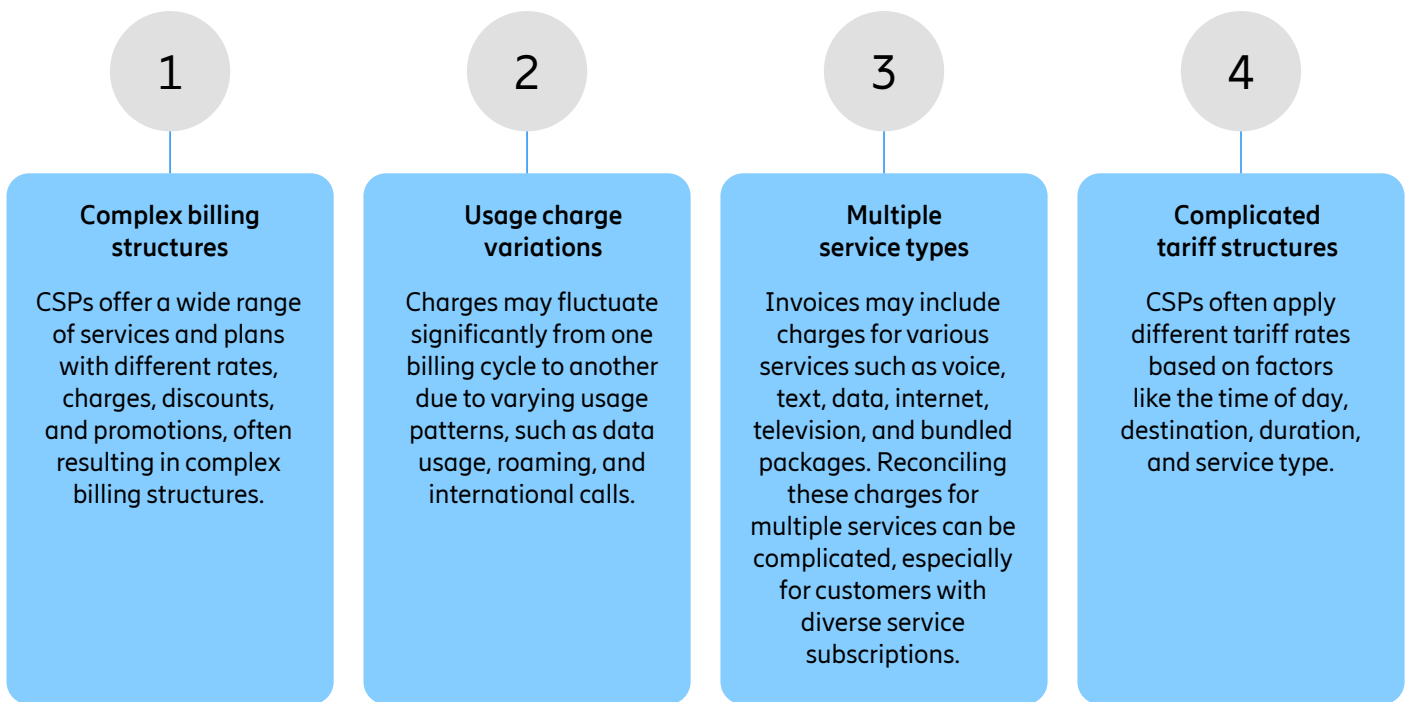


Figure 2: Causes of invoice anomalies

Additionally, other factors contributing to invoice issues include proration, partial billing, discrepancies in usage data, and more. These factors can lead to invoice anomalies, such as incorrect charges, missing charges, overbilling, underbilling, and invoice amount variations. Although anomalies in telecom billing represent a minority of invoices, their consequences can result in significant financial losses, customer dissatisfaction, and regulatory complications.

Existing invoice anomaly detection solutions are primarily rule-based and often limited in effectiveness. They require frequent updates to accommodate various rate plans, discounts, and contracts. Revenue assurance teams struggle to ensure invoice accuracy each billing cycle, often resorting to spot checks on selected samples because it is impractical to scrutinize every invoice. This approach is time-consuming and prone to errors. To address this, Ericsson has developed a Gen-AI VAE-based solution for the swift, efficient, and effective detection of invoice anomalies.

# Leveraging VAE for invoice anomaly detection

Utilizing AI-driven solutions enhances the precision of detecting invoice anomalies while minimizing false positives. Additionally, AI can recognize non-compliant behaviors, such as a customer being charged for two mutually exclusive services or an unauthorized discount being applied. AI can also uncover hidden patterns that often elude human detection, like unusual spikes in usage or charging a customer for roaming while on their home network.

Traditional methods of anomaly detection often fall short when capturing nuanced patterns or adapting to evolving trends. Gen-AI, specifically VAE models, offers a promising solution to improve invoice anomaly detection.

While Gen-AI is commonly associated with search engines and conversational chatbots powered by large language models (LLMs), it also includes innovative models like the VAE, which excels at detecting anomalies. VAEs are a class of generative models in machine learning, designed to generate new data points that resemble the data they were trained on. They are considered a form of Gen-AI because they learn the

underlying distribution of the training data and can generate new samples from this learned distribution.

The VAE encodes input data into a latent space representing the underlying data distribution. By learning this distribution, the VAE can generate similar data points and detect deviations from it. This ability to differentiate between normal and anomalous data makes the VAE a powerful tool for anomaly detection.

In simple terms, the VAE simplifies complex data, acting like a skilled artist. They summarize vast amounts of information into understandable forms through two main steps:

- **Simplifying (encoding):** CSPs generate a large number of invoices each billing cycle. The VAE condenses their details into a summary while preserving essential information.
- **Rebuilding (decoding):** After simplification, the VAE reconstructs the original invoices from the summary. The goal is to ensure that the rebuilt invoices closely resemble the originals, even though they are generated from summary data alone.

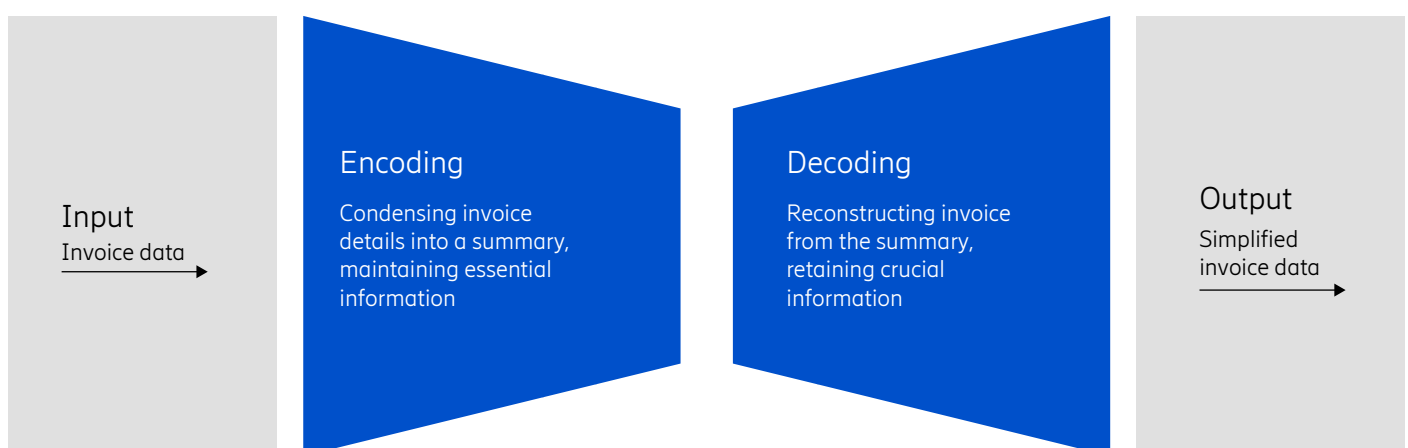


Figure 3: Variational Autoencoder (VAE)

In essence, the VAE acts as intelligent translators, simplifying complex content and reconstructing it while retaining crucial information.

In the realm of invoice anomaly detection, VAEs are ideal for four reasons:

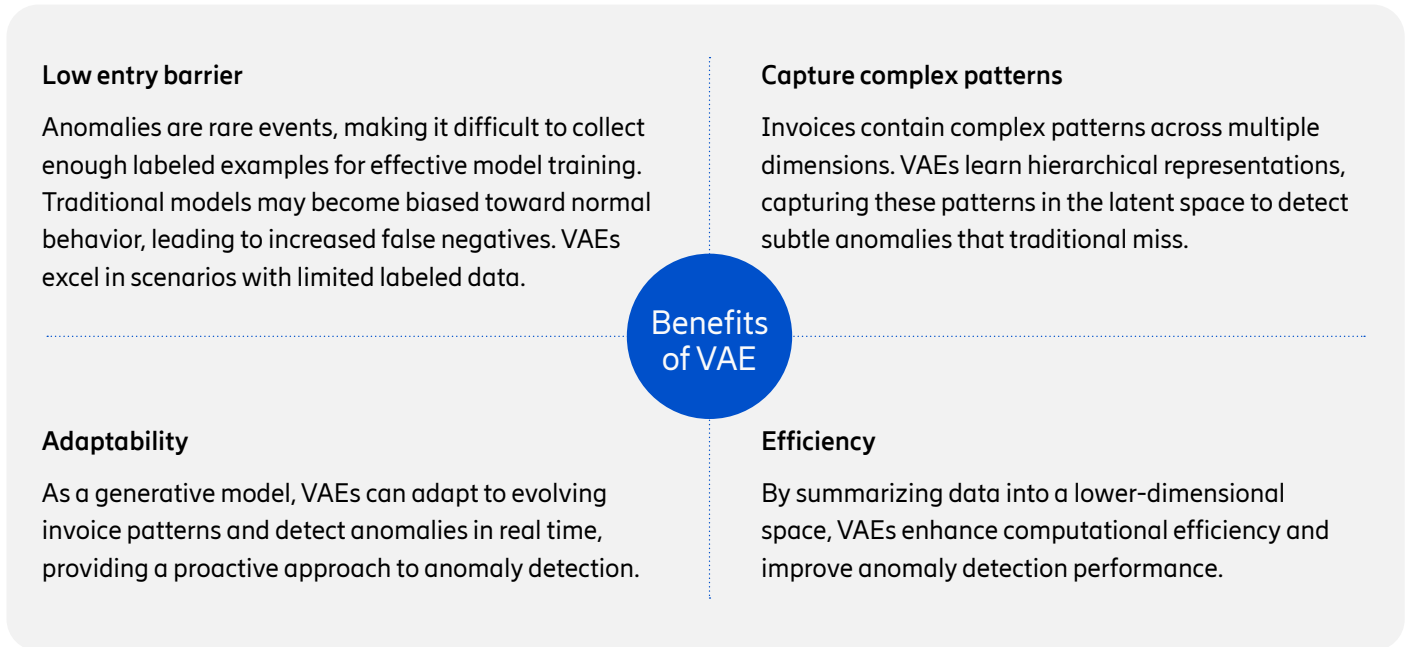
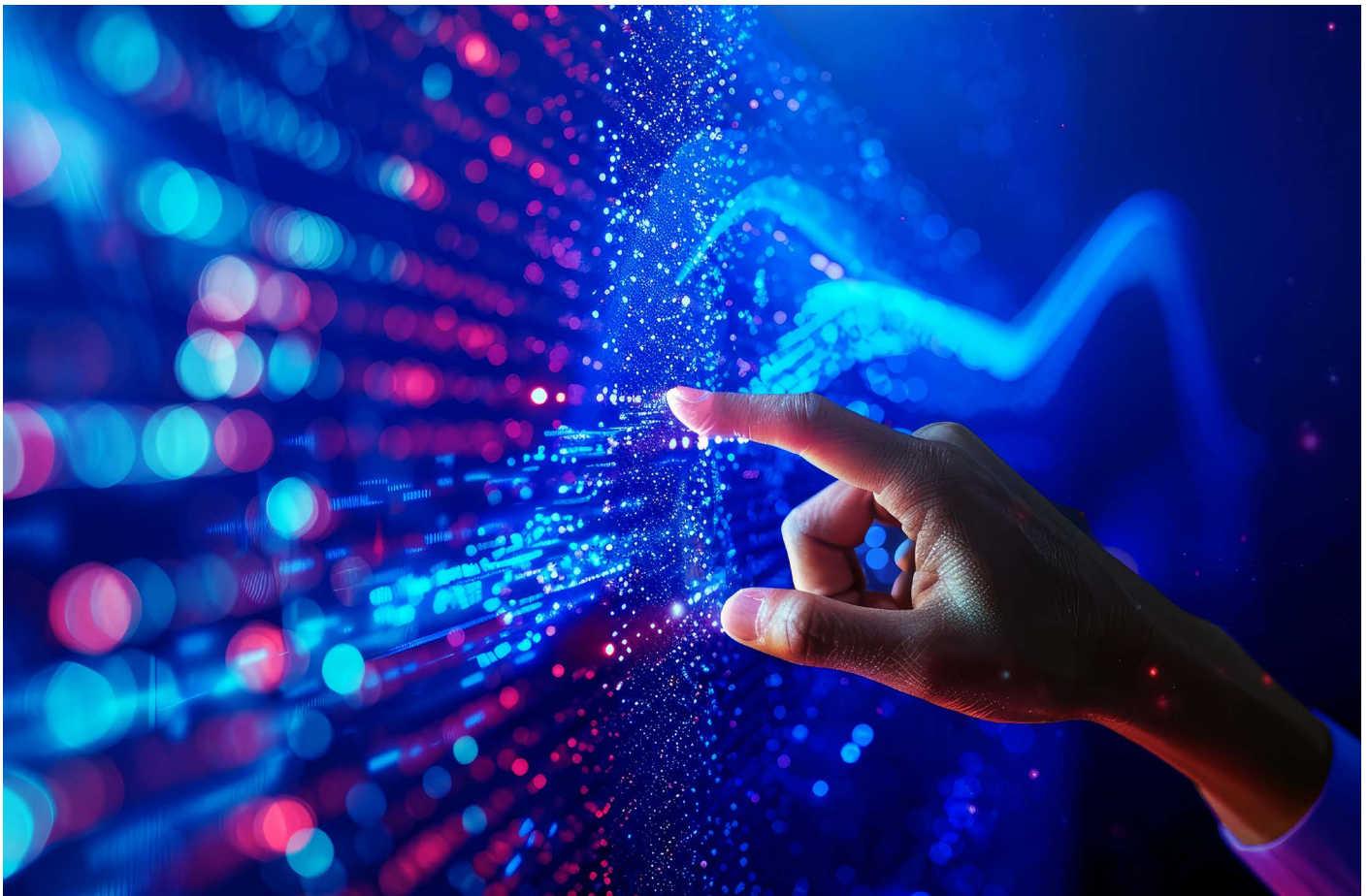


Figure 4: Benefits of Variational Autoencoder (VAE)



# Ericsson's VAE-based solution for swift and efficient invoice anomaly detection

Ericsson's Gen-AI powered intelligent invoice anomaly detection capitalizes on the VAE model and makes use of [Ericsson Mediation](#) for industrialized data ingestion. The VAE model transforms a large amount of complex billing data into understandable form, enabling CSPs to identify anomalies accurately and swiftly.

This solution leverages Amazon SageMaker for machine learning operations (MLOps). Amazon SageMaker is a fully managed machine learning service from Amazon

Web Services (AWS) that facilitates the rapid preparation, building, training, and deployment of high-quality machine learning models. It brings together a broad set of capabilities specifically designed for machine learning.

The solution can also be deployed on other hyperscale cloud provider (HCP) platforms.

Ericsson's intelligent invoice anomaly detection is aligned with the TMF SID model (TMF 678A) and comes integrated out-of-the-box with [Ericsson Billing](#).

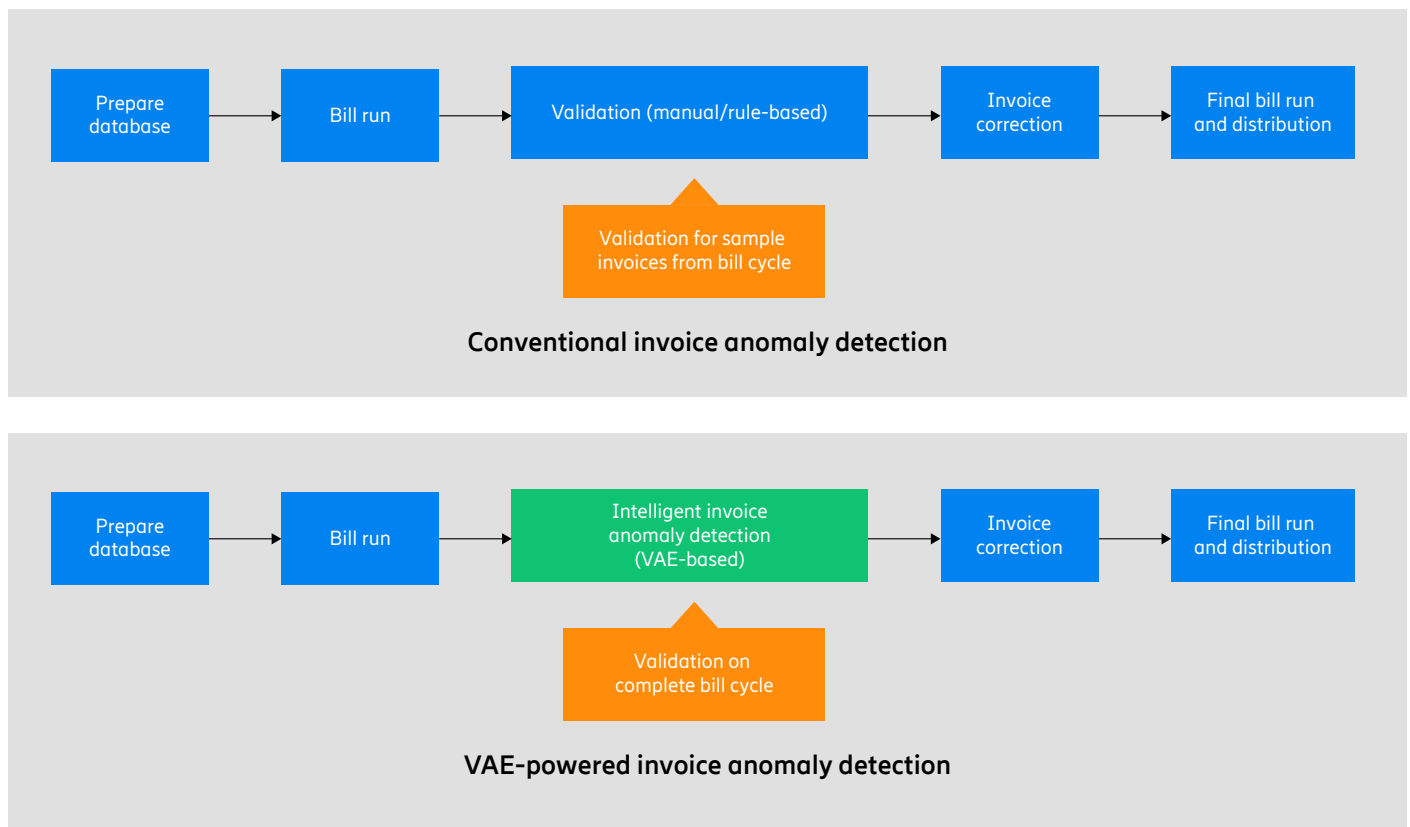


Figure 5: Conventional vs VAE-powered invoice anomaly detection

Ericsson's intelligent invoice anomaly detection presents anomalies through an intuitive web user interface and dashboard, enabling billing support and revenue assurance teams to act promptly before the final bill run. This helps prevent customer dissatisfaction and mitigate revenue loss. The solution identifies anomalies such as:

- invoice amount variation
- invoice item amount variation
- incorrect charges
- missing charges

Conventional invoice anomaly detection considers only a sample of total invoices for review. For example, **20 percent** of total invoices might be checked for anomalies. Ericsson's intelligent invoice anomaly detection empowers CSPs to review **100 percent** of total invoices for the anomalies which can impact revenue and customer satisfaction. Additionally, it reduces the time and efforts consumed at the pre-verification stage in billing.

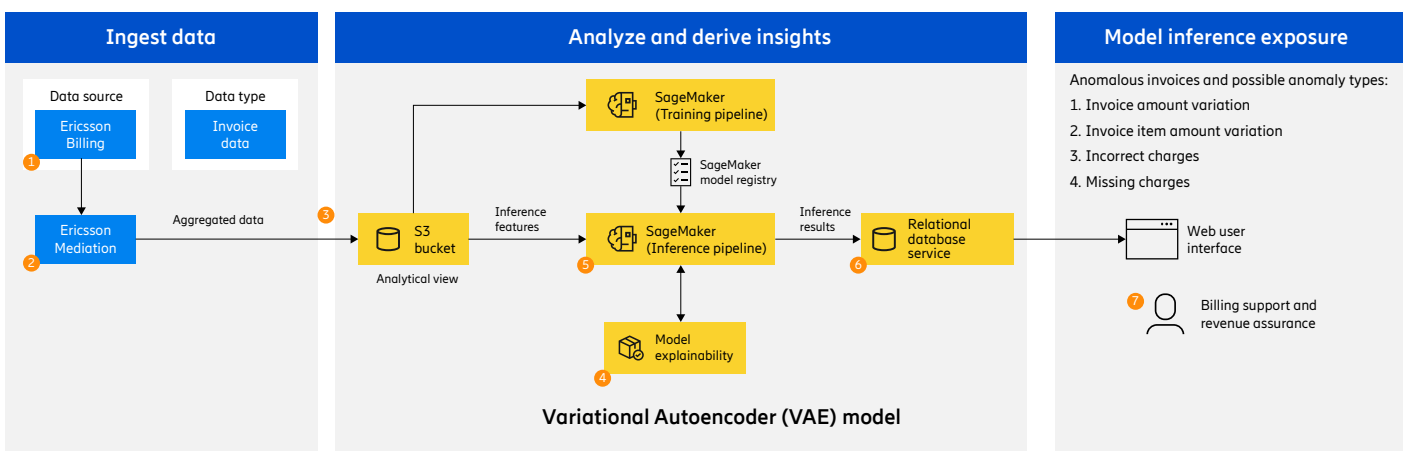


Figure 6: Ericsson intelligent invoice anomaly detection solution overview

Based on these flagged anomalies, Ericsson Billing reprocesses customers' invoices using a two-step billing process, enabling the re-rating and re-billing necessary to ensure accuracy.

The solution requires training data (invoices), which are ingested and transformed by Ericsson Mediation, then used to train a VAE model. Once trained, the model is stored in the Amazon SageMaker model registry.

The process of identifying invoice anomalies occurs as follows for each billing cycle (see Figure 6):

1. Ericsson Billing initiates invoice generation for a billing cycle.
2. Ericsson Mediation ingests invoice XMLs and runs feature transformation jobs.
3. Ericsson Mediation pushes the extracted features to Amazon Simple Storage Service (Amazon S3) for further processing.
4. A VAE model is automatically used to evaluate the ingested invoices, using an Amazon SageMaker inference pipeline.

5. Once the VAE-based invoice evaluation is concluded, the results undergo model explainability and customizable rules to identify potential anomaly types.
6. The list of identified anomalous invoices, along with associated explanations, is stored in Relational Database Service and made available for visualization in the user interface (UI) and further actions.
7. Billing support users review the identified anomalous invoice details and initiate necessary actions.

Amazon SageMaker plays an integral role in this solution, streamlining the machine learning workflow and accelerating both development and deployment.

Ericsson's intelligent invoice anomaly detection is part of the [Ericsson Telco IT AI Apps](#) offering. Ericsson Telco IT AI Apps offers a set of cloud native AI applications designed to augment OSS/BSS features and improve the observability of OSS/BSS systems through various AI use cases. They provide intelligent insights for [OSS/BSS](#), empowering CSPs to minimize revenue loss, improve marketing strategies, reduce customer attrition, boost customer satisfaction, and capitalize on new revenue-generating opportunities.



# Conclusion

Ericsson's intelligent invoice anomaly detection, leveraging VAE, represents a significant advancement in billing accuracy and customer service.

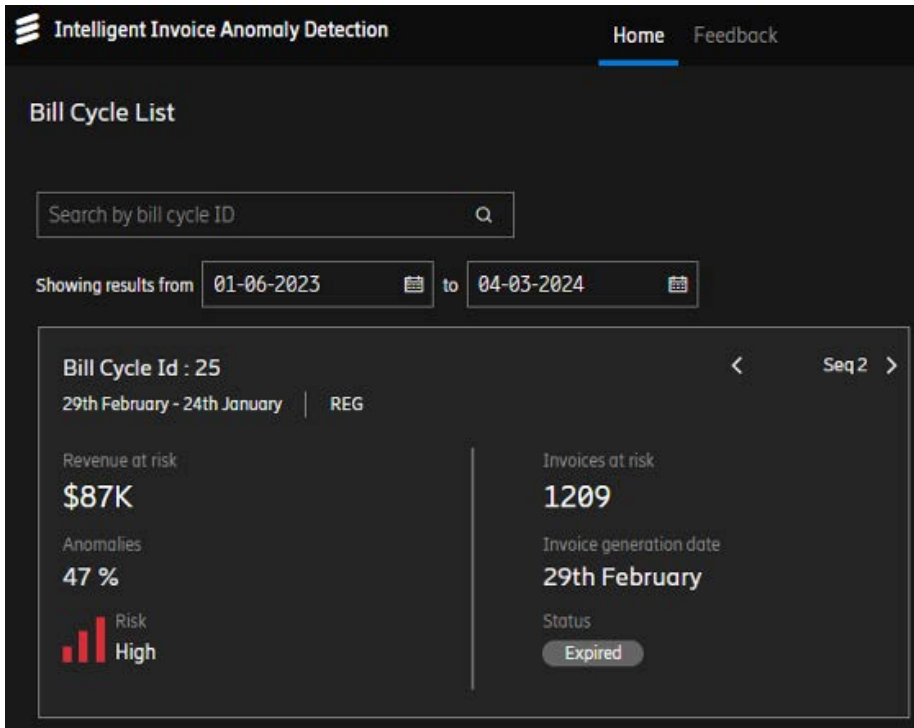


Figure 7: Ericsson intelligent invoice anomaly detection web user interface

Harnessing the power of VAE, Ericsson's solution efficiently processes vast amounts of complex billing data, identifies discrepancies, and adapts to new patterns in real time. Billing anomalies are presented through an intuitive web user interface, enabling billing support and revenue assurance teams to correct issues before they impact subscribers. This streamlines and accelerates anomaly detection, maintaining billing accuracy, minimizing financial losses, and preventing customer dissatisfaction.

This VAE-driven approach offers clear advantages. It reduces reliance on scarce labeled data for rare billing anomalies and provides proactive adaptability to evolving telecom

services, especially with the rise of 5G. The integration of Amazon SageMaker streamlines the machine learning model development and deployment process, ensuring scalability, flexibility, and seamless integration with AWS services.

By adopting this innovative approach, CSPs can not only detect but actively prevent anomalies, safeguarding their revenue and enhancing customer trust.

As billing complexities continue to grow, Ericsson's intelligent invoice anomaly detection will become increasingly crucial to the industry, promising a more accurate, efficient, and customer-centric future for telecom billing.

## Further Reading:

[Ericsson Telco IT AI Apps](#)

[Ericsson Billing](#)

[Ericsson Mediation](#)

[Telecom analytics: transform data into action – Ericsson](#)

[OSS/BSS evolution for successful 5G monetization - Ericsson](#)

[Maximize OSS/BSS impact with AI and Gen-AI](#)

[Artificial intelligence, analytics, and automation](#)

[Driving business growth with AI-enhanced OSS/BSS](#)

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