MOBILEWARE

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Validating source data + workflow

UNITY REVENUE ASSURANCE

Contents

1. Validator Overview

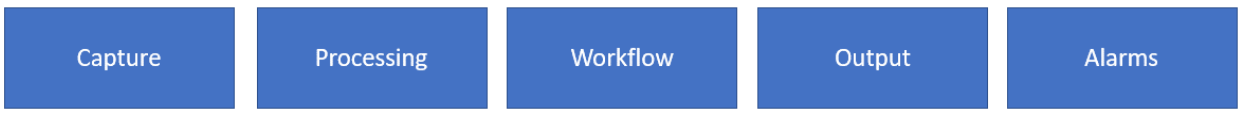
Unity revenue assurance do validate abnormal provisioning, billing and traffic patterns – and allow the operator to validate that they are able to generate stable provisioning, billing and monitoring end to end. Our existing revenue assurance functionality have mainly been focusing at the actual rating and billing functionality like in other telecom providers.

As a new focus area do, we now extend the existing functionality so that the actual revenue assurance does include more validation directly on source data, package configuration as well as actual data workflow across the different key points. This mean that the validation will be looking more at all the data being processed through the system, configuration setting and not only at the actual rating functionality.

The enhanced validation will target to improve the general usability, the quality of the output as well as give the operator a tool that allow them to see if they have misconfigured rating plans, subscription templates and alike.

Our data validator - add an extra level of revenue assurance across multiple areas:

- Across data capture (Data from Interfaces, Internal data, remote CDRs…)
- Data preprocessing (Service orders, Mediation...)
- Data workflow through Unity (Notifications, Subscriptions, Auto suspend…)
- Data output (Fees, Rated data…)
- Alarms (Generated based on abnormal data)



This new data validation is combined with a new set of monitoring APIs that allow the validation flow to be easily integrated into remote SNMP monitoring systems – and also allow Unity integrated monitoring setup to generate alarms linked to abnormal data, data flow, output – it basically extends the existing application monitoring with the ability to monitor data flow through the different measurement points.

An example could be an alarm indicator when traffic CDR's are delayed from the data source provider, no workflow through a certain module, no data output for certain time interval and similar.

1.1 What will this validator deliver?

The expected output from this validator will be improved data quality, faster discovery of modules mis performing, missing data from external satellite network operators, discovery of abnormal data and in the end a general better quality delivered to customers.

And it will make it easier for the operator to see trends on what is taking place in their own setup, how many CDR's per day, how many activations per month, listing top users across different technologies and especially be listing abnormal traffic patterns so that the operator fast can stay on top of the situation. Generally, will this bring a fast and solid overview across the data and work flow through the system. It will also allow alarms to be generated if patterns are changing – it can be that 25% less traffic CDR's have been collected in a day, it can be that traffic CDR's are getting 25% delayed and more.

1.2 Validation interfaces

There will be different ways to be using this enhanced validation setup, the first target is to improve the visibility for mobilware staff, the next part will be to bring key points to the operator, that will allow them to monitor revenue assurance closer though GUI interfaces, alarm display, reports.

- Mobilware Staff interface
- Operator GUI in Frontend and Operator dashboard
- Ability to define thresholds that can trigger outgoing alarms
- API interface that allow direct integration with any external environment incl. SNMP
- Revenue Assurance Reports
- Database access to RA – incl. interface for SAP Crystal reports

The first implementation will allow status display, mobilware staff access and full API access, there will also be a small subset of key points being displayed in status page for each single satellite technology, meaning overview display for Inmarsat I4, Inmarsat I5, Iridium, Thuraya, Eutelsat etc.

1.3 Data capture

Quickly and effectively capture data through multiple channels wherever and whenever it originates – example traffic CDR data from remote satellite network operators, data entered by users into the frontend or dashboard, data from templates for product activation and similar.

When transactions need data that's located within content like with traffic CDRs, you can automatically classify, find and extract data — but this date can contain correct format but start having associated data problems like content getting delayed, content getting new delivery formats, getting new data types and more.

Enrich the data and derive understanding using Unity's cognitive technologies. With near real-time digitization, you can improve productivity and accelerate business processes to achieve faster responses linked to issues as well as to ensure highest possible quality to customers.

The following list the main points that we do focus on in our data capture validation.

Accuracy

Reduce errors associated with manual data entry by automating data capture and validating data at the point of contact, while accelerating content integration into a case file or business process.

Speed and Efficiency

Make documents and their data available to business applications and users more quickly with time-saving and labor-saving automated processing that improves employee productivity.

Customer centricity

Create exceptional customer experiences by capturing content from any source — a mobile photo, a fax, scanned documents and digitally created content. Respond quickly even when the information is located within a document.

Unity focus at fully automated data capture, data recognition and classification of what further process is to be applied - to quickly and accurately extract important information from those documents to accelerate business processes.

Unity data validator supports the next generation of data capture — the cognitive era. The solution enables you to identify, classify and extract content from unstructured or highly variable data sources without manual intervention. It uses natural data format processing, data analytics and abnormal validation technologies. By applying cognitive capture to complex tasks, the solution can significantly accelerate processes, reduce labor costs, deliver meaningful information, prevent wrong data listings, wrong invoices, improve customer experience and improve the responsiveness of the operator's customer service.

More about data capture handling in the dedicated chapter

1.4 Data pre-processing

Unity will collect data from different sources, on the different interfaces can a certain level of data validation be applied – that allow Unity to ensure the best possible data quality.

1.4.1 Frontend interface

Integrated part of our easy to use frontend environment are the already building data validation that are using adaptive interfaces, meaning forms, display and similar are adapting to the role authenticated, the content on each line, the selected data in the drop-down interfaces and basically all menus are based on the technology called content-based menu's.

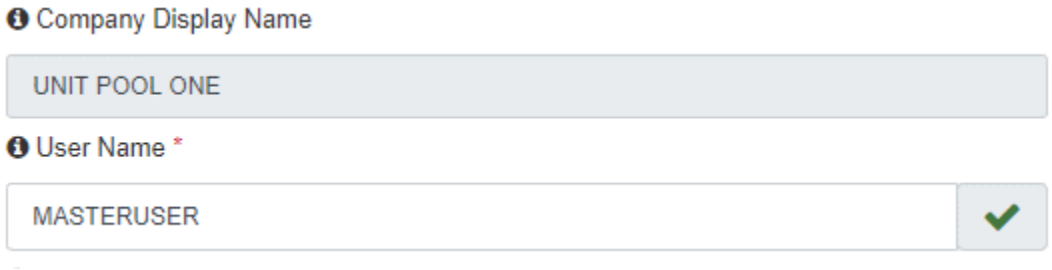
Our form fields are performing on the fly validation where needed – entered data will be validated on the fly with remote content to ensure that it is correct data as well as to improve the usability of the implemented interfaces.

The different interfaces will automatically adapt to the selected content making the possibility to perform wrong data entrance a lot smaller. Examples can be sim card validation, on the fly username validation and alike.

When it comes to most drop-down interfaces will these as well automatically adapt to what validation rules are applied in the possible remote satellite networks – when a user select vessel type, airplane type and similar are these data all pre validated options that ensure that the user are getting entered data pro processed already when selecting and filling the general data across users, packages and similar settings.

All our frontend interfaces are using conditional content layout – this are forcing the users to filter out potential wrong selections – meaning wrong data.

Here is a sample on pre-data validation performed in Unity frontend interface, as soon as the user have entered the given data like MASTERUSER' then will Unity lookup the validation in the backend. Other fields are performing on the fly validation meaning when the user are typing will data be validated on the fly that could be example when entering an IMSI number.



These interface validations are ensuring that correct and valid data are entered into Unity as well as ensuring that data are valid for the possible remote satellite networks.

1.4.2 Operator Dashboard Interface

Our operator dashboard interface does like the frontend have integrated field validations applied to ensure that correct and example mandatory data are captured before being send back to the backend environment to be entered into the database tables. Each field do in operator dashboard similar to the frontend have small helper icons next to each single field to allow the user to understand the needed content and the possible format of the content.

1.4.3 Iridium Provisioning

Iridium provisioning are integrated into the API interfaces that are provided by Iridium for Openport, Postpaid, Prepaid, SBD, GDB, PTT and Unity interfaces will automatically display only valid interface data capture forms, to make the captured data as correct as possible.

Unity do have all provisioning based on subscription templates that allow a specialist in the operator to create and develop new offers – this expert will be predefining the actual offer based on direct integration into Iridium sales catalog for the given operator.

Unity do offer multiple methods to ensure that as many errors as possible are captured before sending the actual provisioning request back to Iridium for fulfillment.

The entered data will be used internally in Unity to perform billing, rating and finally invoicing so it is important to ensure that provisioning data are captured in the best possible way.

1.4.4 Iridium Traffic CDR's

Iridium traffic CDR files are captured directly from Iridium CDR traffic delivery folders – Unity will be using the integrated CDR collector that will ensure that files are only collected a single time in case there is duplicated files added to the folder. After collection will collector ensure that files are copied across to archive to make it clearer what have been processed and to make it visible if there is duplicated files delivered.

When traffic CDR files get mediated for splitting will Unity perform data validation to ensure that there are not duplicated records present in the mediated data- this is done based on patterns that get compared like IMSI, call/session start, call/session amount, session id and similar.

This functionality prevents duplicated data to get inserted into the billing process.

Mediation will as well perform data validation linked to being able to analyze and mediate data in the expected format – after mediating data will it validate that correct and valid user can be located, and the last part is validation linked to service being in Unity – in case any validation is failing will the Traffic CDR be added to failed CDR table – same will be the case when rating process is parsing the given mediated CDR – in the case no rating plan are located for the given service will rating data validation also be adding the given data to the failed CDR table.

All billable events will be validated – including data not collected from external location like Iridium – so internal fees like subscription fees, one-time fees, topup events and similar.

In the case CDR's are failing can the issue be sorted and data can be revalidated and if it is fine will the process be completed successfully and failed data will automatically be removed from the given failed data folder.

1.4.5 Inmarsat I4 Provisioning

Inmarsat provisioning are getting pre-validated when captured – basically directly in the browser interface that are used by partner or operator staff. Inmarsat do require to get a given user structure defined when creating users and associated products.

To ensure this process in creating user structure are done in the best possible way have Unity implemented all the same validation rules as Inmarsat are having across all levels partner, company, subscriber, vessel and aircraft.

It is extremely important to have very strict data validation on Inmarsat user structure because after entering all data will a business request be send to Inmarsat and a business response will be received with possible errors after 5-6 minutes. To prevent this long difficult process in reworking a faulty creation – do Unity implement a lot of data validation on especially Inmarsat I4 user creations.

It is also possible to operate Unity in decoupled mode – meaning internally – in that case can a single user structure be reused again and again – that will allow instant user create and will completely remove the need to perform very strict data validation.

When it comes to package creation are this done like with Iridium using subscription templates that have our package wizard integrated to Inmarsat package definition documents to ensure correct and valid package data mapping.

This does not ensure that the operator are selecting the correct underlaying plans – so it is important that the superuser at the operator that build the different product templates do know the understanding of these packages and the way they should be named internally.

1.4.6 Inmarsat I4 Traffic CDRs

Inmarsat I4 CDR files are collected directly from SFTP using Unity collector that perform the same file validation as on Iridium, there are three different CDR formats from Inmarsat, based on collected files are Unity performing different file and data valuation based on type.

Inmarsat I4 CDRs are parsed using the type of CDR file combined with the service codes and the dialing plan that allow Unity to map traffic to specific internal event id - that each link to a specific service.

These detected events will be mapped to the rating plans.

Inmarsat CDR data are mapped to a long range of different billing models across SCAP groups, Groups for vessels, combined SCAP/Group, postpaid with allowance having in band rates, out of band rates, prepaid plans, common service polls, wholesale plans and alike.

Each of these many billing models do have their own setup and Unity do need to validate the date across each of these. In case they are failing then will traffic CDRs be added to failed CDR table - so the problem can be resolved.

1.4.7 Inmarsat I5 Provisioning

Unity do have all of the new Inmarsat I5 products fully implemented using Inmarsat SEP API and APIGEE API - Unity are fully integrated with Inmarsat Maritime FX, Government GX, Enterprise GX, Aero JX and have for more than 4 years been operating many operators across all levels of the new API interfaces performing operator onboarding, site onboarding and terminal activations.

Unity do manage all level of the provisioning process and the following data flow process that allow enhanced data pulling directly from IDirect platform.

Inmarsat new GX/FX provisioning workflow are very complex - each terminal provisioning can consist of 30-40 API calls before a terminal are fully activated - Unity package wizard is integrated directly with the new Inmarsat I5 sales catalogue interface that allow Unity to extract hundreds of configuration data needed to activate an Inmarsat GX/FX terminal through the API interface.

Unity do perform a comprehensive data validation when a terminal is getting provisioned to ensure that it will successfully be activated.

1.4.8 Inmarsat I5 Traffic CDR's

Inmarsat I5 do not provide any form for traffic CDR data linked to data traffic - there is only CDR data delivered for VoIP traffic for vessels.

Unity do generate internal traffic CDRs for Inmarsat I5 traffic every 5 minutes - this is done based on integration with IDirect platform that allow Unity to extract data that can be used to generate needed traffic CDR files.

There is no data validation to be performed as there is no collected external CDR data.

1.4.9 Thuraya Provisioning

Thuraya provisioning across all the different package types are done in the same way as with other plans - Unity will fully based on predefined subscription templates allow easy and simple provisioning.

Entered data like sim card and similar are pre-validated by Unity before send across over Thuraya API interface.

1.4.10 Thuraya Traffic CDRs

Thuraya traffic CDRs are collected like other external CDR files - Thuraya provide an FTP interface that Unity collector can collect traffic files from, these are like on the other interfaces checked for duplicated files, following will Unity mediate and rate these traffic CDRs.

1.4.11 Duplicated files and CDR content

Preventing duplicated traffic CDR files and records will be handled automatically by Unity, it will in the collector automatically detect duplicated file names and simply not be collecting the duplicated file.

If traffic events have been duplicated inside actual files with different naming then will Unity mediation process be detecting these duplicated traffic CDR s based on several parameters like IMSI, timestamp, destination, usage and similar – these detected events will be marked as duplicates and be added to failed CDR table.

1.5 Subscription template configuration

Subscription templates and rating plans are the master configuration files associated with basically any product created inside Unity, the actual configuration of the subscription templates is defining the layout and setup of a product.

This configuration defines the possible underlaying satellite network operator products, the default settings like APN speed, services, POP integration, default naming and much more, and one of the especially important settings are the associated allowance across data, streaming, voice or money bundle – it is also inside these templates that it is defined which services are part of allowance or money bundle.

A given subscription template are only used under actual activation process – in the case that data are missing on a given template that aren't mandatory then will these data not be added to a package even then they are added following to a template.

Template data are very important, it will manage example if a plan will have subscription fee, that can be monthly, quarterly, yearly, floating, fixed, and with forward fee or backward fee, possible plan ranking linked to migration, commitment period linked to disconnect and more.

So subscription templates are together with rating plans the most important configuration part for the operator and can be having big impact if done in a wrong way linked to having the correct or wanted rating and workflow applied.

1.6 Rating plan configuration

Rating plans configuration are like subscription templates the main files used to ensure correct data processing through Unity – in the case the rating plan are having wrong data will this we having impact on all the products that are based on the given rating plan.

Rating plans can be nested together – so that Unity first will validate if there is a rating plan for the IMSI level, then will it validate for rating plan on subscriber level, then for company level, then for partner level and if this isn't the case will it look for the default rating plan mapped to the given subscription template that have been used to activate the product.

Inside rating plans are their all data linked to prices and rules associated to rating and charging.

When it comes to charging are rating plans are there in a rating plan a line for each single service that can be generating charging on a given product – for each single service are their multiple prices defined. At least three prices will be defined for cost, partner price and end user price.

Unity rating plans operate with in band prices and out of band prices – these will each be defined with three prices – in the case where only out of band prices are defined will rating still work fine – but both in band and out of band prices will in that case be using the same prices.

Price rules also need to be defined for the services that need this to be defined – sample of price rules can be minimum usage for a service, or minimum increment on partial traffic CDR files, or it can be minimum commitment rules defined for subscription fees.

In the case where no events and price are defined in the rating plan will the processed CDR file just be added to the failed CDR table and the error can following be sorted and failed data can easily be reprocessed.

1.7 Data work flow

Unity have a lot of work flow linked to the different processes - this validation are only focusing a certain work flow in Unity that are directly relevant for the output.

1.7.1 Provisioning work flow

Unity do for each product category have predefined work flow to be performed to execute the different provisioning actions internally as well as external.

These work flow will be a part of a service order - there can be multiple work flow in a single service order - the different remote satellite network operators demand different work flow to be completed - Inmarsat I4 have different work flow for their many provisioning actions, Iridium have different work flow, same with Thuraya, Inmarsat I5 have a lot of work flow to be performed for each single action.

Our data validation will count and validate all service orders, successful and failed across all

- Activations
- Suspend
- Resume
- Disconnect
- Add services
- Remove services
- Change settings
- Provisioning module uptime

A normal service order like for an Inmarsat I4 activation will have a single service order that are three work flow, first will generate a Business Request and send it to Inmarsat, the second will be collecting a notification from Inmarsat, and that last will be collecting a business response from Inmarsat.

Revenue assurance will capture all work flow details linked to provisioning actions.

There can be multiple other work flows associated to the same service order, if Unity are having POP defined in the subscription template ten will Unity after completed activation start another set of work flow tat add example a Static IP address to the product.

1.7.2 CDR collect work flow

Work flow linked to CDR collection and processing:

- Collected files across categories
- Mediated traffic CDRs
- Rated CDRs - Failed CDRs
- Informative events
- CDR delivery delay
- Subscription fees

Unity will capture work flow information linked to traffic processing

1.7.3 Rating work flow

Work flow linked to rating process

- Financial output
- Invoice output
- Rating plans
- Rating module uptime

1.7.4 User & Package work flow

Package related work flow are linked to counters and data updates on packages,

- Creating partners, companies and subscribers
- Package types - Active, Disconnected¨
- Migrations, Sim swap, Package moves
- Group plans, SCAP plans, Postpaid, Prepaid

1.7.5 Monitoring work flow

Triggers set on monitoring for usage and spending, auto suspend, notifications.

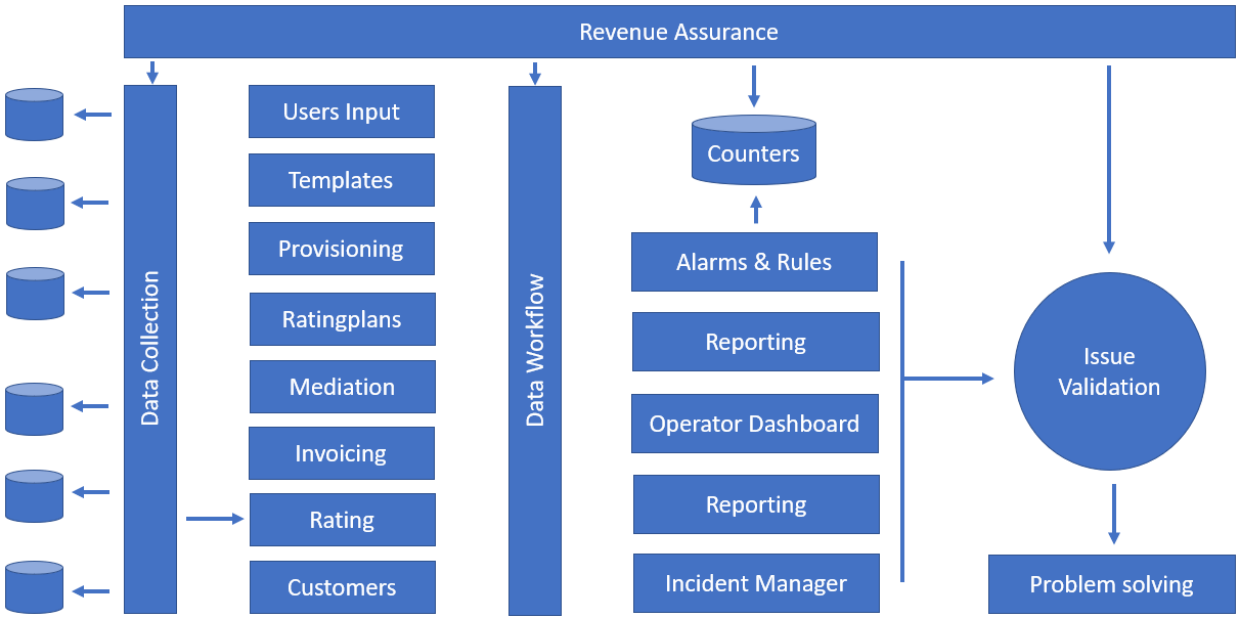
- Usage monitoring enabled - high and max
- Usage autosuspend enabled
- Spend monitoring enabled - high and max
- Spend autosuspend enabled
- Notifications generated
- Notification uptime status

Unity will capture all monitoring related work flow.

2. Revenue Assurance (RA)

Unity have developed a dedicated revenue assurance that target to validate remote collected data, manually entered data, configurations, provisioning work flow, billing workflow, data output, abnormal patterns all to ensure a higher quality of service delivery, maximized revenue and less support actions.

The activity is the use of stored data quality and process improvement methods that improve all area of the business workflow, profits, revenues and cash flows without influencing demand.



The new extra added source data validator is an extended part of our revenue assurance – that cover part of the full revenue assurance setup – our data validator does mainly focus at actual data validation, work flow validation to improve the general reliability in the invoice output.

Revenue assurance are used in most telecom companies to ensure that billing flow are as correct as possible to minimize potential loose for the operator as well as to ensure that customers are getting correct invoices.

The main points in our existing Revenue Assurance validation are:

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- Revenue leakage – ensure not losing money on sold packages
- Cost leakage – ensure that satellite networks operators are charging correctly
- Margin leakage – ensure that there is revenue on packages
- Fraud management – this is a minor part linked to satellite business
- Network or Application downtime

This new validator that mainly focus at source data, Unity workflow and correct application flow are extending the existing RA solution with more visibility into actual collected source data, platform configuration and workflow through Unity.

If the source data are incorrect, or if provision workflow are incorrect, or configuration are incorrect - then will the generated billing in general be incorrect – this extended validator will be expanding the normal RA validation with more details and make it visible that there are abnormal data patterns that potentially are having impact on the RA.

2.1 Revenue Assurance Process

The Revenue Assurance processes in many ways can be regarded as an auditing process across data input, provisioning workflow, billing workflow, configuration, correct rating data, ability to keep data in sync, ensure that code are providing the correct output.

The objective is to ensure that the processed data are correct, configuration are correct, provisioning / billing data are in sync and that the templates used to generate output are correct implemented. Outcome should be that no or minimal failures – making sure that revenue leakage identified and that customers are getting correct monitoring, traffic charges as well as invoices.

2.1.1 Detective processes

Revenue Assurance Detection is the process of spotting a change in value of a dimension relative to its movement from System A to System B or within a given systems itself. The change in the value is relative to a dimension is question. Detection in RA will be achieved by both manual and automated means. Our RA will periodically extract data from database and validate some elements in near real time and will end of the billing period validate results.

Typical detection activities include monitoring, summarization, investigation and auditing.

- **Monitoring:** Monitoring activities in Revenue Assurance refers to observing data, system or a process for any changes which may occur over a period of time. With the use of automated scripts that can achieve constant monitoring which can notify us (via API connected monitoring, email, or periodic reports) in case of any changes. The various processes which typically are monitored by our Revenue Assurance include daily usage, profile and configuration changes, mediation, rating, billing, provisioning workflow, fee generation, CDR collections, Manual data added and suspend related processes.
- **Summarization:** When dealing with large volumes of information like traffic usage, it may not be practical to go through CDR by CDR and compare the same between 2 systems – we perform format, duplicate validation and validate if the associated reference exists in Unity. In such cases summarization will help in quickly examining and finding out the preliminary problem's areas. For example, one could first summarize information on the basis of few dimensions like events (voice, SMS, data, streaming), customer type (postpaid, prepaid, SCAP, Group, in band / out of band),. and compare the measures like count and duration of these dimensions. Such rapid assessments help in identifying the problem areas or dimensions quickly and a further

detailed investigation can be carried out for those dimensions identified. Summarization greatly reduces the manual effort in identifying problem areas within a large data stream generated by the operator's customers.

- **Auditing:** A revenue assurance audit is a set of activities carried out to ensure that the we can be taking necessary steps to remain compliant to the evolving changes of technical updates, new requirements and market conditions. Every Revenue Assurance audit has a list of specific objectives which may come from management, regulations or industry standards. The actual tasks of the audit do differ based on the information, system or processes being audited. Each RA audit can span into different segments, each with its own specialized technical requirements.
- **Investigation:** Investigation is the act of detecting something new, or something "old" that had been unknown. Investigation leads to discovery which is the observation of new actions, or new events and providing new reasoning to explain the knowledge gathered. Our RA investigation is a series of scripts, processes or procedures carried out to identify the Root Cause of an anomaly. This is also known as Root Causes Analysis (RCA) procedures or activities. Root Cause Analysis (RCA) is a method of problem solving that tries to identify the root causes of faults or problems that cause operating events. An investigation would try to identify and correct the root causes of events, as opposed to simply addressing their symptoms. By focusing on correction of root causes, revenue assurance problem recurrence can be prevented.

2.1.2 Corrective processes

Correction is the set of activities and processes related around getting the process structures correct in order to minimize the changes identified as per the detection techniques. Correction itself is the act or method of correcting a discrepancy. Typically some information, configuration, amount or quantity needs to be added, edited or removed from a system, process or procedure in order to correct the anomaly. In Revenue Assurance activities, the process of correction of a root cause could involve correction of information, processes, technology or people.

- **Information Correction:** This refers to the process of correcting or updating a value for a configuration element or a reference table. This is typically the result of a missing data set in a particular given table or system file. For example, a particular number of series may be missing in the rating plans, event plans or updating a missing tariff plan in rating engine leading to unrated CDRs etc.
- **Process Correction:** Process correction refers to the modification of an activity by adding, modifying or removing an activity step which will prevent a miss-configuration or revenue leakage in the process. Typically process correction is required to have a pro-active revenue assurance step to provide better governance across the operations. For example, the pre-bill verification process may be required to be modified when a new service line or product is introduced into the market. The new service line may be required to be included within the pre-bill process.
- **People Correction:** People correction is required when skills of the resources are in question – this can operator staff that handle provisioning, staff that manage configuration, rating plans as well as staff at mobilware that handle support and coding. This leads to many Revenue Assurance need to ensure that possible inexperienced people get more knowledge.

- **Technology Correction:** The very nature of the satellite business changes frequently at the moment with new satellite networks, new services and new ways to offer products – and example is the relative new Inmarsat GX/FX, or Iridium NEXT. When new technical changes are applied by satellite network operators will Unity be updated and tested.
- **Test Environment, Staging Environment:** Unity offer three environments for an operator setup – a test environment that get connected to the remote satellite operator test interfaces, this is the first system that new software or new functionality can be tested on. When software or functionality have been tested on test platform then can it be installed on staging environment that will have direct access to the operators live interfaces shared with the production environment. This setup allows early validation of any new part of the system functionality
- **Reference Environment:** Mobilware have developed a reference system that allow testing of billing functionality and invoice templates output – this system have more than 500000 CDR's that have a known output across all measurement points including invoice output values. After a software upgrade or an invoice template change can this reference data set be processed to validate output and it will show if there is issues in certain parts.

2.1.3 Preventive processes

Prevention is the process of performing an activity in order to avoid a high risk situation. It is essentially an action carried out to de-risk a threat. For example, if there is risk that a tariff plan (rating plan) is not correctly implemented, then the preventive action could be to simulate calls on test SIMs on the new tariff plans prior to launch and confirm the tariffs coming in the test CDRs. Preventive activities lead to effective risk management around Revenue Assurance.

- **Synchronization** - A set of activities which ensure that data sets are synchronized over a period of time – across provisioning, billing as well as possible external financial and potential external billing systems.
- **Integrity Checks** - These are individual activities carried out to ensure the integrity of the data, configuration, system or process. This is an effective check in gaining insight into an individual process and to assess whether it has anything in their immediate background that may be a cause for concern. For example, performing a package data validation – making sure the needed configuration is on the implemented packages that ensure correct billing.
- **Pre Process Checks** - Any checks performed on the input parameters of a process to ensure that the right data is fed into the process. Pre Process checks are necessary for complex processes like rating and billing which involve multiple sub processes and consume a lot of time for each run. Some sample preprocess checks could include validation of CDR sequence number before rating, duplicate CDR check, report all postpaid customers that do not have the correct bill cycle, validate entered data when entered into GUI, validate migrated packages, validate package configuration etc.
- **Post Process Checks** - Post process checks are required to verify the reliability on the outputs of a given process. Some processes of Revenue Assurance can produce multiple co-related outputs which need to be verified before being released to the consumer either internally or externally. Some examples of post process checks are validating invoice output, financial output, rated CDR output, failed CDR output…

2.2 Normal Sources of Revenue Leakage

The following will explain where operators are using revenue assurance techniques to track down potential problems when it comes to handle provisioning, generating billing and invoicing for services and products.

- Poor sync of provisioning w. billing system – different dates, actions, data…
- Subscription templates contain wrong setting – allowance, null values…
- Bad formatting / Content of CDR records / Failed CDRs
- No – Real time prepaid control – in case of prepaid services
- Traffic settings & accuracy – increment, min usage, commitment…
- CDRs/EDRs Errors due to mediation rules
- Incorrect or no – rating plan / service events
- Wrong prices in rating plans – wrong dialing plans, event plans..
- No monitoring of traffic, usage, spending to minimize potential credit risks
- Fraud management – small in satellite business
- Partner & Satellite network operator contracts and discrepancy
- Missing invoice configuration – free use products
- Collection process and account receivable process

Most of above listed points are already a part of the existing Unity revenue assurance functionality, that through reports and counters can be monitores closely. Whit the new and enhanced data validation and work flow validation will we enhance the existing RA so that it become more visible for the operator what is taking place daily through Unity environment.

A satellite service provider organization's revenue chain is usually a very complex set of inter-related technologies across multiple satellite services and a large set of processes providing a seamless set of services to the end consumer. As the set of technologies and business processes constantly grows bigger and more complex, the chance of failure increases in each of its connections. A revenue leakage is typically attributed to when a telco organization is unable to bill correctly for a given service or to receive the correct payment. As the organization grows the probability of revenue leakage only increases.

2.3 Ensure solid revenue assurance

Revenue assurance solution can only help in pointing toward the error locations or problem areas. New services, new workflow will demand improvement on the RA process – to ensure that validation are able to capture as many as possible measurement points ensuring the best ability to capture possible issues.

2.3.1 Extract, Transform and Load

Satellite Services is an environment where there are many heterogeneous systems creating a multitude of data. This creates a need to have very proficient and rigorous extraction, transformation and loading tool for a Revenue Assurance validation. Listing main points:

- Import data in all common formats of data (ASCII, ASN, TAP2, BCD, Binary etc.)
- Import data directly from common databases
- Ability to receive data feeds from various data sources of the Network, Operational and Business support systems
- Extensive audit log to track files and records status - received, processing, duplicate, loading, error etc.
- Provide an integrated environment to perform data integrity checks
- Offer report capability – allow RA API to integrated with data extract
- Ability to normalize, enrich and transform business rules as applicable into a data model
- Look up large tables or files for reference information
- Creation of new data fields by manipulating and calculating values based on other fields
- Capability to monitor the progress and success of the whole ETL process from start to end
- Handle unexpected errors and continue processing and maintain the appropriate audit logs
- Support full automation of the ETL procedure from file pick up to record entry in the DB or file system.
- Ability to store historical summary and detail information for a period of time configurable by the user
- Summarize information on the fly based on configurable dimensions
- Have the ability to configure ETL level alarms and thresholds on data and notify relevant users of any exceptions

2.3.2 Analysis of data values

Once all the information has been received into the Revenue Assurance systems will it crunch numbers and generate reports. The critical part is the analytical capabilities linked to data in Unity.

- Capability to create measures based on the output of selected reconciliation and control rules and/or other user-definable criteria e.g. Customer Account Number, Product Code
- Create alerts based on the application of thresholds to measures and dynamically change the thresholds based on business logic
- Create KPIs based on various measures (such as count, sum, average, etc..) and multiple dimensions.
- Showcase trends based on KPI values over the period of time and raise alarms when thresholds are crossed (for example alarms could be raised on a) Zero duration CDRs; b) Short duration calls; c) Long duration calls; d) Duration discrepancies; e) Invalid structure code/call types etc.)
- Forecast information based on past records and raise alarms or reports
- Able to set thresholds of KPIs on the total value as well as on the value per specified dimension, e.g. the system should be able to alert on the situations when the threshold per a specific attribute is violated.
- Categorize alerts and alarms based on priorities (e.g. critical, major, minor)

- Create new, and update and delete existing, KPIs and measures at any time through a simple graphical user interface. This should include full KPIs definition – calculation, dimensions, thresholds, calculation frequency.
- Ability to support detection, investigation, validation and correction of discrepancies resulting from audit comparisons
- Co-relate gaps in the reconciliations with missing profile information or missing reference information or other system errors and prepare a consolidated report.

2.3.3 Operator Dashboard and RA

A Revenue Assurance are getting integrated into Operator Dashboard – allowing the operator to monitor and read key values across the different satellite technologies. It will example present all Inmarsat BGANcounters , CDR's processed, CDRs failed, active packages, packages that are not generating any traffic etc.

- Operator Dashboard interface will in the beginning only be listed summery of captured RA data from Unity associated tables. In phase 2 will monitoring triggers be possible to manage through dashboard.
- Main counters being presented will be captured every 5 minutes – and data will be gathered from the database tables linked to revenue assurances tables.

2.4 Unity best practice linked to Revenue Assurance

Unity do consist of a handful of main building blocks that have been used by many operators of the last 15 years so these modules are well proven when it comes to processing and handling of known data patterns like example Inmarsat traffic CDR parsing and similar.

These core modules are mainly configured and handled using configuration files, the associated rating rules and workflow for these modules are not changed often.

So, the main parameters when it comes to validating revenue assurance related issues are often in the areas listed in the next few sub chapters.

2.4.1 Rating issues

These are main coming from following issues:

- Subscription templates having wrong configuration when products are activated
- Products are located under wrong users
- Provisioning data not aligned with data used in billing

2.4.2 Invoice issues

Invoice issues can be covering many different type of issues:

- Provisioning issues – data not aligned, wrong billing data, wrong package data
- Template based issue – missing allowance, wrong subscriptions, wrong plans..
- Issues in the associated customized invoice templates

3. Technical implementation

Our revenue assurance implementation is divided into several parts – each delivering a separate functionality.

3.1 Database table for Revenue Assurance

A dedicated table for revenue assurance has been implemented into Unity, this table will be used as a common placeholder for RA measurement point values, it will daily capture relevant counters, for example number of Iridium CDR's collected. Number of Iridium CDRs failed mediation, number of duplicated CDR files, number of duplicated CDRs, number of data related CDR's, number of voice related CDRs and similar across all other measurement points.

Separate revenue table for alarm definition, that keep track of alarm threshold levels, notification emails – this will not be available in the current version but in one of the next phases this will allow the platform to allow the operator to define own alarm levels linked to key measurement points.

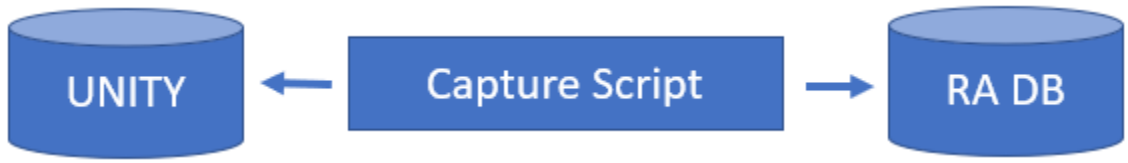
3.2 Data Extraction Scripts

A set of capture scripts are running every 15 minutes – they collect the counter values across a long set of key measurement points – and insert these values into our RA table – these capture scripts do not perform any for intelligence on top of the collection – they only make sure that the latest values get updated periodically.

These scripts contain simple SQL statements that will extract the needed values and be adding these to the relevant table with a date and time stamp – a simple example could be getting the number of CDR files processed on the 31 of May – on the actual day like:

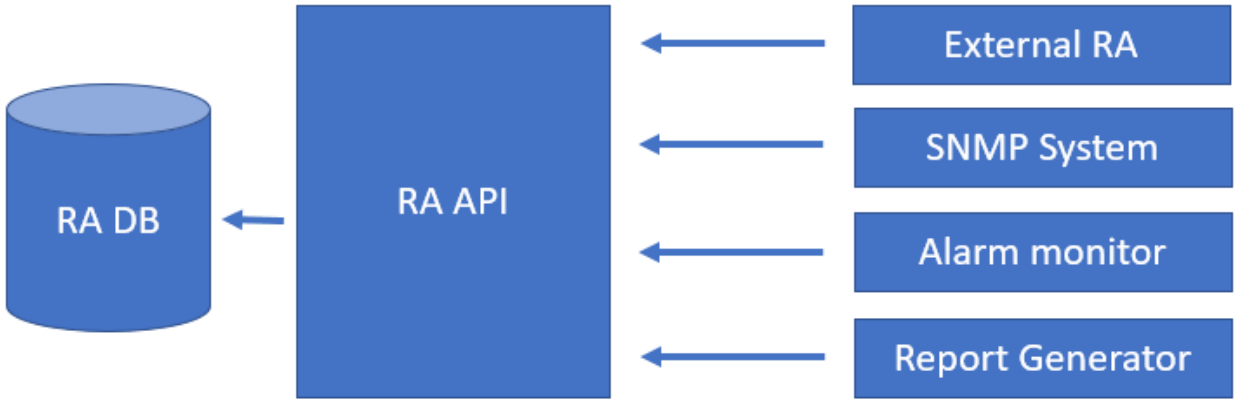
```
SELECT COUNT(id) FROM EVENTS WHERE created_at>'2018-05-31';
```

This will return the number of CDRs successfully processed on that day.



3.3 Revenue Assurance API module

There is developed a dedicated API that allow easy and simple integration to our revenue assurance module, internally as well as externally.



This API will allow the operator to easily integrate RA counters and measurement points into existing alarm solutions like SNMP based systems. Our RA API allow the operator to pull a lot of data points – as an example is it possible to pull the status of each single module inside Unity, get status from provisioning, from notification, from billing, from mediation, and even get status from external connected systems like Iridium, Inmarsat I4, Inmarsat I5, Thuraya and much more.

Inside Unity are we also directly using our own RA API interface – our operator dashboard is able to show status of all modules, present the workflow related counters, show CDR's being processed and alike.

In our operation and support center do we also have an online wall monitor that present live status from each single operator.

3.4 Operator Dashboard and RA

Our operator dashboard has the ability to present key measurement points from RA database – this allow the operator to gain access to module status, to see traffic CDR flow, to see provisioning status, to see active subscriptions and much more.

In the next version of our RA module will we be adding alarm configuration to this dashboard interface so that the operator can configure levels to be monitored, it could be getting an alarm in case Inmarsat CDR files are getting delayed more than 24 hours.

3.5 SNMP & Monitoring integration

Our RA module will allow monitoring of data quality, of module status, of work flow, this is a big extension of the monitoring level comparted to the traditional hardware and operation system alarm management normally provided using SNMP monitoring.

Mobilware SNMP monitoring and the dedicated application monitoring have been integrated to our RA API interface where we remote are performing data pulling periodically to ensure that all parts of the solution are processing data. This is a lot different from normal monitoring as this do monitor actual traffic flow through the system – meaning if there is no traffic CDR's for more than 2 hours then can it automatically generate an alarm or similar.

Our RA API allow multiple monitoring systems to be connected to the same interface – that mean Mobilware as well as the operator can integrate own monitoring systems.

3.6 Report Generation – SAP Crystal Reports

Our RA module do have the ability to generate internal reports that allow an overview over the status, workflows and general situation across data integrity, data quality and output quality.

Reports can be generated using our existing report module integrated in our operator dashboard – where it is possible to get customized reports.

RA Database access can also allow the operator to directly establish SAP Crystal Report connectivity – allowing the operator to develop and generate own reports – daily, weekly, when certain thresholds are hit or monthly.

4. Revenue Assurance Functionality

RA will be validating many areas of the Unity system with the main focus at data validation, work flow validation and output validation. It will not focus are Credit Risk validation – this can be implemented our credit risk module that allow monitoring of partners or reseller linked to spending – where certain spending threshold values are defined.

Our RA functionality are constantly evolving to make sure that we can deliver increased level of functionality with a minimal level of issues that affect the output quality of Unity.

4.1 Monitoring of module status

RA will every 5 min monitor each single main module in Unity and be validating if the modules still are operational across:

- Provisioning
- Billing
- Monitoring

This validation will not look at data being processed through the modules but only monitor is processes still are active.

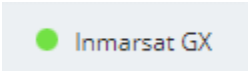
4.2 Monitoring of External API interfaces

Every 15 minutes will Unity perform an API / interface test across following interfaces:

- Inmarsat I4 DPI
- Inmarsat I5 - GX/FX SEP API
- Inmarsat I5 – APIGEE API
- Iridium SOAP API
- Thuraya API
- Eurotel API
- Orbcomm API
- SAP Finance
- Navision API

It is possible to get the status of these external API interfaces using Unity API as well as RA API – Unityy frontend are using this to display the current state of an integrated API.

Sample if gree then have interface been validated within the last 15 minutes.



4.3 Monitoring of provisioning workflow

RA will capture all provisioning actions across following:

- Package Activations
- Package Disconnect
- Package Suspend (manually / automated)
- Package Migrations
- Reseller create
- Company create
- Subscriber create
- Vessel create
- Aircraft create
- Site create

It will be showing succesfull business request/business request responses - and also be listing unsuccesful request - and it will capture the average response time.

4.4 Usage + Spending related Notifications

All generated usage and spending related events like high trigger, max trigger across streaming, data and voice - will be captured and associated notifications.

4.5 Traffic related CDRs

RA will count the number of CDR files collected and mediated across each of the technologies integrated, meaning a separate section for Iridium, for Inmarsat I4, for Inmarsat I5, for Thuraya and alike.

Following will be counted daily:

- CDR files
- Actual CDR's mediated
- CDRs failing
- CDR's across different traffic types (voice, data, streaming, SMS, ISDN...)

4.6 Packages

RA will capture monthly number of active, disconnected, suspended, hibernated packages across the different templates - including friendly package name

- Active packages for each template type
- Disconnected packages for each template type
- Suspended packages for each template type
- Group / SCAP packages across the different types

4.7 Inventory counters

RA will capture monthly counters for each inventory type - across following per category like Inmarsat BGAN, Inmarsat GSPS, Iridium Openport, Iridium prepaid etc:

- Free inventory unassigned
- Assigned inventory free
- Used inventory

4.8 Fees generated

One-time fees, subscription fees, disconnect fees, migration fees. RA

4.9 Hardware sales & Leasing

RA will capture count of hardware sold per month as well as leased out.

4.10 Invoice, Financial output

RA will manually be able to perform a compare across generated output values to ensure that there is consistency across output for invoices, financial reports as well as GUI listed values.

This validation is performed based on totals across outputs.

4.11 Total invoices customer, packages

RA will monthly be able to capture numbers of customers having invoice markers, capture number of invoices below trigger value, invoices will be listed across the different types - meaning different invoice templates as well as across customer levels, reseller, company, subscriber as well as invoice groups.

- Customer list divided into resellers, companies, subscribers - dedicated or decouples
- mode
- Packages and associated values
    - Customer
    - Template
    - Usage separated across services (data, voice, streaming..)
    - Dates - created at, date for last traffic CDR received
    - Balance / spending / data / voice / streaming
    - Allowance type
    - Allowance values minutes, bytes...
- SCAP / Group plans
- Wholesale plans
- Poolmaster / common Service Pool plans

4.12 Package configuration

RA will be able to validate main setting across the different activated packages, this is to ensure that there are not loaded packages based on templates having missing or faulty data.

4.13 Rating plans

RA will manually be able to validate certain parts of the rating plans and their settings - it is not possible to validate wrong configured rates - but it is possible to highlight possible missing values in minimum subscription period, packages not having minimum usage, minimum increments and alike.

4.14 Traffic usage - charges

RA can manually extract packages having no charges but still having traffic generated, identify packages that have the highest level of data or voice usage.

4.15 New measurement points

RA are constantly getting expanded with more and more validation check - this will keep increasing the level of validation to be better and better. If you as an operator want to get specific measurement added then please feel free to get in contact with us.

5. Alarms based on abnormal patterns

Abnormal pattern detection is currently not implemented into RA, this will be implemented in one of the next phases – that will allow RA to detect subscriptions that have abnormal traffic patterns. Detect users not receiving any invoices even then they have active subscriptions etc.

6. Revenue Assurance & Validation API

A complete set of API calls have been developed that extend the ability to connect external monitoring solutions – these API calls allow the operator to integrate their existing SNMP system to monitor applications, system availability as well as all these new data validation measurement points.

This document will not describe this API setup as it is a part of the standard API documentation.

But we will illustrate a small sample to give an idea about how this API interface will be working.

Simple call interface URL after getting IP address allowed access:

URL https://operator -url/system/ping


```
{"node":"active","up-time":"4 days 23 hr 55 minutes","db-up-time":"28 days 20 hr 4 minutes","status-code":"AIRTIME-P4001","status-msg":"DB date is 2018-10-23 08:47:55","software-version":"2.27.57","http-code":200}
```


Any other data validation are also available with dedicated URL calls, that allow remote systems to monitor application functionality, data workflow like failed CDRs, total number of CDR’s, number of activations, service orders etc. All divided across the different satellite technologies, meaning Inmarsat I4, Iridium, Thuraya and similar.

For more details on revenue assurance API please contact us.

7. Operator Dashboard and Data Validation

Unity have also introduced the first validation display inside our latest version of the operator dashboard that allow the operator easy and simple access to see what is taking place in the Unity system across basically any data processing, work flow handling, input, output.

This allow the operator to get a fast overview into possible area's where there can be abnormal traffic or workflow patterns.

This will in the next phase be expended with integrated alarm monitoring – where the operator can define certain alarm thresholds – when these are hit will Unity generate an outgoing email or alarm that will allow the operator to take action before it is hitting the end users or start generating possible revenue issues.

8. Alarm output from validator

Unity Operator Dashboard will have a data validation overview section that allow easy and simple overview, this interface will show the counters that get updated every 15 minutes allowing a complete overview across all main data points across data capture, data entrance, data processing, delays, actions, errors, abnormal traffic patterns and similar.

These alarm outputs are today integrated through the building API interface to our SNMP platform as well as one of our overview screens allowing us to see and remote monitor application, generate alarms in the case the workflow have under the threshold – that could be if no traffic CDRs have been collected for the last hour or similar.

In the next phase will Unity Operator Dashboard be delivered with a GUI environment that allow the operator to define own trigger levels for the different area's and the different counters. This environment will also allow the operator to have a permanent monitoring screen running showing the full end to end status of Unity and all associated processes.

It is already today possible to pull all the counters and the status using our implemented API interface for Revenue Assurance – that will allow the operator to display and integrate Unity directly into their existing monitoring environment.

9. Validation Reports

In phase two will we implement revenue assurance reports that contain data and workflow validation results, these will be divided into general data, as well as be grouped per product category, meaning Iridium in one section, Inmarsat I4 in a separate one, Inmarsat I5, Thuraya and similar.

Allowing a simple and easy overview across the end to end data processing, work flow as well as abnormal data in a certain product group or on a certain customer group.

9.1 Data Trend Analysis

Analyzed data will generate a report with the key value´s – RA will maintain daily counters for the different monitoring area's – end of the day will these counters be saved and can be used for trend analysis. During a given day will the counters in the morning start from zero and will during the day be increasing.

This mean the resolution in captured data will typically be daily – data updating during a day will typically be set to 15 minutes.

Data is example traffic CDRs, entered provisioning data, output data and alike.

9.2 Workflow Trend Analysis

Provisioning workflow will all be captured and counters will be available, delay in responses, ftp sftp status etc.

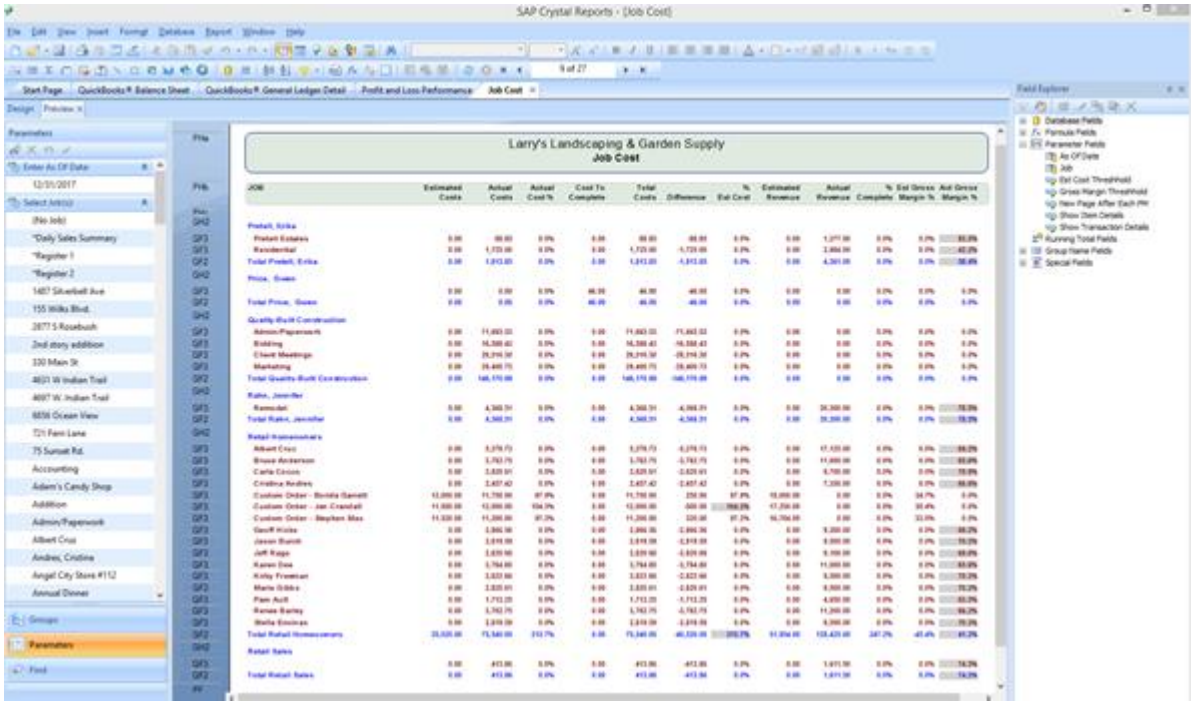
Workflow will be related to internal processes this can be collected CDR's, mediated CDRs, failed CDRs, provisioning disconnects, provisioning activations and similar.

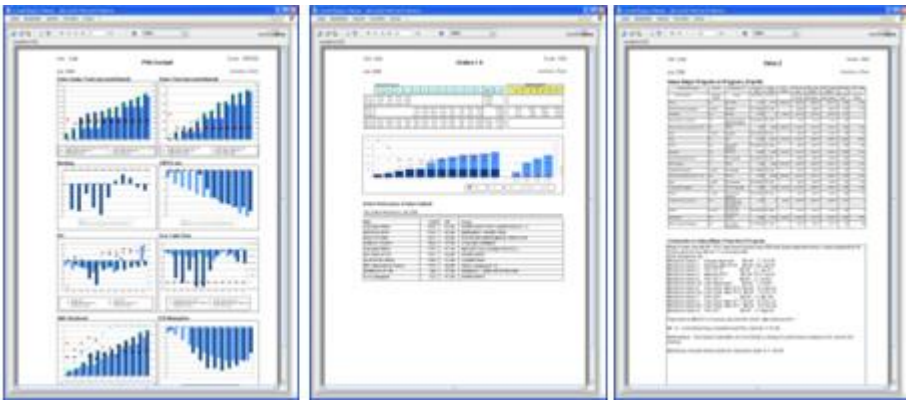
9.3 Daily & Monthly

Unity will default display the daily revenue assurance data view in the operator dashboard and the staff can at any time generate the enhanced daily view – as well as generate graphs that display the monthly view across a full year.

9.4 SAP Crystal Reports and RA

It is possible to generate complete RA Counter export into CSV files allowing more detailed processing inside Excel – Their is also direct access for SAP Crystal Report generation interface allowing the operator to generate their own custimized reports.





10. Source Code validator

We have also introduced a source code validator that allow us to pre-validate new billing code as well as customized invoice templates + financial output reports.

Our source code validator is based on a well-known output from a solid code based – where we have processed more than 500000 traffic CDR data – this data set have a well-known and pre-validated output across invoices and financial output – it can validate multiple invoice templates at the same loop if the operator is using multiple invoice templates.

When new billing software are developed or associated hot fixes are loaded then can we validate the correctness of the code changes by processing the known data set – in the same loop will we be validating the invoice templates as well as financial output.

Meaning in a single validation can we verify if there have been introduced issues in any part of the delivered code base – it will as well be easy to see where the possible issue are located – if it is linked to certain services, to certain customer related area's or simply are general issues in a certain part of the functionality.

This new code validator is a very powerful solution – it has the ability to validate multiple operators' formats ion the same data loop – making it a lot easier testing and locating issues on especially customized functionalities developed for specific operators.