Smart Transport Accelerator

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Overall Solution Overview

In this section, we'll cover the role played by each of the TIBCO Cloud™ applications used within the Accelerator, including:

- **TIBCO Cloud™ Integration** - Develop capability (powered by Flogo) for API-led and event-based integration

- **TIBCO Cloud™ Events** for rule based detection of incident events

- **TIBCO Cloud™ Live Apps** for low-code case management

- **TIBCO Cloud™ Data Streams** for stream processing

- **TIBCO Cloud™ Spotfire** for visualisations and analytics

These components are seen in the architecture diagram below
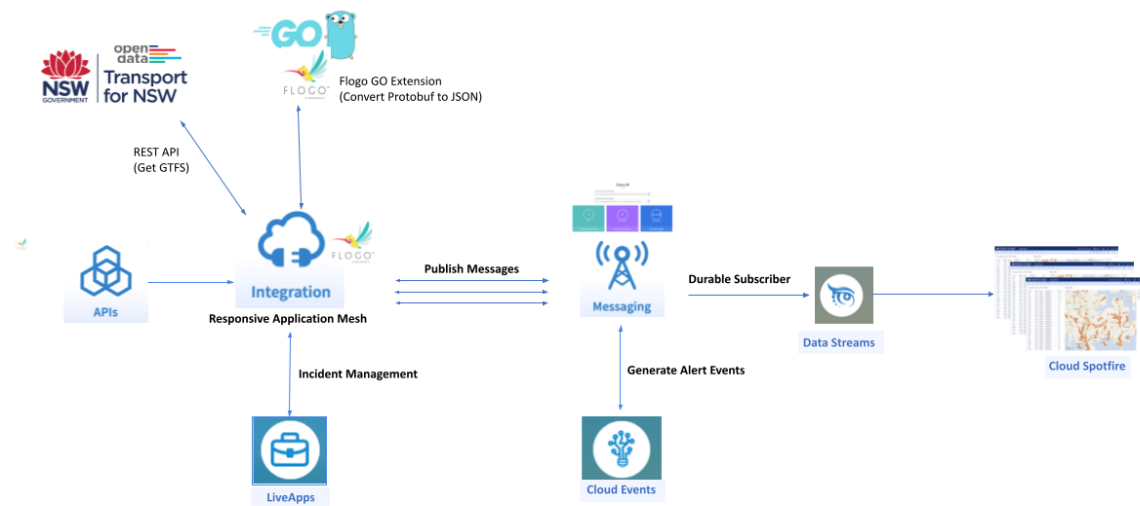
The internal interaction diagram, below, shows the communication between the different components.
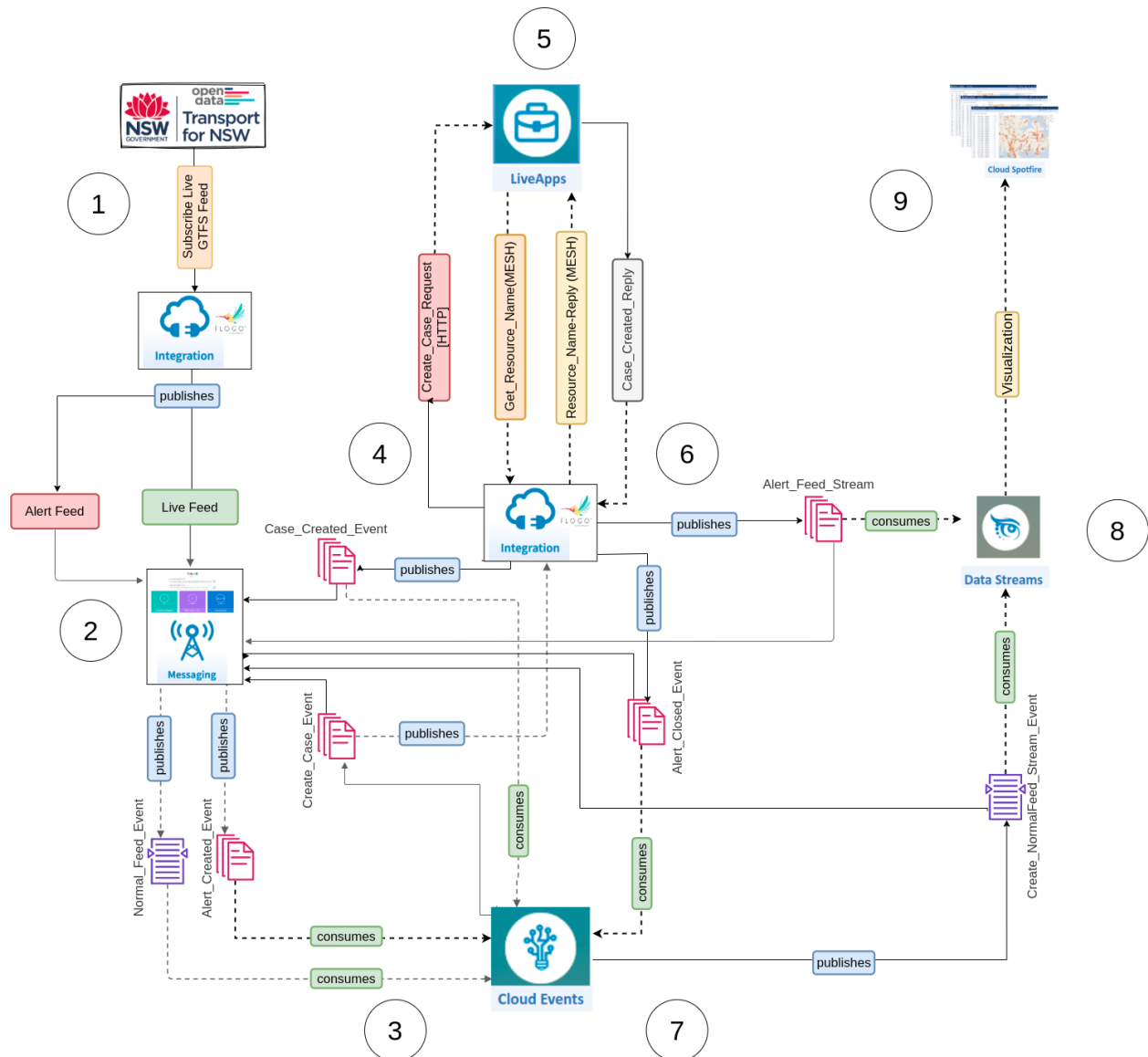
Internal Interaction Diagram

Looking at step each in turn:

1. The Develop capability of TIBCO Cloud™ Integration, powered by Flogo, ("**Integration**" in the diagram) extracts and transforms the real-time GTFS position and trip update feeds published on Transport for NSW's Open Data Hub in Protobuf format. Integration publishes the live feed as streaming data in JSON format to TIBCO Cloud™ Messaging eFTL service ("**Messaging**" in the diagram). Integration also has an Alert Feed that it publishes to Messaging, to simulate incidents such as a breakdown or accident.

2. Messaging distributes these data streams by publishing a Normal_Feed_Event and an Alert_Created_Feed

3. TIBCO Cloud™ Events ("**Cloud Events**" in the diagram) subscribes to the incoming Normal_Feed_Event and Alert_Created_Feed streams and runs them through a series of prescribed business rules. Based on these business rules, Cloud Events will publish a Create_Case_Event back to Messaging, and, from there, to Integration.

4. A Create_Case_Event message will trigger Integration to create a new case within TIBCO Cloud™ Live Apps ("**Live Apps**" in the diagram). It does this using a standard API based HTTP request. Integration will also publish a Case_Created_Event to Messaging and thence to Cloud Events.

5. Staff can review and make decisions on how to process the case within Live Apps. Decisions, such as closure of the case are sent back to Integration using the Case_Created_Reply API call.

6. When the case is closed, Integration will publish a Alert_Closed_Event to Messaging, which is also consumed by Cloud Events. Integration also publishes an Alert_Feed_Stream to Messaging as well as to TIBCO Cloud™ Data Streams ("**Data Streams**" in the diagram)

7. Cloud Event consumes the Alert_Closed_Event and the other streams mentioned above, and publishes a general Create_NormalFeed_Stream_Event feed.

8. Data Streams is used as a durable subscriber to the Alert_Feed_Stream and a general Create_NormalFeed_Stream_Event feed and provides the live streaming data directly to TIBCO Cloud™ Spotfire ("**Cloud Spotfire**" in the diagram).

9. Cloud Spotfire displays the visual analytics and allows a person to explore the data as well as open cases within Live Apps.

TIBCO Cloud Integration (TCI Flogo)

The Accelerator utilises a number of different TIBCO Cloud Integration (TCI) applications and custom built extensions for data integration & transformation. These applications and extensions have been created using the Develop capability of TCI, powered by Flogo (TCI Flogo).

Custom TCI Flogo Extensions

1. **CI_utils_2.0**.zip

   Using open source go technology to convert and transform protobuf to JSON format (much improved version w.r.t. Memory and CPU utilization compared to v1 release)

2. **Arraymerge**.zip

   Using open source to identify & merge arrays: The payload from two different API response array sets based matching IDs. As well as identifying non-matching sets of responses based on ID.

3. **Rest**.zip

   This is an OSS invoke rest service activity used for calling the restful services.

4. **Actreply**.zip

   This activity allows you to reply to a trigger invocation and map output values. After replying to the trigger, this activity will allow the flow to continue further.

TCI Flogo Applications

1. **PublicTransportAccelerator_MockAlertAPI**

   - The Public API is created with the sole purpose of asserting mock Alerts in the live GTFS feed subscribed from TfNSW.

   - The API will emit Live GTFS Position information for Clients and also, randomly assert one alert payload in one of the buses based on predefined rules.

   - It will produce only 3 alerts/hours. Currently, we're targeting only Alert_Accident,Alert_Techinical_Problem, Alert_Med_Emergency incidents and with move forward we will be adding the remaining.

2. PublicTransportAccelerator_PublishGTFS_v2

- This app is discoverable via Cloud Mesh to get Live GTFS position and real time trip update feed from TfNSW's Open Data service.

- And run the required tasks to convert, transform and split the GTFS feed to individual streaming messages for each entity contained in the feed.

- Furthermore, each message will be published to TCM-eFTL via Publish to eFTL app. The messages will be published to separate TCM-eFTL destinations based on type of message feed (alert or normal feed).

3. PublicTransportAccelerator_PublisheFTL

- Publish feed messages to eFTL server - Discoverable via Cloud Mesh to publish a streaming message to TCM-eFTL server.

4. PublicTransportAccelerator_LiveAppsCase

- The app is configured to receive the TCM-eFTL messages generated by TCE application events for different types of alert messages.

- Once an application is triggered through a TCM-eFTL message, it will start the Live Apps case workflow by calling the Live Apps Application through TCI Flogo Live Apps Connector and respond back to the TCE app event with Case id, if created.

- This app keeps track of each case generated and its status by maintaining the DB tables and periodically, checks the status of each case in the DB.

- Also, provide TIBCO Cloud Mesh API for Live Apps Application to perform the task of Auto-assigning the Resource to Case for workflow handling from available existing users in subscription using Live Apps ReST APIs.

5. PublicTransportAccelerator_APIsToMonetize

- This app contains APIs that can be exposed publicly for external vendors to consume and use the live data or details.

- The API list can grow based on user requirement and availability of the data.

Please refer to the 2_Integration_Solution_Setup_readme.pdf and follow the steps to configure above outlined applications and run them efficiently.

TIBCO Cloud Events (TCE)

The Accelerator uses TIBCO Cloud Events (TCE) as the event processing application to apply predefined rules to the incoming feed messages or alerts reported from TIBCO Cloud Messaging. Events detected by Cloud Events will then trigger TCI Flogo applications to start a TIBCO Cloud Live Apps case.

TIBCO Cloud Events Application

1. **Incident_Feed_Processing**

   - The application will process all incoming messages published through the TCI Flogo application (PublicTransportAccelerator_PublishGTFS_v2).

   - It will trigger the Live Apps case workflow through the TCI Flogo app (PublicTransportAccelerator_LiveAppsCase) by emitting the events for trigger.

   - The application is also responsible for creating a series of message streams of bus feed messages for data streams that will be visualised in spotfire based on delay_status variable.

   - The color of the bus will be decided by the value of delay_status variable evaluated in the TCE application.

Please refer to the 3_Events_Solution_Setup_readme.pdf and follow the steps to configure above outlined applications and run it efficiently.

TIBCO Cloud Messaging (TCM-eFTL)

The eFTL service of TIBCO Cloud Messaging (TCM-eFTL) is the backbone of the architecture and responsible for connecting different components of the Accelerator.

You need to start your eFTL server if it is not already running (by default it's always in running state)
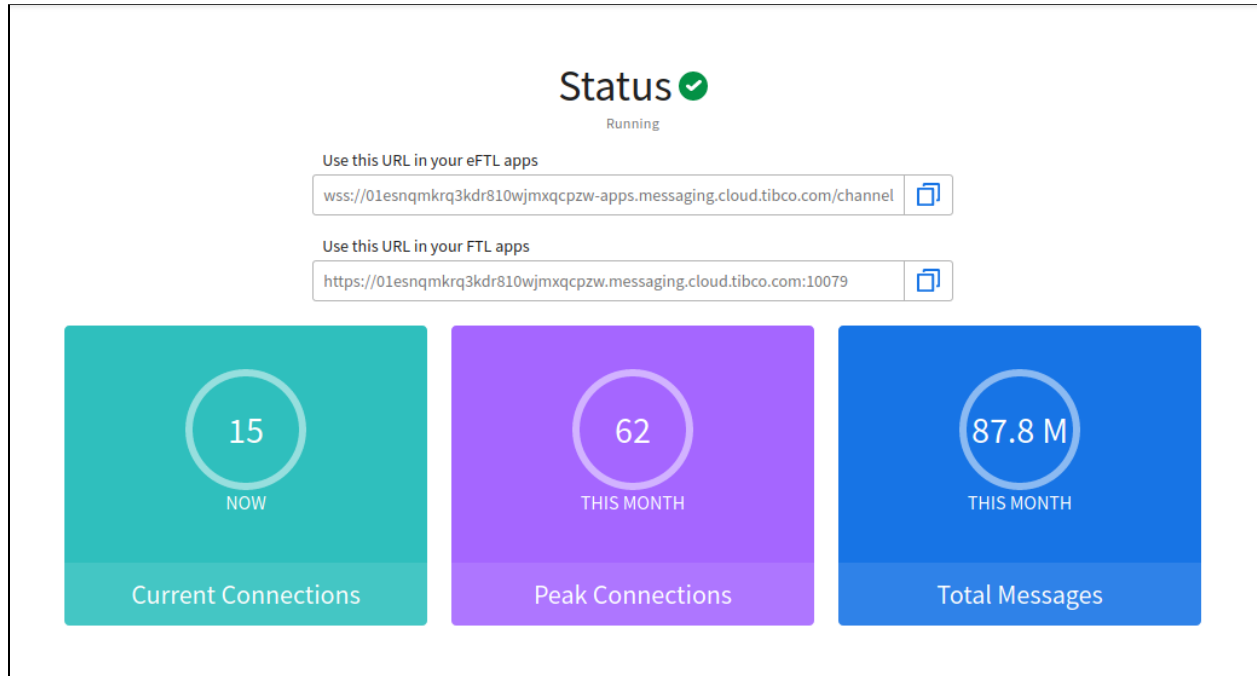
TIBCO Cloud Live Apps

TIBCO Cloud Live Apps is a low-code case management application that will create a new case whenever an incident is reported by Cloud Events application. Live Apps will keep track of that incident throughout the life-cycle of the incident.

This Accelerator includes the following Live Apps applications:

1. **Alert_Processing**

    - The application is built for the Public transport Incidents processing.

    - It possesses all necessary states, data and workflow to handle the life-cycle of the incident.

Please refer to the 4_LiveApps_Solution_Setup_readme.pdf and follow the steps to configure above outlined applications and run it efficiently..

TIBCO Cloud Data Streams

TIBCO Cloud Data Streams acts as a durable subscriber to TCM-eFTL to then stream the received messages to TIBCO Cloud Spotfire for visualization and analysis.

This Accelerator includes the following Data Streams:

1. **NormalDataFeed_detail**

    Content matcher = *{"_dest":"SydneyBuses_NormalFeedStream"}*

    This stream that stores the historical data (1 hour and configurable) for spotfire dashboard

2. **NormalDataFeed_header**

    Content matcher = *{"_dest":"SydneyBuses_NormalFeedStream"}*

    The stream will have only latest information to visualise it in spotfire

3. **IncidentData**

    Content matcher = *{"_dest":"SydneyBuses_incidentStream"}*

    The stream will populate all the incidents reported in public transport and reported incidents in liveapps application for visualisation

TIBCO Cloud Spotfire

In TIBCO Cloud Spotfire, you can view the data streams alongside historical data or other streaming data, create aggregations, and even apply data science.

This Accelerator includes these two dashboards

1. Summary

2. Public Transport Incidents

Please refer to the [5_Steaming_and_Visualization_Solution_Setup_readme.pdf](#) and follow the steps to configure above outlined applications and run it efficiently.

Additional Information

Performance Tuning

In this Accelerator we are working with very large amounts of data from Transport for NSW. The number of buses may grow from few 100 to more than 6,000 in peak hours. The data that we're receiving is in Protobuf format, so we need to convert it into JSON to use in TCI Flogo applications.

This conversion operation takes a toll on memory if the Protobuf payload is large and sometimes memory usage goes beyond 80% and may crash the application container. We do not have any provision to increase the memory allocated to the TCI Flogo app beyond the default value of 1GB.

So to avoid this situation, we need to call the GC quite frequently to reclaim the memory. You need to add the **'GOGC'** variable to the Engine Variables section and set the value to "20" as shown below.

You need to add the GOGC variable to the **Engine Variables** Section for given below applications:

1. PublicTransportAccelerator_PublishGTFS_v2

2. PublicTransportAccelerator_PublisheFTL

Working with Non-GTFS Data Feed

The Accelerator can be enhanced & extended to achieve additional use-cases where you do not have data in standard GTFS format, as seen in the TIBCO Can Do That [Sydney Harbour Bridge demo video](.).

Here, we have enhanced the accelerator to accommodate the use-case that connects the event feeds delivered through modern messaging formats (TCM- eFTL) detected through AI enabled smart cameras (non- GTFS Structure) published to TIBCO Cloud Messaging (TCM eFTL), the TIBCO Cloud Events will subscribe to these feeds and run through the set of predefined business rules. When an incident occurs the accelerator then creates a TIBCO Cloud Live Apps case for the management of the incident. And all this data will be visualised using TIBCO Cloud Spotfire.

Let's jump into the solution design and details that will give the complete overview of a solution covering different TIBCO Cloud Components in use.

We have used the external database for storage, monitoring and tracking purposes. A User needs to create the following tables in MySQL database. All DB table scripts available under ~/../src/TCI-Flogo/resources/MySQL-DB_Tables/

- **dtvd_alertcasetracking**.sql

  The purpose of this table is to keep track of live/reported incidents through TIBCO Cloud LiveApps case flow. Also, used for creating Stream of data for visualization.

- **dtvd_incidenthistory**.sql

  This table will hold the closed incident data over a period of time. This data will be helpful for Data Science and predictive analysis.

❏ TIBCO Cloud Integration (TCI Flogo)

The Accelerator utilises the below TIBCO Cloud Integration (TCI) application for data integration & transformation. This application has been created using the Develop capability of TCI, powered by Flogo (TCI Flogo).

1. **PublicTransportAccelerator_LiveAppsCase**

This will receive the incoming events from TIBCO Cloud Events app for over speeding incidents and will start the TIBCO Live Apps case management flow for the same.

We have used below flows in this implementation.

- TCM-eFTL Message Subscriber Trigger Flow

  CreateNewAlertForDTVD

  This flow is responsible for creating the case for each message received from TIBCO Cloud Events through TIBCO Cloud Messaging. It will return the CaseId and State of case on successful execution as a response to the received event.

- Timer Based Trigger Flow

  DTVD_CreateStreamForIncidentData

  The flow is responsible for producing a stream of data for DataStream and that subsequently will be visualised in Spotfire Dashboard.

  DTVD_CloseOfTCEEvent

  As soon as Case State changes to Closed is detected, the flow will send the closure message to TIBCO Cloud Events to clear the Alert from its working memory. This correlation arrangement avoids the duplication of the alerts and Live Apps cases.

- Subflows

  DTVD_CreateNewCase

  This flow is actually responsible for handling the case creation through Live Apps connector, add newly created Alert to DB for tracking and send response for TCE through main flow.

  DTVD_SendNotifications

  This is a place holder created for users to add the choice of notification mechanism whenever any new alert is created. The notification could be SMS, E-Mail, Phone Call, etc. We're allowing users to choose their own option.

❏ TIBCO Cloud Events

The Accelerator uses TIBCO Cloud Events (TCE) as the event processing application to apply predefined rules to the incoming feed messages or alerts reported from TIBCO Cloud Messaging. Events detected by Cloud Events will then trigger TCI Flogo applications to start a TIBCO Cloud Live Apps case management workflow.

1. Alert_Processing

We are using the same TIBCO Cloud Events application, it has implemented all the Concepts, Events and Rules with a prefix as **'DTVD'**.

The event application that will create an incident whenever any vehicle breach the speed limit of 75 kmph.

- Incoming Message from TCM-eFTL to Events Solution (TCE)

    We need to have messages coming into TIBCO Cloud Messaging in below format so TIBCO Cloud Events application can subscribe to it and run through defined business rules.

```
{
    "_dest": "DeptTransportVictoria_liveFeed",
    "trackid": 37,
    "avg_centroid_speed": 77.110454942,
    "direction": "left",
    "class_name": "car",
    "lastupdate": 1613752733257,
    "lastcnt": 4,
    "image": "http://sample.com/image1.png"
}
```

    _dest is TCM-eFTL destination where messages will be sent to.

❏ TIBCO Cloud Live Apps

TIBCO Cloud Live Apps is a low-code case management application that will create a new case whenever an incident is reported by TIBCO Cloud Events

application. The TIBCO Cloud Live Apps application will keep track of that incident throughout the life-cycle of the incident.

1. **DTVD_IncidentProcessing**

   It possesses all necessary states, data and workflow to handle the life-cycle of the incoming incident

   The application has the same workflow, states and action created as outlined in the above section created for the Accelerator.

   NOTE: Please follow the steps outlined in 4_LiveApps_Solution_Setup_readme.pdf for Alert_Processing application.

❏ TIBCO Cloud Data Stream

The TIBCO Cloud Data Stream is configured as a durable subscriber to TCM-eFTL and the messages received will be visualised in the Spotfire dashboards.

Please follow the same steps outlined in 5_Steaming_and_Visualization_Solution_Setup_readme.pdf to configure the data stream and spotfire dashboard for visualization.

We need the following Data Stream to be created for the spotfire dashboard to visualise the incidents reported through the accelerator for AI enabled Camera Feed.

● **DTVD_IncidentData**

   Content matcher = {"_dest" : "DeptTransportVictoria_liveFeed"}

   The data stream will populate all the incidents reported in visualisation.

❏ TIBCO Cloud Spotfire

We have below dashboards set-up to visualise the different aspects of the data/incidents.

The dashboard report included in the .dxp available under ~/src/Spotfire/

- **Harbour Bridge Incidents**