EOPEN

opEn interOperable Platform for unified access and analysis of Earth observatioN data

H2020-776019

D6.4

EOPEN 2nd Prototype

[User and Developer Guides]

Dissemination level:	Public
Contractual date of delivery:	31/12/2019
Actual date of delivery:	31/05/2020 (resubmission)
Work package:	WP6 System Development and Integration
Task:	T6.2 EOPEN System Integration T6.4 Interactive real-time user-friendly visualisations
Type:	Demonstrator
Approval Status:	Approved
Version:	1.1
Number of pages:	98
Filename:	EOPEN-SA-D6.4-v1.1 - EOPEN 2nd Prototype.docx

Abstract

This document describes the features and the capabilities supported by the EOPEN 2nd Prototype software. It is part of the result of the work performed on T6.2 "EOPEN System Integration" and T6.4 "Interactive real-time user-friendly visualisation".

The document is a volume containing two independent parts:

- **PART A** contains the User Guide of the EOPEN Platform. It describes how an end-user may use the platform to search for and visualise the available data.
- **PART B** contains the Developer Guide. Its purpose is to describe the features provided by the EOPEN Platform to import new algorithms and implement new workflows.
  Annexes include a glossary of the main terms as well as an inventory of the EOPEN modules available in the Second EOPEN Prototype (D6.4).

co-funded by the European Union

Table of Contents

PART A. EOPEN User Guide

Abstract

This document is the EOPEN User Guide. Its purpose is to describe the features and the capabilities supported by the EOPEN User Portal.

The content of this document is part of the result of the work performed on T6.2 "EOPEN System Integration" and T6.4 "Interactive real-time user-friendly visualisation".

History of PART A

Version	Date	Reason	Revised by	Approved By
1.0	13-Jan-2020	First Release	Authors	Leslie Gale

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Executive Summary of Part A

This deliverable presents the intermediate result of the work performed on the "interactive real-time user-friendly visualisations" task. This result corresponds to the software integrated in the second prototype EOPEN Platform.

The objective of the EOPEN User Portal is to provide to end-users means to search for and visualise the data available in the EOPEN Platform in the most appropriate manner. The available data may be "proxied" (thus fetched in real-time from external sources such as FMI), may have been manually or automatically ingested as it is the case of weather forecast and tweets data, or may have been generated within the platform as it is the case of water body masks and rice paddy fields maps.

The EOPEN User Portal is meant to be generic. It integrates a series of System Dashboards that are pre-configured to display different types of data of interest whatever the use case. It also provides a series of graphical components that may be used to create custom dashboards.

This document describes how users may use the EOPEN User Portal to find and visualise data but also how to create new dashboards to better meet their needs.

How to access the Second EOPEN Platform Prototype User Portal

The EOPEN User Portal described in this document is available at the following address:

https://proto2.eopen.spaceapplications.com

Abbreviations and Acronyms

AOI	Area of Interest
API	Application Programming Interface
ASB	Automated Service Builder
EO	Earth Observation
EOPEN	opEn interOperable Platform for unified access and analysis of Earth observatioN data
ESA	European Space Agency
FSM	Full Strip-Map
FTP	File Transfer Protocol
GDAL	Geospatial Data Abstraction Library
GPT	Graph Processing Tool
GUI	Graphical User Interface
HTTP	Hyper-Text Transfer Protocol
JSON	JavaScript Object Notation
OGC	Open Geospatial Consortium
S1, S2, S3	Sentinel-1, Sentinel-2, Sentinel-3
SNAP	Sentinel Application Platform
SpaceApps	Space Applications Services
VM	Virtual Machine
WFS	Web Feature Service
WMS	Web Map Service
WPS	Web Processing Service

1 INTRODUCTION

This document describes the features and capabilities implemented in the EOPEN User Portal integrated in the second EOPEN Platform prototype. It is an intermediate result as the current capabilities will be improved and new components will be added to support additional data types and visualisations.

The next version will be integrated in the final release of the EOPEN Platform.

1.1 General Concepts

The EOPEN User Portal makes use of a few general concepts to refer to its building parts.

First of all, there is the **Portal** itself. This refers to the whole Web application. All the pages, menus, graphical components visible in the Web browser are considered as building blocks of the Web portal.

Besides a couple of special pages (including the "Home" page and the "About" page), the pages that are used to display data available in the EOPEN Platform are called **Dashboards**. Dashboards contain one or more graphical (web) **Components** which are used to search and visualise the data. Different filters and viewers are available to support the different types of data present in the platform.

The next chapter describes in details the available dashboards and components and explains how new custom dashboards can be created by selecting and arranging components as needed.

1.2 User Accounts / Authentication

The EOPEN Web Portal is currently accessible without restrictions. The displayed information and the dashboards created by the users are publicly accessible.

This is a temporary situation. The implementation roadmap foresees a merge of the EOPEN Web Portal with the Developer Portal. At that time the role-based access control already used to restrict access to the developers will also be applied to the end-users who only need to access the Web Portal described in this document.

1.3 Configuration

As users are not yet individually recognised, the changes applied to the portal pages are shared and customisable by anyone.

2 THE EOPEN USER PORTAL

This chapter describes the user interface of the **EOPEN User Portal**. Next section gives an overview of the available pages and the main navigation links.

The remaining of the chapter describes the pre-defined pages, the available components and the controls for creating and customising new pages.

2.1 Site Map and Page Layout

Figure 1, below, shows the structure of the EOPEN User Portal. Except the banner panel shown on the left, each box represents a Web page and the arrows show the navigation between the pages.

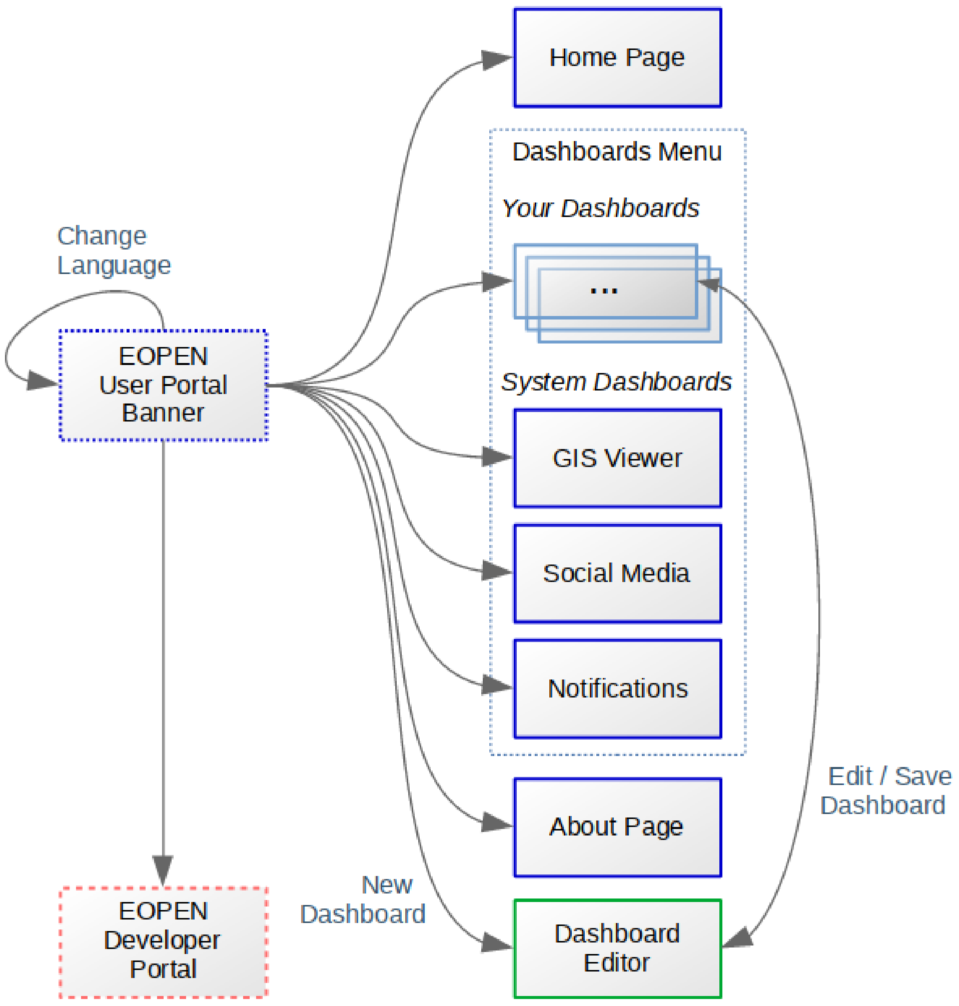


Figure 1 – EOPEN User Portal Site Map

The EOPEN User Portal Home Page (https://proto2.eopen.spaceapplications.com) welcomes the visitor. The page body informs about the EOPEN project and provides a link to the Developer Portal, described in a separate document.

The page banner, included in all pages, contains the following elements:

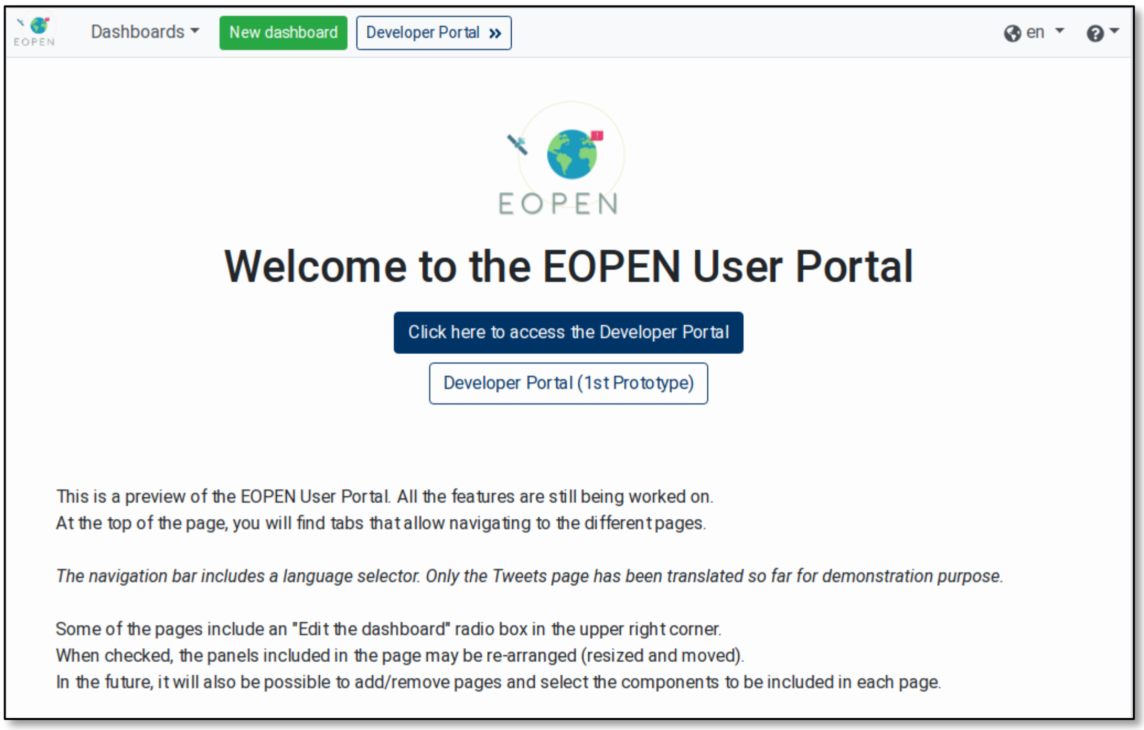
- The EOPEN logo that leads to the Home Page.
- A Dashboards menu which lists the available dashboards grouped in two categories:
  - "*Your dashboards*" contains the dashboards created and configured by the users. In a fresh installation this category is empty.

    Important: As the dashboards are currently shared among the users, pay attention not to modify a dashboard without the consent of its creator, if known.
  - "*System dashboards*" lists the built-in dashboards. These are pre-defined in the EOPEN Portal and are not editable.

    The GIS Viewer dashboard allows searching and visualising geospatial data on backgound maps. The GIS Viewer dashboard is described in section 2.2.1.

    The Social Media dashboard allows searching, inspecting and visualising collected Tweets on an interactive map. This dashboard is described in details in section 2.2.2.

    The Notifications dashboard displays the messages issued by the applications running in the EOPEN Platform through Mattermost channels. The Notifications and Instant Messaging dashboard is described in section 2.2.3.
- A New dashboard button that allows creating custom dashboards, as described in section 2.3.
- A Developer Portal » button that leads to the EOPEN Developer Portal described in the dedicated *EOPEN Developer Guide*.
- An Edit dashboard button is displayed on the right side and only when an editable Dashboard is selected. Click on this button to enter the dashboard editing mode, as described in section 2.3
- A menu that allows selecting the display language. Supported languages are English (en), Italian (it), Finnish (fi) and Korean (ko, as shown on Figure 3).
- A question mark icon leads to the About page. This page provides technical information about the portal including the list of the integrated third party data and software.


EOPEN
Dashboards
New dashboard
Developer Portal
en
EOPEN

Welcome to the EOPEN User Portal

Click here to access the Developer Portal
Developer Portal (1st Prototype)

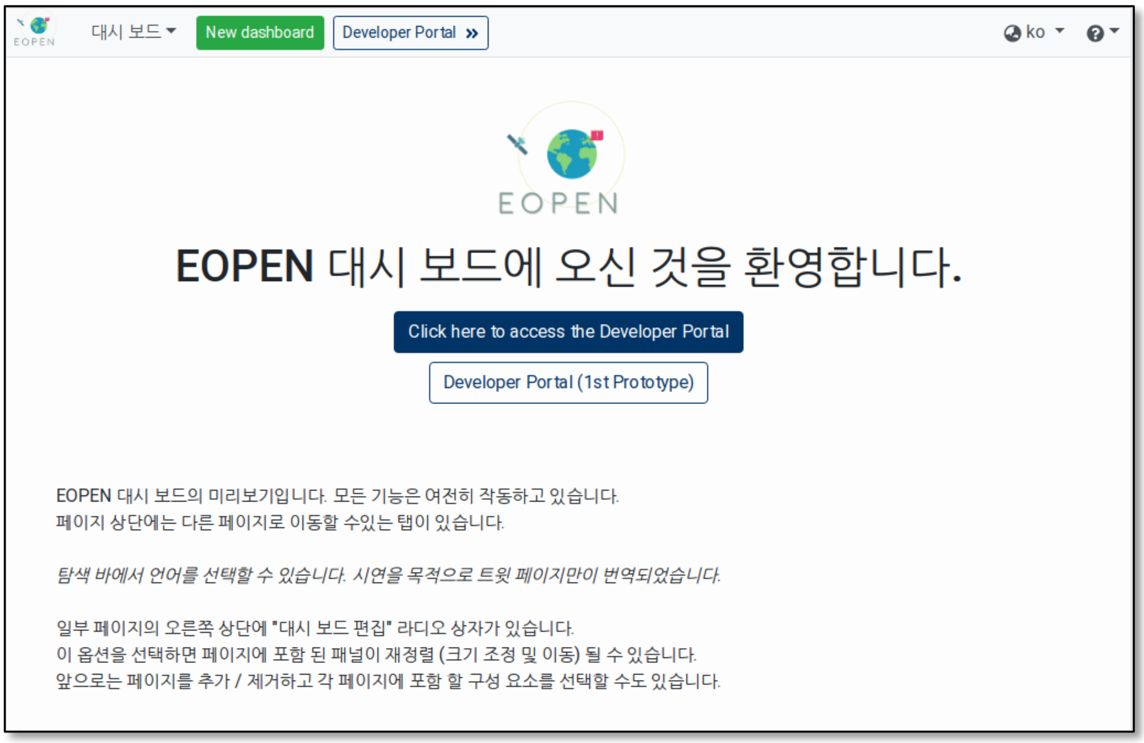
This is a preview of the EOPEN User Portal. All the features are still being worked on.
At the top of the page, you will find tabs that allow navigating to the different pages.

The navigation bar includes a language selector. Only the Tweets page has been translated so far for demonstration purpose.

Some of the pages include an "Edit the dashboard" radio box in the upper right corner.
When checked, the panels included in the page may be re-arranged (resized and moved).
In the future, it will also be possible to add/remove pages and select the components to be included in each page.

Figure 2 – Home Page

The following screenshot shows how the Home page is displayed when the Korean language is selected:


EOPEN
대시 보드
New dashboard
Developer Portal
ko
EOPEN

EOPEN 대시 보드에 오신 것을 환영합니다.

Click here to access the Developer Portal
Developer Portal (1st Prototype)

EOPEN 대시 보드의 미리보기입니다. 모든 기능은 여전히 작동하고 있습니다.
페이지 상단에는 다른 페이지로 이동할 수있는 탭이 있습니다.

탐색 바에서 언어를 선택할 수 있습니다. 시연을 목적으로 트윗 페이지만이 번역되었습니다.

일부 페이지의 오른쪽 상단에 "대시 보드 편집" 라디오 상자가 있습니다.
이 옵션을 선택하면 페이지에 포함 된 패널이 재정렬 (크기 조정 및 이동) 될 수 있습니다.
앞으로는 페이지를 추가 / 제거하고 각 페이지에 포함 할 구성 요소를 선택할 수도 있습니다.

Figure 3 – Home Page (Korean Version)

2.2 System Dashboards

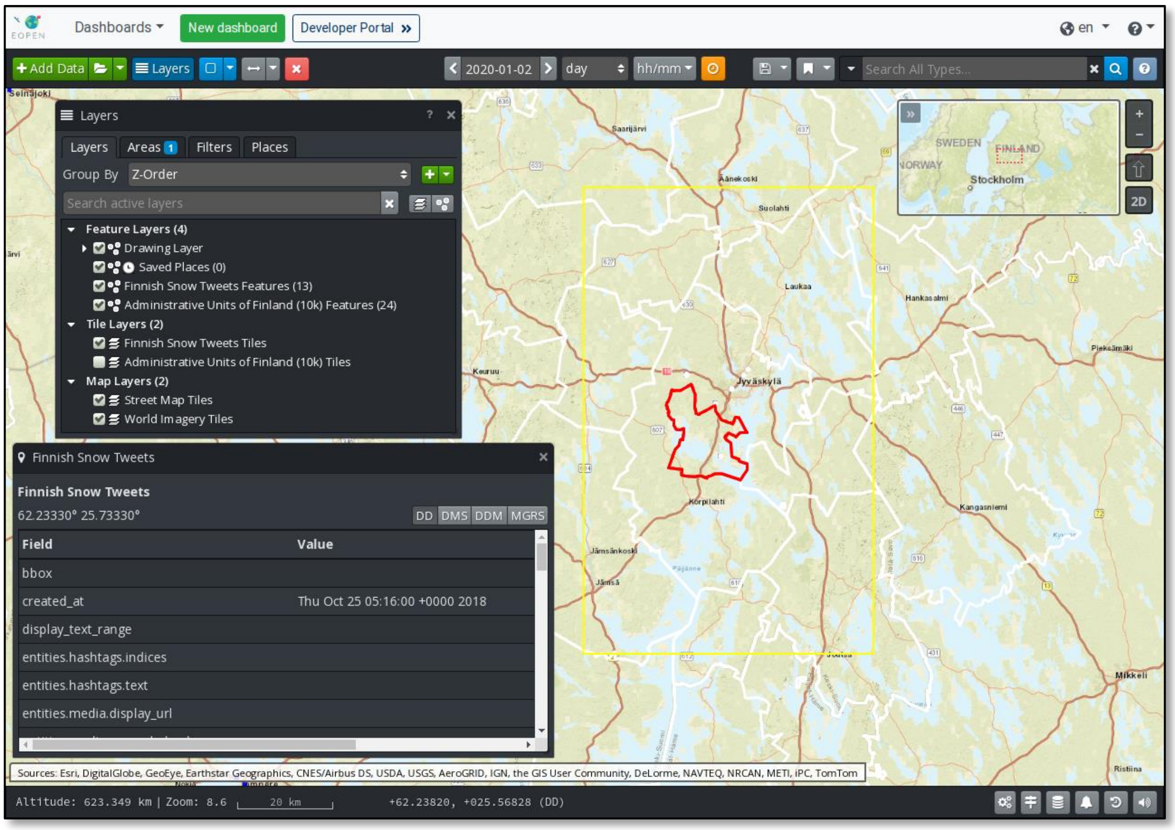
Pre-defined pages already combine available components to provide general purpose features. These are introduced in the following sections.

2.2.1 GIS Viewer

The GIS Viewer page allows visualising the geo-localised data available in the platform on interactive 2D maps and 3D globe. The page is accessed by clicking on the GIS Viewer entry in the Dashboards menu.

As may be seen on Figure 4, besides the banner at the top, the GIS Viewer occupies the entire page. The Viewer is implemented with the open-source software **OpenSphere** whose technical information may be found at: https://opensphere.readthedocs.io/en/latest/. The tool includes embedded help information, accessible through the question mark button located in its upper-right corner.

In this section we explain how data available in the EOPEN Platform may be selected and visualised on the map. The geo-localised data is stored in a GeoServer instance pre-configured in the viewer.



Feature Layers (4)
- Drawing Layer
- Saved Places (0)
- Finnish Snow Tweets Features (13)
- Administrative Units of Finland (10k) Features (24)

Tile Layers (2)
- Finnish Snow Tweets Tiles
- Administrative Units of Finland (10k) Tiles

Map Layers (2)
- Street Map Tiles
- World Imagery Tiles

Finnish Snow Tweets

Finnish Snow Tweets

62.23330° 25.73330°

Field	Value
bbox	
created_at	Thu Oct 25 05:16:00 +0000 2018
display_text_range	
entities.hashtags.indices	
entities.hashtags.text	
entities.media.display_url	

Sources: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, the GIS User Community, DeLorme, NAVTEQ, NRCAN, METI, iPC, TomTom

Altitude: 623.349 km | Zoom: 8.6 20 km +62.23820, +025.56828 (DD)

Figure 4 – GIS Viewer

Proceed as follows to visualise data as layers on the map:

1. Click on the Add Data button located in the upper-left corner of the viewer.
2. In the Add Data dialog box (Figure 6), identify and expand the "EOPEN GeoServer" source.
3. Toggle the switch next to the layers of interest. The changes are immediately applied. There no button to accept the changes. Click on the Close button when done.
4. If the Layers floating panel is not visible, click on the Layers button in the banner.
5. The Layers panel lists the selected Feature Layers, Tile (Raster) Layers and the (Base) Map Layers.
6. In order to focus the map on the data of a certain layer, select the layer in the list, right-click on it to reveal a popup menu, then select the Go To entry in the menu. Figure 5 shows the map focusing on a water mask product.

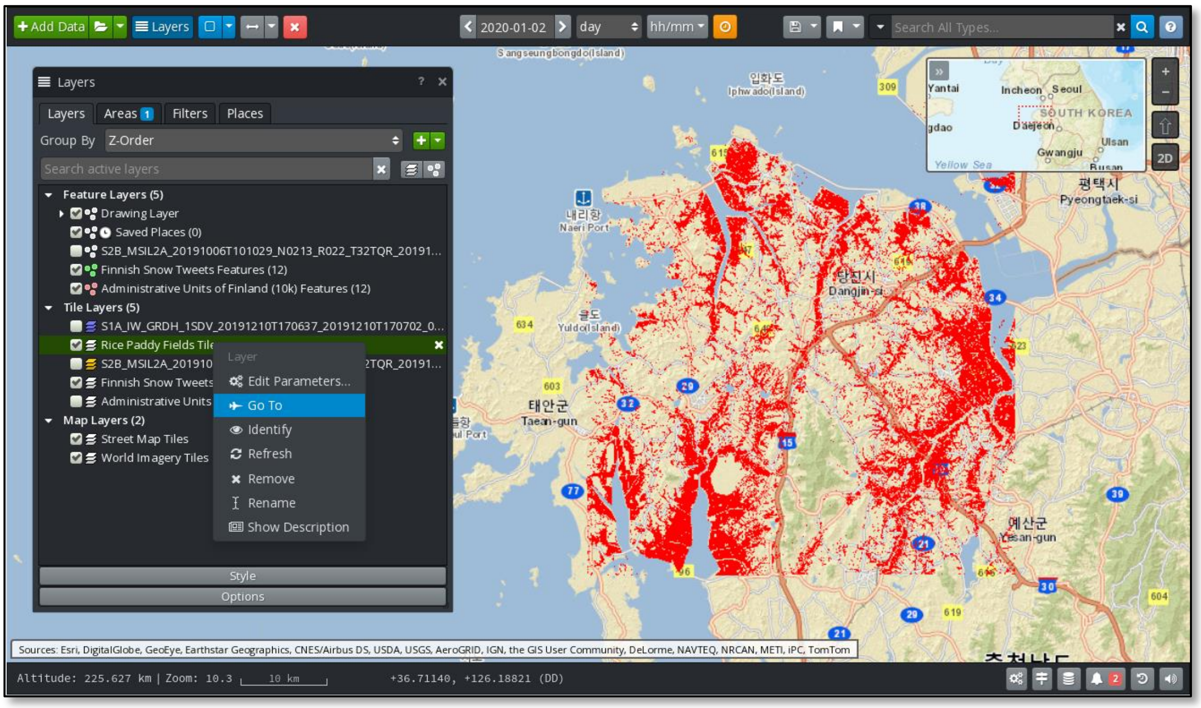


Figure 5 – GIS Viewer: Go To Rice Paddy Mask Layer

Available Data

Geo-localised data available in the EOPEN Platform include the data ingested and generated by the Pilot Use Cases. Examples are:

- Water body masks (raster and vector) extracted from Sentinel-1 and Sentinel-2 scenes.
- Rice paddy masks (raster, as shown on Figure 5)
- Collected Tweets in different languages and matching each use case (vector/features)
- Weather (temperature, wind, precipitation, …) forecast data (raster)
- Administrative data from Finland (raster and vector)

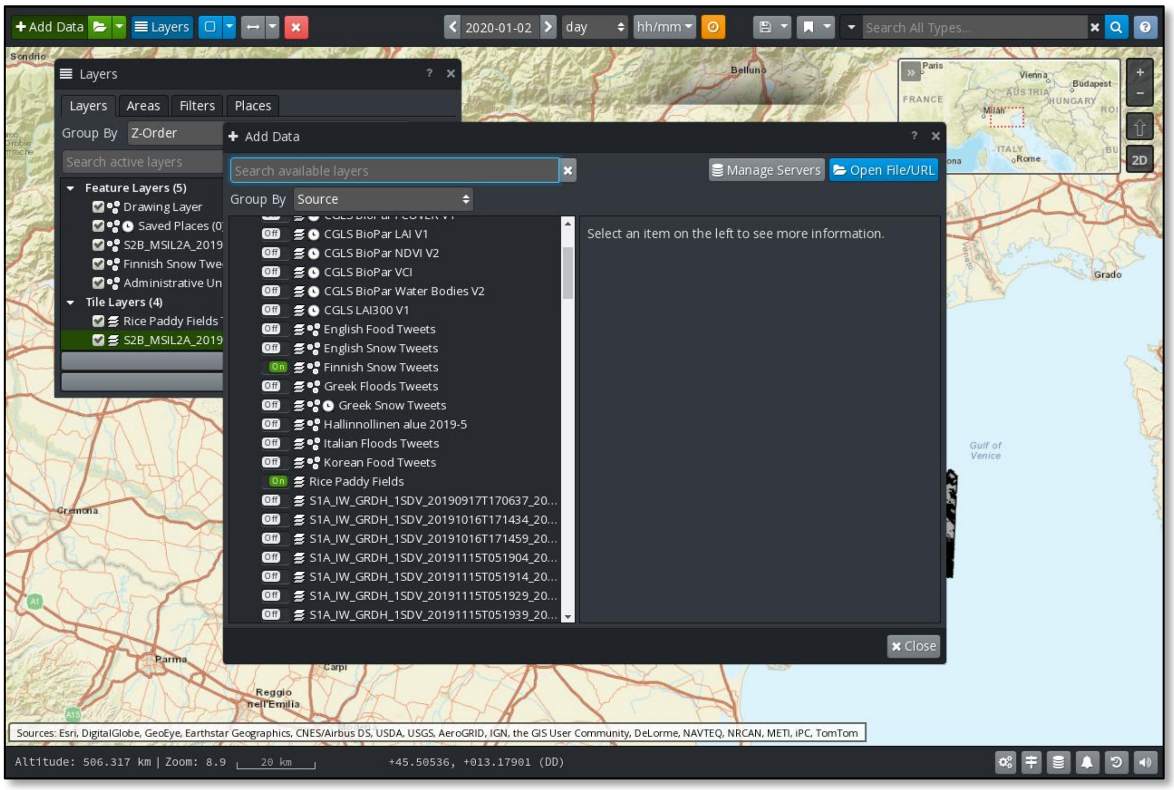

Add Data
Layers
2020-01-02
day
hh/mm
Search All Types...
Layers
Layers
Areas
Filters
Places
Group By
Z-Order
Search active layers
Feature Layers (5)
Drawing Layer
Saved Places (0
S2B_MSIL2A_2019
Finnish Snow Twe
Administrative Un
Tile Layers (4)
Rice Paddy Fields
S2B_MSIL2A_2019
Add Data
Search available layers
Manage Servers
Open File/URL
Group By
Source
CGLS BioPar LAI V1
CGLS BioPar NDVI V2
CGLS BioPar VCI
CGLS BioPar Water Bodies V2
CGLS LAI300 V1
English Food Tweets
English Snow Tweets
Finnish Snow Tweets
Greek Floods Tweets
Greek Snow Tweets
Hallinnollinen alue 2019-5
Italian Floods Tweets
Korean Food Tweets
Rice Paddy Fields
S1A_IW_GRDH_1SDV_20190917T170637_20...
S1A_IW_GRDH_1SDV_20191016T171434_20...
S1A_IW_GRDH_1SDV_20191016T171459_20...
S1A_IW_GRDH_1SDV_20191115T051904_20...
S1A_IW_GRDH_1SDV_20191115T051914_20...
S1A_IW_GRDH_1SDV_20191115T051929_20...
S1A_IW_GRDH_1SDV_20191115T051939_20...
Select an item on the left to see more information.
Close
Sources: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, the GIS User Community, DeLorme, NAVTEQ, NRCAN, METI, iPC, TomTom
Altitude: 506.317 km | Zoom: 8.9
20 km
+45.50536, +013.17901 (DD)
2D

Figure 6 – GIS Viewer: Add Data

Layers Panel

The Layers Panel contains 4 tabs:

- Layers: Lists the pre-configured and the selected layers, organised in three groups:
  - Feature Layers: Includes areas drawn on the map, and vector layers (i.e. served via OGC WFS)
  - Tile Layers: Includes the raster layers (i.e. served via OGC WMS and WMTS)
  - Map Layers: Includes the pre-configured base maps: a Street Map and a World Map (satellite imagery) both served by ArcGIS Online.

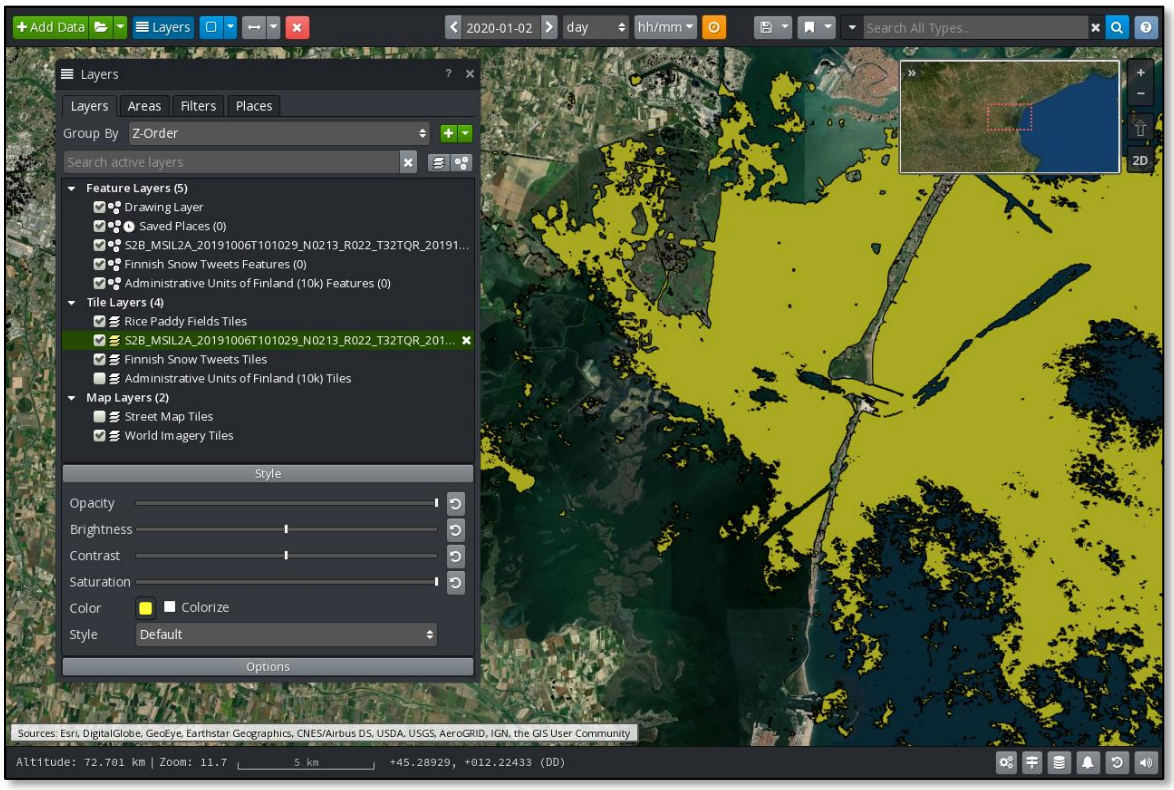
  The layers may be enabled and displayed using check-boxes and may be moved up and down with the mouse to control in which order they appear on the map.

  At the bottom of the panel, an option area allows automatically refreshing the data at a regular interval.
- Areas: Lists the areas drawn on the map and the closed polygon features converted into areas. Areas may be selected to filter the features to be displayed on the map. This is further explained below.
- Filters This tab allows creating and managing advanced filters by combining layers, areas and feature properties.
- Places: This tab allows creating and managing custom locations.

Layer Styling

When a layer is selected in the list several buttons appear at the bottom of the panel:

- A Style button appears. Clicking on this button reveals controls for customising the appearance of the layer on the map. As can be seen on Figure 7, available controls include the opacity, brightness and contrast as well as the base colour. If a Feature Layer is selected, the display size may also be adjusted.
- If a Feature Layer is selected a Label button is also available. This allows selecting which feature properties must be displayed on the map and how (size and color).
- Controls under the Options button allow configuring how often the layer will auto-refresh on the screen.



Add Data
Layers
2020-01-02
day
hh/mm
Search All Types...
Layers
Layers
Areas
Filters
Places
Group By
Z-Order
Search active layers
Feature Layers (5)
Drawing Layer
Saved Places (0)
S2B_MSIL2A_20191006T101029_N0213_R022_T32TQR_20191...
Finnish Snow Tweets Features (0)
Administrative Units of Finland (10k) Features (0)
Tile Layers (4)
Rice Paddy Fields Tiles
S2B_MSIL2A_20191006T101029_N0213_R022_T32TQR_201...
Finnish Snow Tweets Tiles
Administrative Units of Finland (10k) Tiles
Map Layers (2)
Street Map Tiles
World Imagery Tiles
Style
Opacity
Brightness
Contrast
Saturation
Color
Colorize
Style
Default
Options
2D
Sources: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, the GIS User Community
Altitude: 72.701 km | Zoom: 11.7
5 km
+45.28929, +012.22433 (DD)

Figure 7 – GIS Viewer: Styling a Layer

Features Filtering

As mentioned above, the features, including vector data, must be selected using custom areas.

In order to search for features located in a bounding box:

1. Select one or more feature layers from the EOPEN GeoServer.
2. Click on the blue button in the GIS Viewer banner that shows a rectangle. By default, the selection has the shape of a rectangle. Expand the menu associated to the button to select other shape types.
3. When the tool is enabled, use the mouse to select an area on the map. A context menu appears automatically. In this menu select the Load entry. The selected area is added in

the list of areas in the Layers panel and the features located in the area are automatically queried from the server and displayed.

4. It is then possible to select individual features and visualise their properties.
5. If a feature is itself a closed polygon it can be used to define a new area. To do this, select the polygon, open its context menu (click on the right mouse button) and select the Add entry.
6. Custom areas are managed via the Areas tab in the Layers panel. In particular, areas may be renamed, imported and exported, enabled and disabled, etc.

Figure 4, above, shows an administrative region located in Finland (red polygon on the map), used as an area for filtering Tweets about snow in the Finnish language. One of these Tweets has been selected and its information displayed in the floating panel located in the bottom left of the screen.

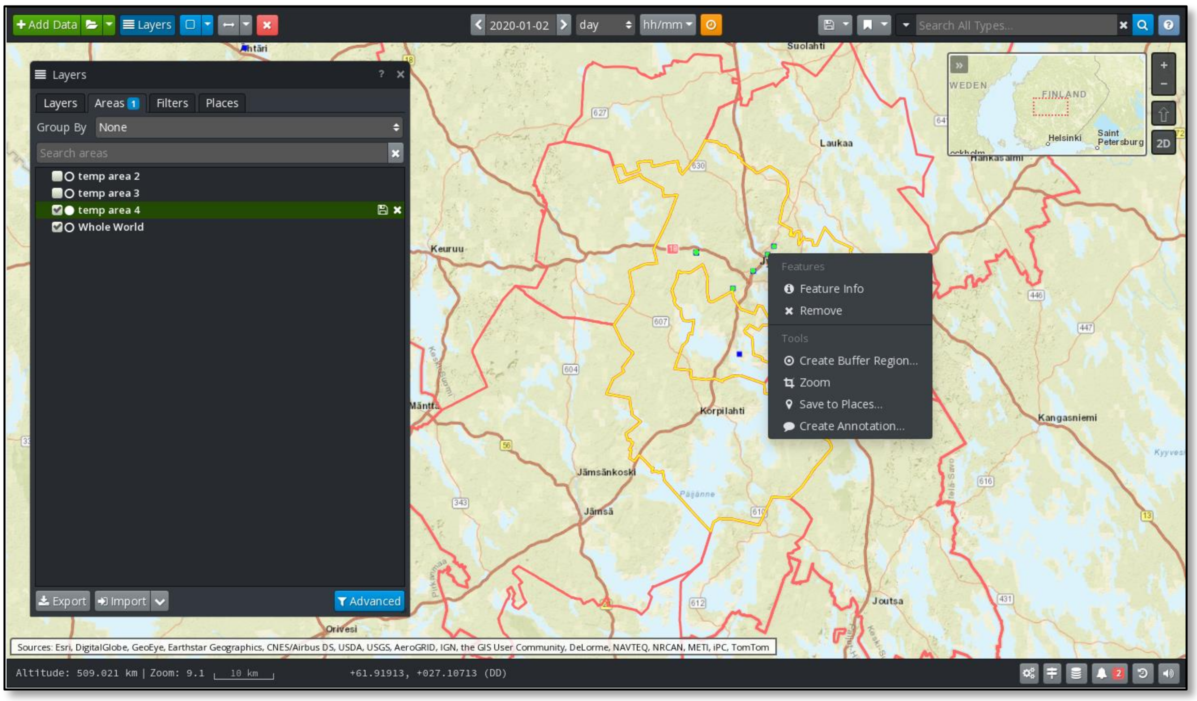
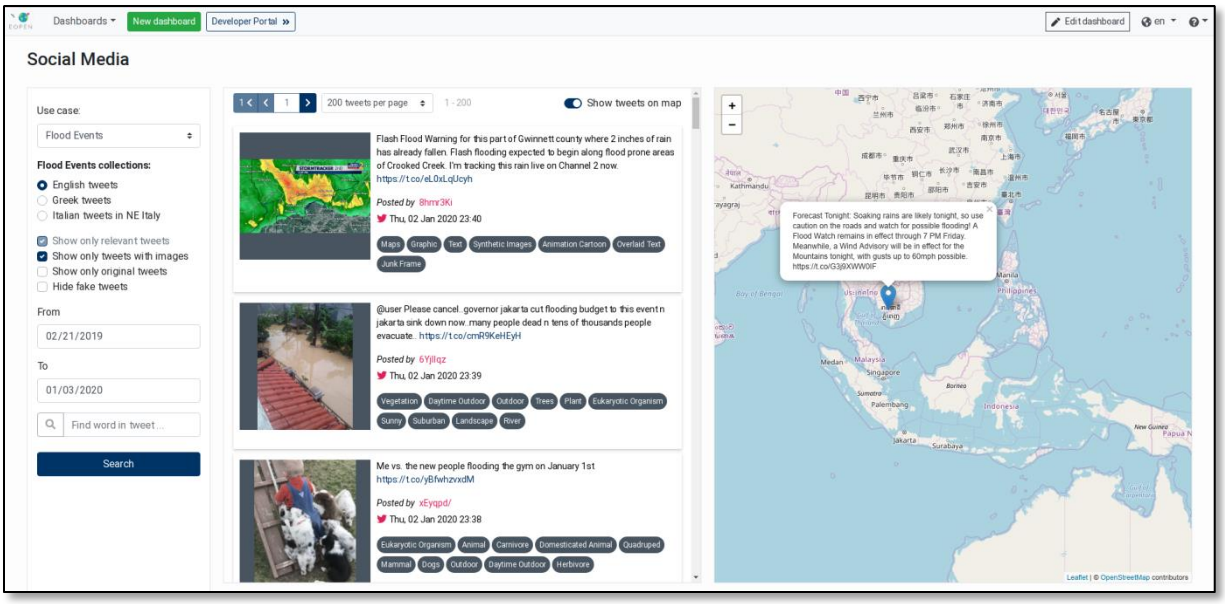


Figure 8 – GIS Viewer: Feature Selection

This is only a short introduction to OpenSphere. Many more features may be discovered by using the tool directly.

2.2.2 Social Media (Tweets) Viewer

The pre-defined Social Media page allows searching and inspecting the available tweets. It is accessed through the entry of the same name in the Dashboards menu.



Use case: Flood Events

Flood Events collections:
- [✓ English tweets]
- Greek tweets
- Italian tweets in NE Italy

- [✓ Show only relevant tweets]
- [✓ Show only tweets with images]
- Show only original tweets
- Hide fake tweets

From: 02/21/2019

To: 01/03/2020

Find word in tweet ...

Flash Flood Warning for this part of Gwinnett county where 2 inches of rain has already fallen. Flash flooding expected to begin along flood prone areas of Crooked Creek. I'm tracking this rain live on Channel 2 now. https://t.co/eL0xLqUcyh

Posted by 8hmr3Ki

Thu, 02 Jan 2020 23:40

@user Please cancel..governor jakarta cut flooding budget to this event n jakarta sink down now..many people dead n tens of thousands people evacuate.. https://t.co/cmR9KeHEyH

Posted by 6Yjllqz

Thu, 02 Jan 2020 23:39

Me vs. the new people flooding the gym on January 1st https://t.co/yBfwhzvxdM

Posted by xEyqpd/

Thu, 02 Jan 2020 23:38

Forecast Tonight: Soaking rains are likely tonight, so use caution on the roads and watch for possible flooding! A Flood Watch remains in effect through 7 PM Friday. Meanwhile, a Wind Advisory will be in effect for the Mountains tonight, with gusts up to 60mph possible. https://t.co/G3j9XWW0IF

Figure 9 – Social Media

As can be seen on Figure 9, the "Social Media" dashboard integrates a form on the left, a list of tweets in the centre, and a map on the right.

Tweets Filtering

Use the form to filter the tweets:

1. Select one of the implemented use cases: Flood Events, Snow Cover, and Food Security.
2. Then select a language, the relevant options (only tweets with images, only original tweets, etc.), and a date range. By default the date range ends on the current day.
3. Optionally, enter a word or a word fragment in the “Find word in tweet …” field.
4. Then click on the Search button.

The tweets matching the search criteria are displayed in the centre. This list is paginated: by default, each page contains 50 entries. Controls located above the list allow moving to the previous and next page, and moving back to the first page. The number of the current page is also displayed. A menu allows changing the amount of entries in a page, between 50 and 500 with steps of 50 entries.

Tweets Information

Each tweet in the list is displayed with the text, an “anonymised” version of the author, and the creation timestamp.

When a tweet contains an image, a reduced version of it is displayed in the list. Click on a thumbnail image to obtain a bigger version.

The EOPEN Platform also integrates a location extraction service, which applies to the text, and a concept extraction service which applies on the images.

Extracted locations are displayed by means of a clickable link. When clicked, the interactive map, on the right, is automatically re-focused on the selected tweets.

Note: When the “Show tweets on map” switch is activated, all the geo-localised tweets are automatically displayed on the map by means of point markers. Click on a marker to reveal the tweet text on the map (as shown on Figure 9).

Concepts are extracted from images. These are displayed within “badges”. Currently, these badges are not active. In a future version of the component, the badges will be clickable and will allow filtering the tweets based on selected concepts.

2.2.3 Notifications and Instant Messaging

The Notifications Dashboard contains the controls and components that allow users receive the notifications issued by the applications running in the EOPEN Platform. The integrated instant messaging system is the open-source (Team Edition) of **Mattermost** (https://mattermost.com).

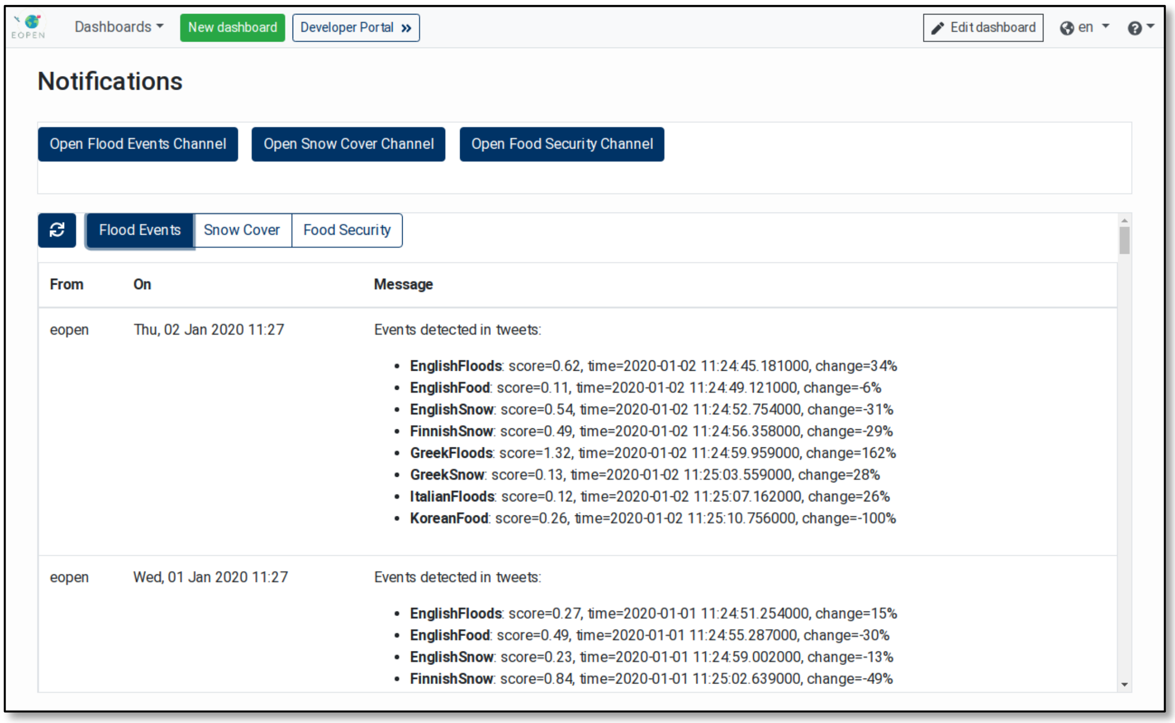
As three Pilot Use Cases (PUCs) are implemented in EOPEN, three dedicated Mattermost channels have been pre-configured and may be used by the application developers to issue notifications from within their workflows.

The page, represented in Figure 10, contains at the top three buttons which allow opening the Mattermost Web Client in a separate window. Each of the three buttons opens Mattermost on a specific PUC channel (see Figure 11).

The Mattermost Web Client is however fully featured. It thus allows selecting and reading from any PUC channel, searching for notifications, and issuing new notifications.

The Notifications Dashboard also contains an integrated Mattermost message viewer. It is currently rudimentary and does not automatically refresh the content nor allows sending new notifications. The message viewer shows three buttons for selecting the PUC channel of interest and a “Refresh” button (double-rotating arrows icon, on the left) for refreshing the content of the viewer.

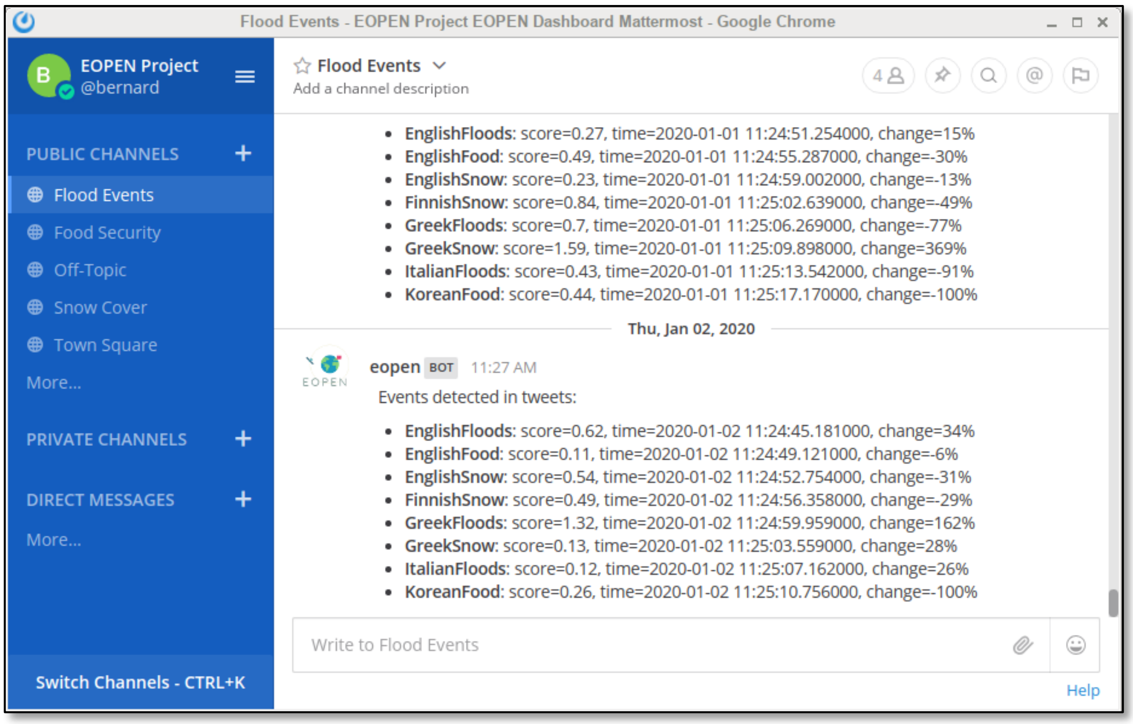
Figure 10 shows the notifications issued by the *Events Detection in Tweets Data* service which is scheduled to run once a day:



From	On	Message
eopen	Thu, 02 Jan 2020 11:27	Events detected in tweets: • **EnglishFloods**: score=0.62, time=2020-01-02 11:24:45.181000, change=34% • **EnglishFood**: score=0.11, time=2020-01-02 11:24:49.121000, change=-6% • **EnglishSnow**: score=0.54, time=2020-01-02 11:24:52.754000, change=-31% • **FinnishSnow**: score=0.49, time=2020-01-02 11:24:56.358000, change=-29% • **GreekFloods**: score=1.32, time=2020-01-02 11:24:59.959000, change=162% • **GreekSnow**: score=0.13, time=2020-01-02 11:25:03.559000, change=28% • **ItalianFloods**: score=0.12, time=2020-01-02 11:25:07.162000, change=26% • **KoreanFood**: score=0.26, time=2020-01-02 11:25:10.756000, change=-100%
eopen	Wed, 01 Jan 2020 11:27	Events detected in tweets: • **EnglishFloods**: score=0.27, time=2020-01-01 11:24:51.254000, change=15% • **EnglishFood**: score=0.49, time=2020-01-01 11:24:55.287000, change=-30% • **EnglishSnow**: score=0.23, time=2020-01-01 11:24:59.002000, change=-13% • **FinnishSnow**: score=0.84, time=2020-01-01 11:25:02.639000, change=-49%

Figure 10 – Notifications in the EOPEN User Portal

Figure 11 shows the same notifications displayed in the Mattermost Web Client:



- **EnglishFloods**: score=0.27, time=2020-01-01 11:24:51.254000, change=15%
- **EnglishFood**: score=0.49, time=2020-01-01 11:24:55.287000, change=-30%
- **EnglishSnow**: score=0.23, time=2020-01-01 11:24:59.002000, change=-13%
- **FinnishSnow**: score=0.84, time=2020-01-01 11:25:02.639000, change=-49%
- **GreekFloods**: score=0.7, time=2020-01-01 11:25:06.269000, change=-77%
- **GreekSnow**: score=1.59, time=2020-01-01 11:25:09.898000, change=369%
- **ItalianFloods**: score=0.43, time=2020-01-01 11:25:13.542000, change=-91%
- **KoreanFood**: score=0.44, time=2020-01-01 11:25:17.170000, change=-100%

Thu, Jan 02, 2020

eopen BOT 11:27 AM

Events detected in tweets:

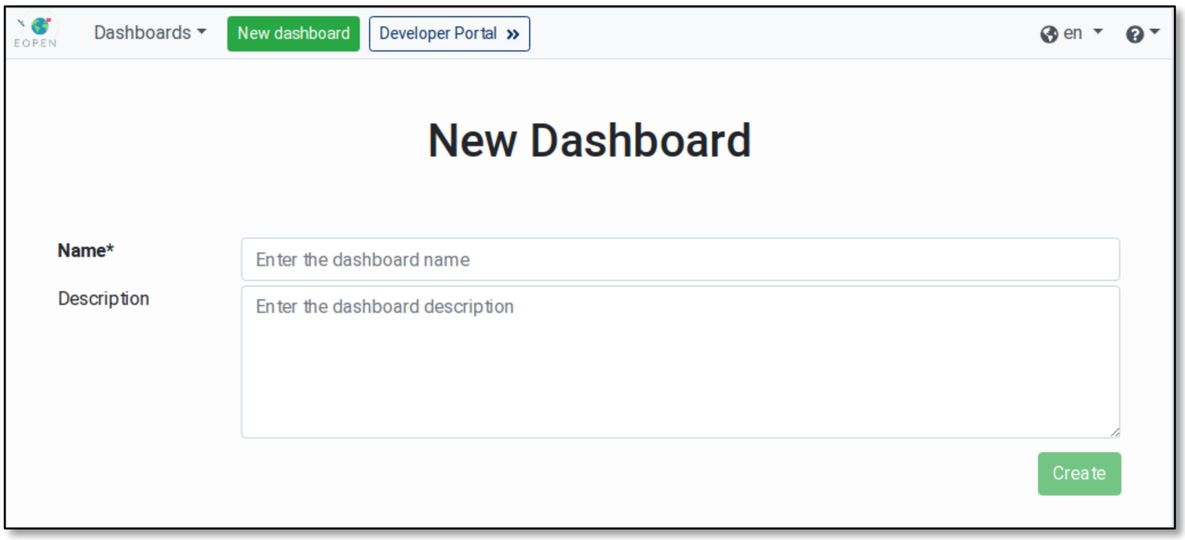
- **EnglishFloods**: score=0.62, time=2020-01-02 11:24:45.181000, change=34%
- **EnglishFood**: score=0.11, time=2020-01-02 11:24:49.121000, change=-6%
- **EnglishSnow**: score=0.54, time=2020-01-02 11:24:52.754000, change=-31%
- **FinnishSnow**: score=0.49, time=2020-01-02 11:24:56.358000, change=-29%
- **GreekFloods**: score=1.32, time=2020-01-02 11:24:59.959000, change=162%
- **GreekSnow**: score=0.13, time=2020-01-02 11:25:03.559000, change=28%
- **ItalianFloods**: score=0.12, time=2020-01-02 11:25:07.162000, change=26%
- **KoreanFood**: score=0.26, time=2020-01-02 11:25:10.756000, change=-100%

Figure 11 – Notifications in the Mattermost Web Client

2.3 Creating Custom Dashboards

As indicated above in the site map section, users may create their own dashboards and integrate in them any combination of web component already available in the platform.

To create a new dashboard, click on the New dashboard button located in the page banner. A new page, shown on Figure 12, is displayed asking for the name and the description of the new dashboard. The name will be used to refer to the dashboard in the Dashboards menu.



New Dashboard

Name*: Enter the dashboard name

Description: Enter the dashboard description

Figure 12 – Creation of a New Dashboard

To cancel the creation of the dashboard, simply navigate to another page of the EOPEN User Portal. Otherwise, enter the dashboard name and description (optional) then click on the Create button.

The new dashboard is displayed. This contains an empty web component. The banner shows a new button labelled Edit dashboard and the "Dashboards" menu now includes the new dashboard:

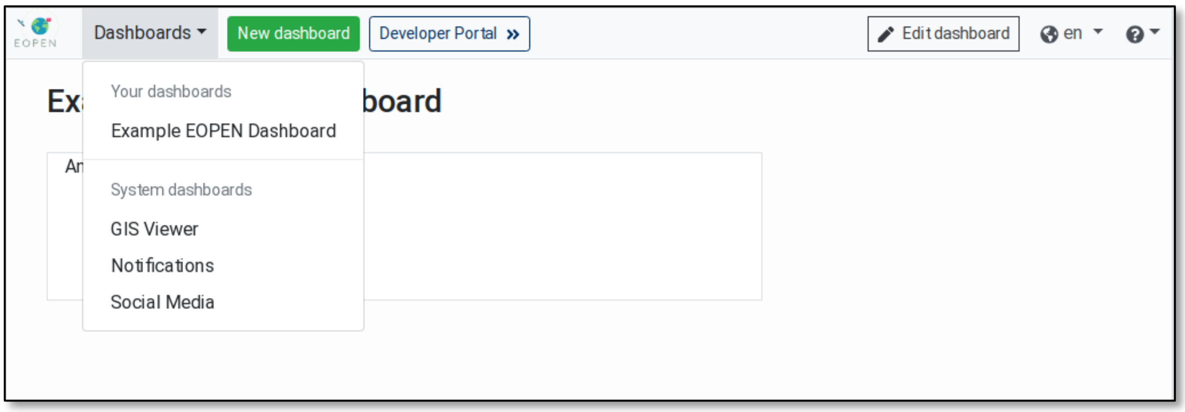


Figure 13 – New (Empty) Dashboard and the Dashboards Menu

Click on the Edit dashboard button to enter the editing mode:

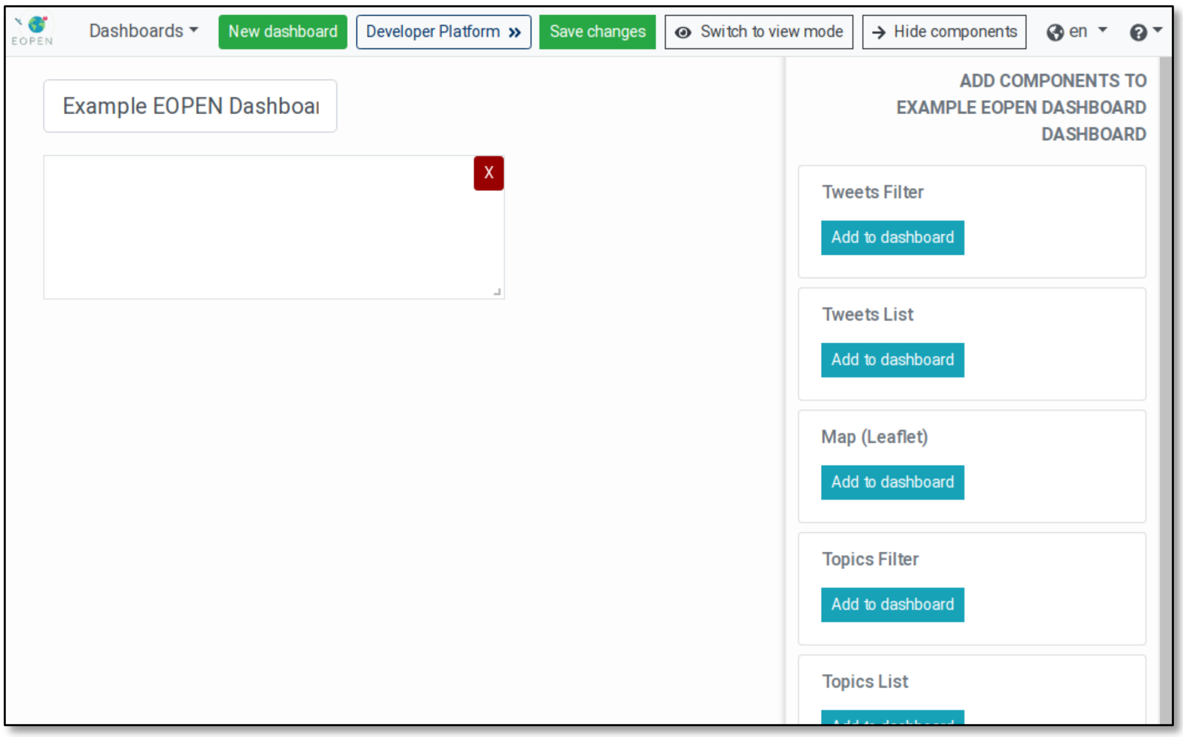


Figure 14 – New Dashboard in Editing Mode

In editing mode, the page displays the following new elements in the banner:

- A Save changes button which, when clicked, stores the new dashboard configuration on the server and quits the editing mode.
- A Switch to view mode button which allows cancelling the changes and exiting the editing mode. When this button is clicked, a popup dialog box is displayed warning that all the modifications will be discarded and asking for confirmation.
- A Hide components button for hiding the components panel (described below) while remaining in the editing mode. This is particularly useful to obtain a preview of the dashboard in normal mode.

The "components panel" located on the right side of the page lists the web components currently available in the platform. Each of these is individually described in section 2.5, below. Click on a component Add to dashboard button to add a new instance of the component into the dashboard.

On the dashboards, each component instance shows two controls:

- An X in a red button located in its top-right corner: Click on this button to remove the component instance from the dashboard.
- An angle icon located in its bottom-right corner. Click and drag this icon to resize the component.

To re-arrange the components click in its center area and drag it around. A component will always be pushed upwards until it reaches the top of the dashboard or encounters another component.

Note: Some of the web components present in the list may already be included in one or more of the System Dashboards. It is for example the case of the Tweets Filter and the Tweets List. This does not prevent using them in other custom dashboards.

As indicated above, when the configuration of the new dashboard is finished, click on the Save changes button to store the configuration and exit the editing mode.

From now on, the custom dashboard may be re-opened by selecting its name in the “Dashboards” menu located in the banner.

2.4 Modifying Custom Dashboards

A custom dashboard created as described in the previous chapter may be modified at any time by selecting it and then clicking on the Edit dashboard button located in the page banner.

The custom dashboard then enters the editing mode. Modify the dashboard as described above then click on the Save changes button to store the new configuration.

2.5 Available Graphical Components

This section introduces each available graphical (web) component.

2.5.1 Tweets Filter

The *Tweets Filter* component (see Figure 15) is used to filter collected tweets (stored in the EOPEN Platform) based on various search criteria. It is meant to be used jointly with the *Tweets List* component as all the tweets selected using this filter will be automatically displayed in the list.

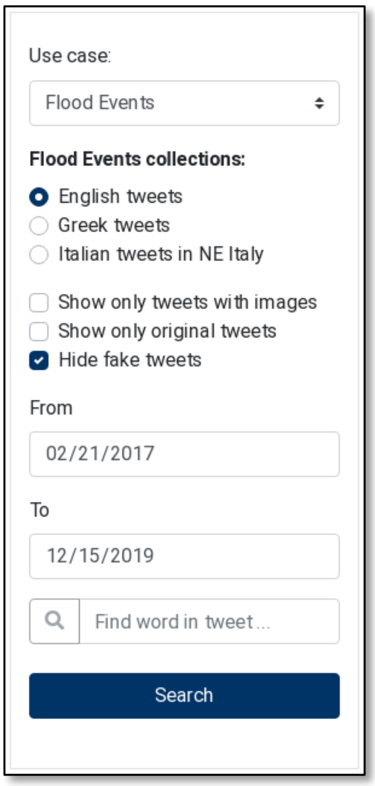
Note: This component is present in the *Social Media* system dashboard (see section 2.2.2).

The tweets are filtered based on the pilot use case, their language, a date range and optionally on a word that must appear in the tweet message.

In addition, switches allow filtering out the tweets that do not include an image, have been re-tweeted (i.e. they are not original), or which are considered as fake by the integrated fake tweets detector.

Clicking on either the start or the end date reveals a calendar in which a new date may be selected.

Click on the "Search" button to submit the filter and update the tweets in the *Tweets List* component described in the following section.


Use case:

Flood Events

Flood Events collections:

- [✓ English tweets]
- Greek tweets
- Italian tweets in NE Italy

- Show only tweets with images
- Show only original tweets
- [✓ Hide fake tweets]

From

02/21/2017

To

12/15/2019

Find word in tweet ...

Figure 15 – Tweets Filter showing search criteria

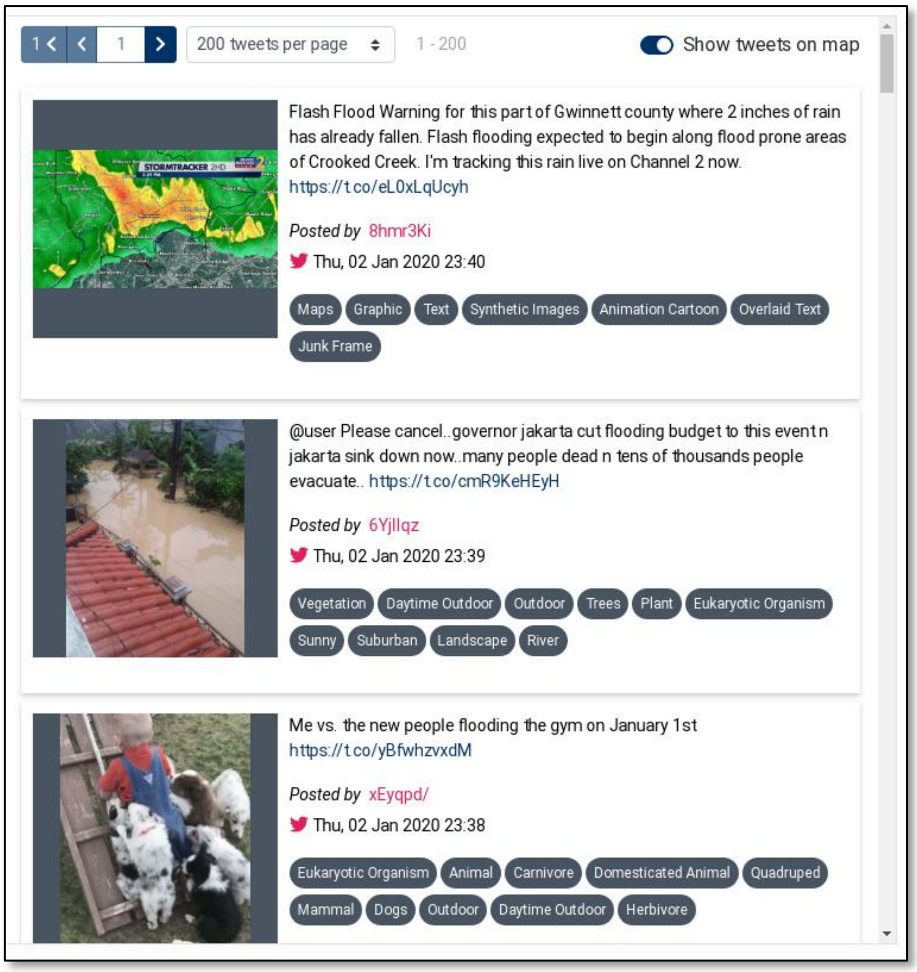
2.5.2 Tweets List

The *Tweets List* component (see Figure 16) displays tweets fetched from the EOPEN Platform. When combined with the *Tweets Filter* component, it displays the tweets matching the selection criteria.

Note: This component is present in the *Social Media* system dashboard (see section 2.2.2).

The *Tweets List* component displays the tweets in a paginated list. Controls located at the top allow selecting the size of each page (between 50 and 500 entries) and navigating between the pages.

A switch allows visualising the tweets on the *Map (Leaflet)* component if this is included in the same dashboard.


1 < | < | 1 | > | 200 tweets per page | 1 - 200 | Show tweets on map

Flash Flood Warning for this part of Gwinnett county where 2 inches of rain has already fallen. Flash flooding expected to begin along flood prone areas of Crooked Creek. I'm tracking this rain live on Channel 2 now. https://t.co/eL0xLqUcyh

Posted by 8hmr3Ki

Thu, 02 Jan 2020 23:40

Maps | Graphic | Text | Synthetic Images | Animation Cartoon | Overlaid Text | Junk Frame

@user Please cancel..governor jakarta cut flooding budget to this event n jakarta sink down now..many people dead n tens of thousands people evacuate.. https://t.co/cmR9KeHEyH

Posted by 6Yjllqz

Thu, 02 Jan 2020 23:39

Vegetation | Daytime Outdoor | Outdoor | Trees | Plant | Eukaryotic Organism | Sunny | Suburban | Landscape | River

Me vs. the new people flooding the gym on January 1st https://t.co/yBfwhzvxdM

Posted by xEyqpd/

Thu, 02 Jan 2020 23:38

Eukaryotic Organism | Animal | Carnivore | Domesticated Animal | Quadruped | Mammal | Dogs | Outdoor | Daytime Outdoor | Herbivore

Figure 16 – Tweets List showing matching tweets

2.5.3 Map (Leaflet)

The *Map (Leaflet)* component displays an interactive map (implemented with the **Leaflet** JavaScript library). It may be used to display simple features on a map.

Currently, only the *Tweets List* component makes use of the *Map (Leaflet)* component to display markers corresponding to the tweets estimated location. Clicking on a marker reveals the tweet message in a popup box.

Note: This component is present in the *Social Media* system dashboard (see section 2.2.2).

2.5.4 Topics Filter

Topics here are defined as groups of social media posts (i.e. tweets) that refer to a specific incident, subject, etc. and are produced by text clustering techniques. The *Topics Filter* component is used to select on which tweets collection topic detection will be performed and it is meant to be used jointly with the *Topics List* and *Topic Tweets List* components.

Topics Filter is a simple form where the user is able to first select the use case of interest and then the collection of interest. By clicking the Get recent topics button, a service searches for trending topics in the 400 most recent tweets of the selected collection and the detected topics are displayed on the *Topics List* component.

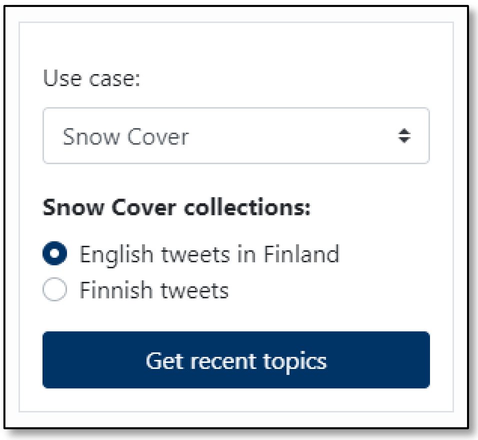


Figure 17 – Topics Filter

Note: Search for topics in Korean tweets about food security is omitted because their special characters cannot be handled yet.

2.5.5 Topics List

The *Topics List* component visualizes the trending topics in the tweets that are collected for the pilot use cases of EOPEN. When the search for topics, which can be triggered by the *Topics Filter* component, is completed, each of the detected clusters is presented as a word cloud, i.e. an illustration of the most mentioned terms per topic, where their frequency is shown with font size. Every time a word cloud is clicked, the complete set of tweets that are contained in the corresponding topic appear in the *Topic Tweets List* component.

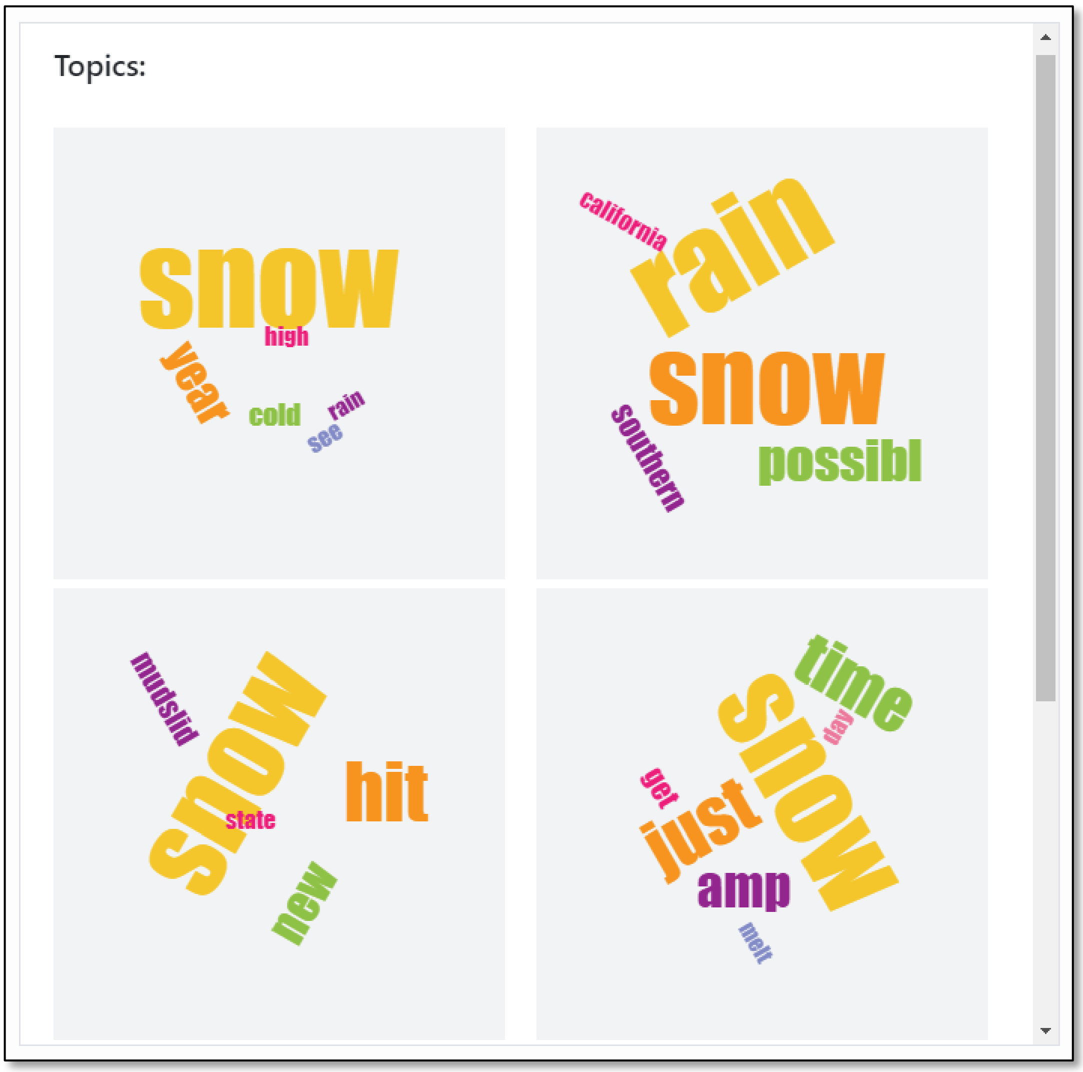
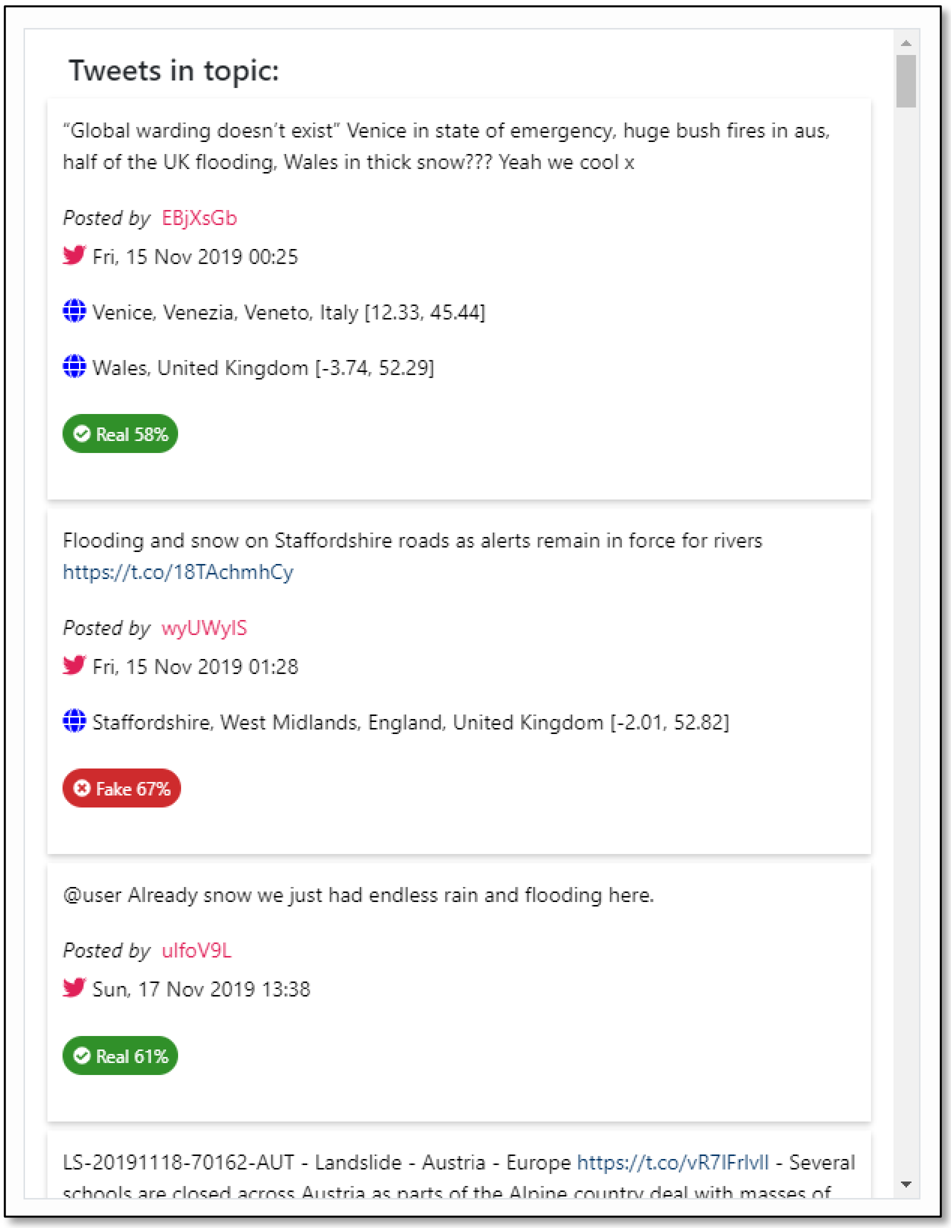


Figure 18 – Topics List

2.5.6 Topic Tweets List

The *Topic Tweets List* component resembles the *Tweets List* component (see section 2.5.2) but contains only the posts of a specific topic. When a word cloud from the *Topics List* component (section 2.5.5) is clicked, then the *Topic Tweets List* is refreshed to display the tweets that the selected topic comprises.


Tweets in topic:

"Global warding doesn't exist" Venice in state of emergency, huge bush fires in aus, half of the UK flooding, Wales in thick snow??? Yeah we cool x

Posted by EBjXsGb

Fri, 15 Nov 2019 00:25

Venice, Venezia, Veneto, Italy [12.33, 45.44]

Wales, United Kingdom [-3.74, 52.29]

Real 58%

Flooding and snow on Staffordshire roads as alerts remain in force for rivers https://t.co/18TAchmhCy

Posted by wyUWylS

Fri, 15 Nov 2019 01:28

Staffordshire, West Midlands, England, United Kingdom [-2.01, 52.82]

Fake 67%

@user Already snow we just had endless rain and flooding here.

Posted by ulfoV9L

Sun, 17 Nov 2019 13:38

Real 61%

LS-20191118-70162-AUT - Landslide - Austria - Europe https://t.co/vR7IFrlvll - Several schools are closed across Austria as parts of the Alpine country deal with masses of

Figure 19 – Topic Tweets List

2.5.7 Weather Data Example (Mockup)

The *Weather Data Example* component contains an interactive chart that displays static data. It is provided for information purpose as this component (or a variation of it) could be used in the future to display historical and near real-time data available in the EOPEN Platform.

The mockup displays weather data, as shown on Figure 20, below.

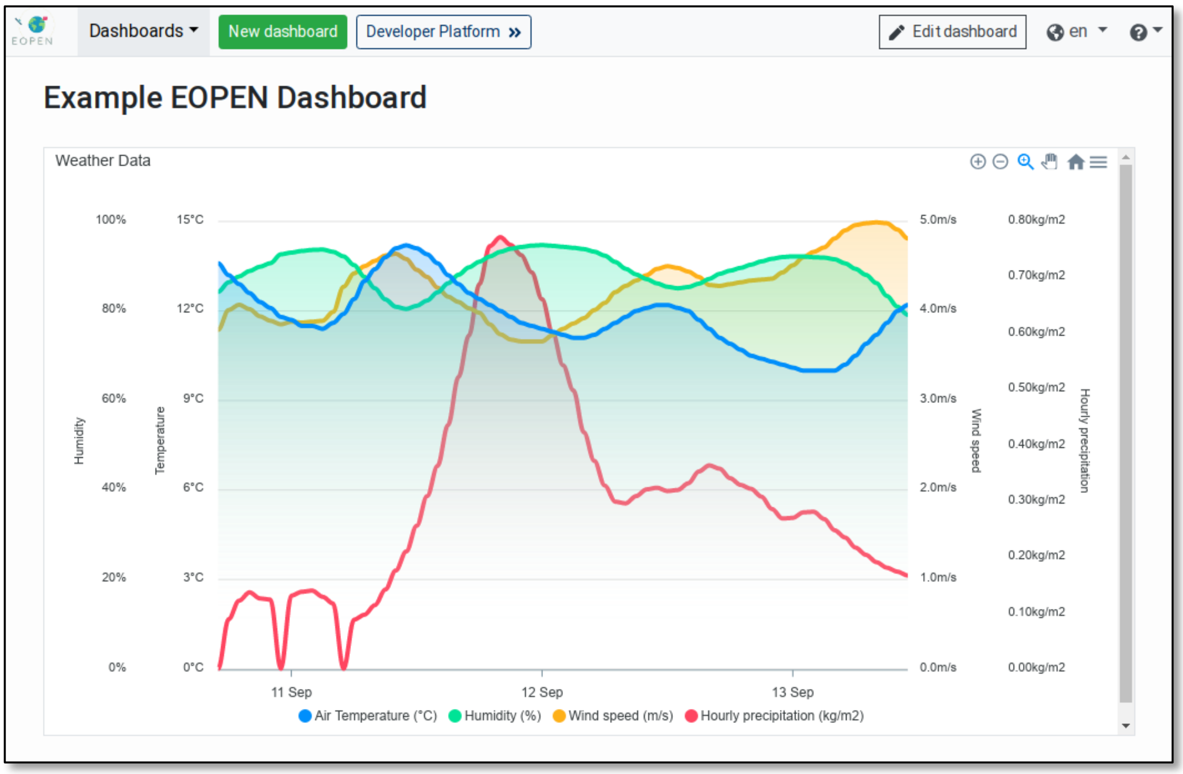


Figure 20 – Example Weather Data (Mockup)

PART B.   EOPEN Developer Guide

Abstract

This document is the Application Developer Guide of the EOPEN Platform. Its purpose is to describe the various features supported by the EOPEN Platform and made accessible to the authenticated developer users through a standard Web browser. Each feature is described individually in a dedicated section.

Guidelines are also included to help developers create algorithms and applications.

Code examples included in this Application Developer Guide are written in the Python 2 scripting language as this is the version still used in the Second EOPEN Prototype. The Final EOPEN Platform will support Python 3 and the examples will be updated accordingly in D6.5 “Final system and interactive visualisations”.

Annexes include a glossary of the main terms as well as an inventory of the EOPEN modules available in the Second EOPEN Prototype (D6.4).

The content of this document is part of the result of the work performed on T6.2 "EOPEN System Integration".

History of PART B

Version	Date	Reason	Revised by	Approved By
1.0	13-Jan-2020	First release	Authors	Leslie Gale
1.1	27-May-2020	Second period review comments	Authors	Leslie Gale

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Executive Summary of Part B

This document is the Developer Guide of the EOPEN Platform. Its purpose is to describe the various features supported by the EOPEN Platform and made accessible to the authenticated developer users, either through a standard Web browser, or an FTP client.

To access the EOPEN Developer Portal navigate to the home page of the Second EOPEN Integrated Prototype (https://proto2.eopen.spaceapplications.com) and click on the Click here to access the Developer Platform button:

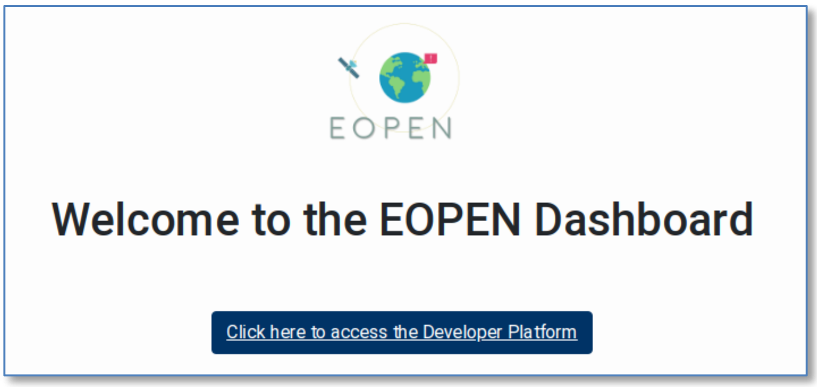

EOPEN
Welcome to the EOPEN Dashboard
Click here to access the Developer Platform

Figure 21 – EOPEN Portal Home Page (Fragment)

Note: Credentials for authenticating in the EOPEN Developer Portal are created upon request.

The document describes each individual feature in a dedicated section. An end-to-end scenario is also included which indicates the logical sequencing of the usage of the features, from the off-line preparation of custom algorithms to the execution of workflows and the retrieval of the generated outputs.

This document focuses on the interfaces and the features available to developer users, not platform administrators.

Document Structure:

- Chapter 1 introduces the EOPEN Application Lifecycle and describes a typical end-to-end usage scenario that covers all the steps that must be executed to develop a custom algorithm, import the algorithm in the Platform and integrate it in a workflow, execute the workflow and access the results.
- Chapter 2 provides a detailed description of each feature implemented in the Platform. Section 2.1 includes a site map which depicts how each feature is accessed in the Web interface and how the user may navigate between them.
- **Error! Reference source not found.** provides the definition of the terms and concepts sed in the EOPEN Platform.
- Appendix B contains the inventory of the EOPEN modules integrated in the First EOPEN Prototype. Concretely, modules may have been implemented as processes, services or workflows, depending on their needs.
- Appendix C instructs on how SNAP graphs designed, tested and exported using the SNAP Graph Builder tool (integrated in the SNAP Desktop application) must be

transformed into parameterised graphs that may be executed using the command-line Graph Processing Tool (GPT). This operation is necessary to allow deploying and executing SNAP graphs within the Platform.

- Algorithms not implemented in Python 2 must be executed similarly, that is using a Python script to trigger the execution of a process using a system call. This applies for example to Python 3, R, Java, and binaries (e.g. compiled C/C++ and Go).
- Appendix D gives example algorithms implemented in Python 2 that permit to execute various processes in the EOPEN Platform.

Main Changes against the First EOPEN Integrated Prototype Platform:

- The Processor and Workflow concepts have been merged in favour of Workflow. This removes the ambiguity that existed between a resource type (Processor) and its definition (Workflow).
- A user who creates a Process or a Workflow is automatically registered as its owner. By default, Processes and Workflows are only visible and may only be managed by their owner.
- The Workspace and user Role concepts have been introduced to allow sharing resources, including Processes and Workflows. The fundamental rule is that a particular resource is only visible by the users who are given a role in one of the workspace the resource belongs to. To share a resource, a user who has the right to do so assigns that resource to one or more workspaces.
- The management of the users and their roles in the workspaces is under the responsibility of the platform administrators. This is thus not covered by the current document as it focuses on the features provided to the process and workflow developers.

Abbreviations and Acronyms

AOI	Area of Interest
API	Application Programming Interface
ASB	Automated Service Builder
EO	Earth Observation
EOPEN	opEn interOperable Platform for unified access and analysis of Earth observatioN data
ESA	European Space Agency
FSM	Full Strip-Map
FTP	File Transfer Protocol
GDAL	Geospatial Data Abstraction Library
GPT	Graph Processing Tool
GUI	Graphical User Interface
HTTP	Hyper-Text Transfer Protocol
JSON	JavaScript Object Notation
OGC	Open Geospatial Consortium
S1, S2, S3	Sentinel-1, Sentinel-2, Sentinel-3
SNAP	Sentinel Application Platform
SpaceApps	Space Applications Services
VM	Virtual Machine
WFS	Web Feature Service
WMS	Web Map Service
WPS	Web Processing Service

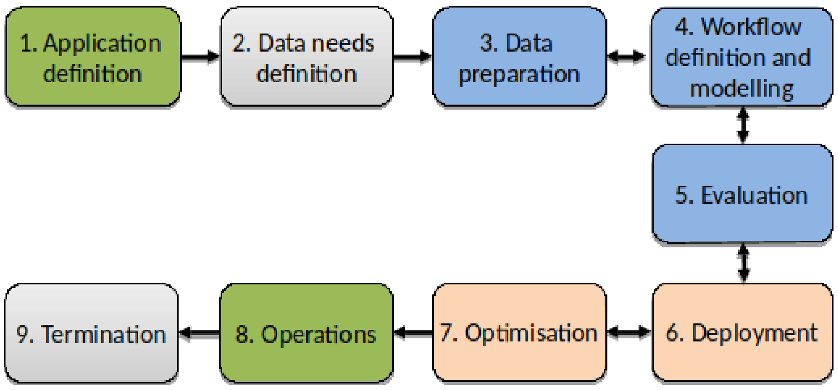
1 INTRODUCTION

The EOPEN Platform is a tailored and customized version of the ASB framework. Available features include the possibility to upload custom algorithms, to integrate these algorithms within new workflows, and to run the workflows in a distributed environment.

This chapter introduces the successive steps to be followed from the local offline development of an algorithm to the retrieval of the generated outputs from the Cloud environment.

1.1 The EOPEN Application Lifecycle

Initially defined as the use case life cycle in the proposal, the application lifecycle depicts the steps to create an operational application (service). It comprises the following steps:



1. Application definition;
2. Data needs definition;
3. Data preparation;
4. Workflow definition and process modelling;
5. Evaluation (Verification and Validation);
6. Deployment;
7. Optimisation;
8. Operations;
9. Termination.

Figure 22 – EOPEN Application Lifecycle

Steps 1 to 5 are performed to establish the concept and validate the models and verify the concept achieves the goals of the application. With respect to the EOPEN platform these are most often performed offline to EOPEN with the developers working on PCs and local servers using example data sets. These activities can however influence the eventual deployment of the concept to create an operational service. For instance the data may only be available on certain platforms, or by choice processing should be performed on a platform where the data is hosted to avoid excessive transfers of data.

Once the concept is verified and validated Steps 4 to 6 are performed using the EOPEN Platform. In general an application will comprise one or more algorithms organised in a workflow. The developer imports the algorithms into the EOPEN platform and using the designed workflow configures the imported algorithms using the workflow editor.

Some terminology is unavoidable. To avoid discussions on what is an application, what is a process ..., the following terminology is used:

- **Process** – A Process is a Dockerised **Algorithm**. A Process definition includes a name, description, and version, as well as (typed) input and output parameters, and software and hardware dependencies. The typed inputs and outputs allow ensuring the compatibility of the parameters inter-connected in the workflows. The EOPEN Developer Platform comes with a Process Import Tool that automates the packaging and the registration of custom processes in the system.

- **Workflow –** A Workflow implements a application by specifying the processes that must be executed together with their inter-connections (data flow). The EOPEN Developer Platform includes a graphical Workflow Editor for creating workflows interactively, e.g. selecting the appropriate processes and connecting parameters with drag-&-drop. Workflows may be executed on-demand, scheduled or externally triggered. The platform automatically generates the parameterization forms that allow giving values to unconnected input parameters. EOPEN includes interfaces for monitoring and control, reporting and data access.

Additional concept definitions are provided in **Error! Reference source not found.** of this ocument.

Step 6, Deployment, is fully automated.

Initially Step 7, Optimisation, is not performed. It may also not be necessary prior to transferring to operation if no performance issue is detected. However should performance be an issue, or a shift to HPC is considered for instance then some re-organisation of the workflow may be needed. Another example is the use of SNAP. Experience shows that by breaking down a SNAP graph into sub-graphs leads to a substantial increase in performance. A developer may choose to do this right from the start, or after confirming the application is performing as expected.

Step 8, Operations, is in most cases performed in multiple stages. The first execution of the user application, execution of the *Workflow*, will be performed to reverify and revalidate the application. Once this is completed then the application is ready for operations.

Step 9, Termination, is performed to end the use of the application with the eventual off-line archiving of the results (output products). In the case of an EOPEN application this will follow the principles set out in the Data Management Plan.

1.2 End-to-End Usage Scenario

This section explains the steps that an application developer follows to make an application operational on the EOPEN platform. To perform the tasks EOPEN provides a Web-based user interface which is described in details in the next chapter. The table below introduces each step and refers to the detailed descriptions.

Lifecycle Step	**EOPEN Platform**
Steps 1 to 5 – Concept Phase	**Application Concept Development** The EOPEN platform does not restrict the application developer in their choice of programming language, toolbox or libraries. Examples of the implementation can be a Python script using the GDAL for processing satellite imagery which can be tested on a local machine, or a SNAP graph edited and executed using the Graph Builder included in the SNAP Desktop application. When the application is considered ready, it may be imported in the framework.

Steps 4 to 8 – Pre-operational	**Importing the developed algorithms** Developed algorithms must be imported in the framework using the Process Import Tool. This is a three steps process, as further described in section 2.5.7: • Generation of a process wrapper template. • Local editing of the template to bind with the developed algorithm. • Import of the edited process wrapper together with the process files. **Configuring a new workflow** Imported processes must be integrated in the workflow of pre-existing or new workflows before being executed. To do so, the Workflow Editor is used to create and edit workflows, integrating and inter-connecting processes in a graphical manner (see section 2.6). Conclusion of the pre-operational phase is the execution of the workflow as described in Step 8 – Operational.
Step 8 – Operational	**Executing the workflow** A workflow may be executed on-demand, through the Service web interface. If the workflow has unconnected inputs, these are used to automatically generate a parameterization form, as described in section 2.6.4. Alternatively, the platform proposes to schedule the differed execution of the selected workflow. A form allows configuring a single deferred execution or multiple executions triggered at regular interval or on specific days in the month. The scheduler pages and controls are described in section 2.6.5. **Monitoring the workflow execution and accessing the results** Workflow executions are displayed in two pages: the Recent Executions page and the Execution History page. The first page displays the recent (started in the last 24 hours) and the on-going executions. The second page displays all the completed executions without age limit. See section 2.6.6. After the successful execution of a workflow, an Execution Report becomes available. This includes the execution metadata, the user-specified input parameters (bounding box, time range, scene identifiers, and other specific input values), the list of outputs and generated product files, and if available quicklooks of the output product. The page also includes the graphical representation of the workflow graph and a Gantt chart showing the times at which each task in the workflow has been executed. See section 2.6.7.

2 THE EOPEN DEVELOPER PORTAL

This chapter describes the user interface of the EOPEN Platform for the application developers. Next section gives an overview of the available pages and the principal navigation links. The remaining of the chapter describes the pages, the operations and the related Platform behaviour.

2.1 Site Map

Figure 1, above, shows the structure of the Platform user interface. Each box represents a Web page and the arrows show the navigation between the pages. Not all navigation links are represented, however. For example, logging out on any of these pages redirects the user to the EOPEN Developer Portal Home Page (grey box on the left).

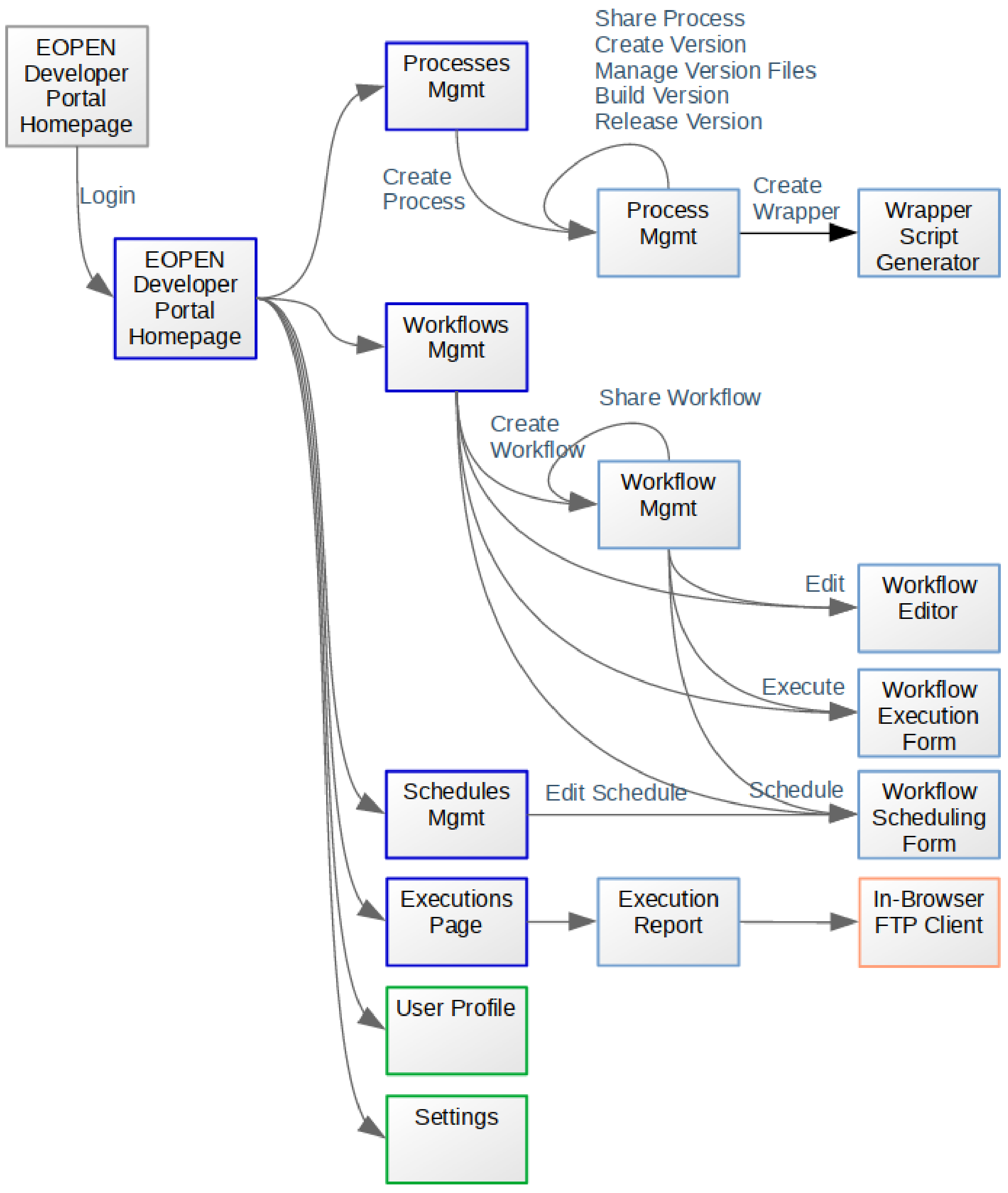
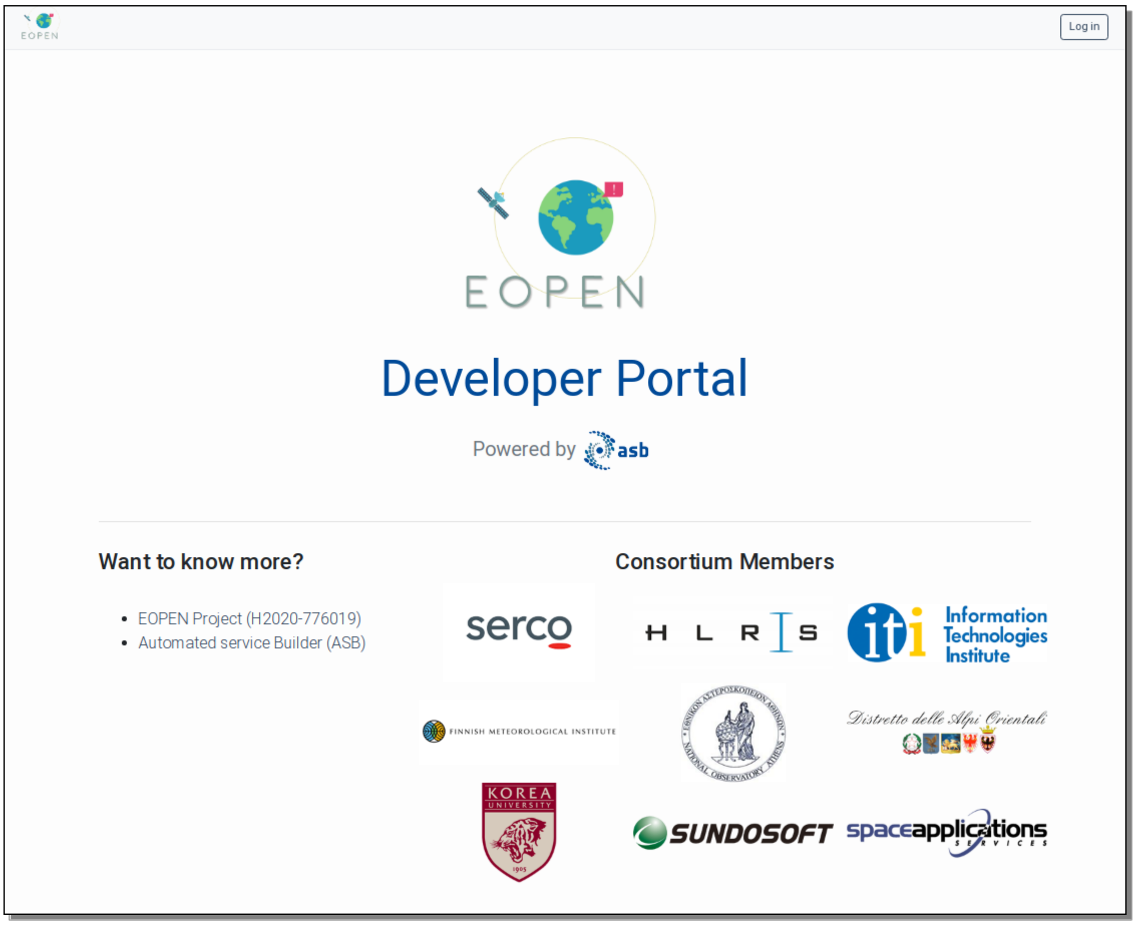


Figure 23 – EOPEN Developer Portal Site Map

2.2 Home Page

The EOPEN Developer Portal Home Page (https://proto2.eopen.spaceapplications.com) is the only page accessible to non-authenticated users. The page body informs about the EOPEN project and the Automated Service Builder (ASB) framework on which the EOPEN Platform is built. It shows in its banner a link for logging-in.



Want to know more?

- EOPEN Project (H2020-776019)
- Automated service Builder (ASB)

Consortium Members

Figure 24 – Home Page for Non-Authenticated Users

Click on the Log in link to open the User Authentication Form.

2.3 User Authentication

The User Authentication Form is displayed when the Log in link located in the page banner is clicked. The form lets you enter your name and password. The Go back to the home page link allows aborting the login process and navigating back to the EOPEN Developer Platform Home Page.

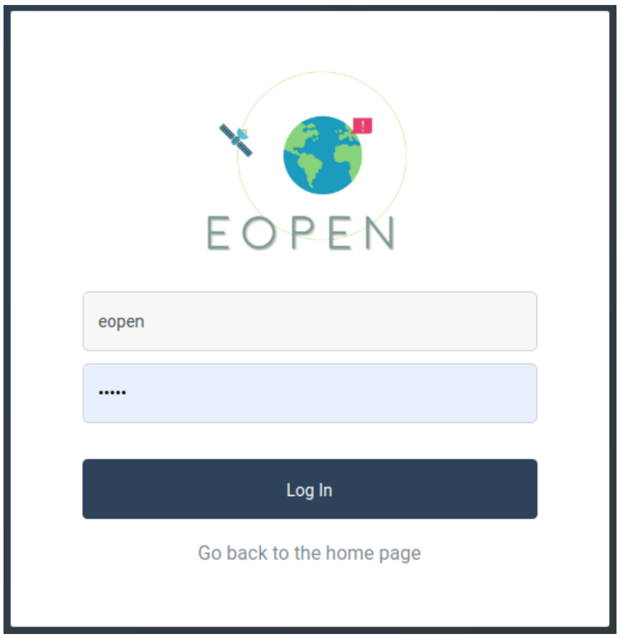


Figure 25 – User Authentication Form

After a successful authentication, the browser is redirected to the EOPEN User Portal. Click on the Developer Portal button to navigate back to the Developer Portal.

2.4 Header Panel

Once authenticated, the top part of the Web pages is extended with links and menus that give access to the different features of the platform:

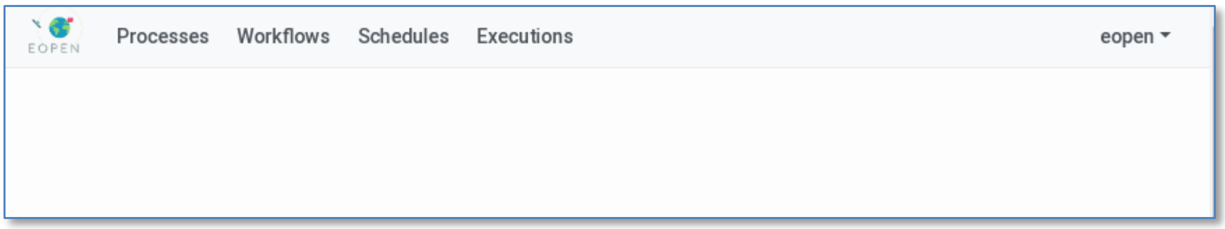


Figure 26 – Header Panel

The header panel provides the following elements:

Label / Icon	Target	Section
The EOPEN icon	EOPEN Developer Portal home page	2.2
Processes	Processes Management pages	2.5
Workflows	Workflows Management pages	2.6
Schedules	Schedules Management pages	2.6.5
Executions	Executions Inspection pages	2.6.6

Label / Icon	Target	Section
<user-name>	Menu with the following entries: • Your Profile • Settings • Logout	

2.5 Processes Management

2.5.1 Process Development Lifecycle

A Process, and more specifically a Process Version, is a single unit of execution. Custom processes and versions may be added in the platform by the developers by executing the following steps, depicted on Figure 27 – Process Development Lifecycle, below:

1. Create a process in the platform (section 2.5.3).

   This is an initialisation step required to declare the process and start working on it.

2. Create a new process version (section 2.5.4).

   Initially, a process version has no implementation files. These must be uploaded in a following step. Concretely, it means the process version may not be built and released yet. Its status is "Unreleased".

3. Generate and prepare a process wrapper script (section 2.5.5).

   A process wrapper script acts as an adapter between the service interface that will allow executing the process remotely and the process implementation files. This step is not represented in Figure 27.

4. Upload the wrapper script and the process implementation files (section 2.5.6).

   This is an interactive step. Files can be added and overwritten until all the files required to implement the process have been uploaded. As long as no valid wrapper script (whose name must be `process_wrapper.py`) has been uploaded the status of the process version remains "Unreleased". As soon as a valid wrapper script has been uploaded, the status changes to "Buildable".

   Note: Importing and testing processes in the EOPEN platform is not as straightforward as executing a Python script offline, on a local system. It is thus advised, in order to same time, to test new algorithms locally before importing them in the platform. Ideally the test should involve the wrapper script as well. This is further described in section 2.5.10.1.

5. Build the process version (section 2.5.7).

   At this step, the process version implementation files are packaged and tested and a dry-run of import is performed. This step is important to determine if the uploaded files can be compiled and loaded to start serving a processing service.

   If the build is not successful, new implementation files may be added or replaced before trying a new build.

   If the build is successful, the status of the process version becomes "Releasable". At this point, it is still possible to add or replace the implementation files.

6. Release the process version (section 2.5.8).

7. At this step, a build is performed again and the resulting package is registered in the platform as an executable process. From this point, the status of the process version becomes “Release” and no changes may be applied to the implementation files anymore. The process version may be selected and integrated in Workflows (see Workflows Management in section 2.6, page 60).

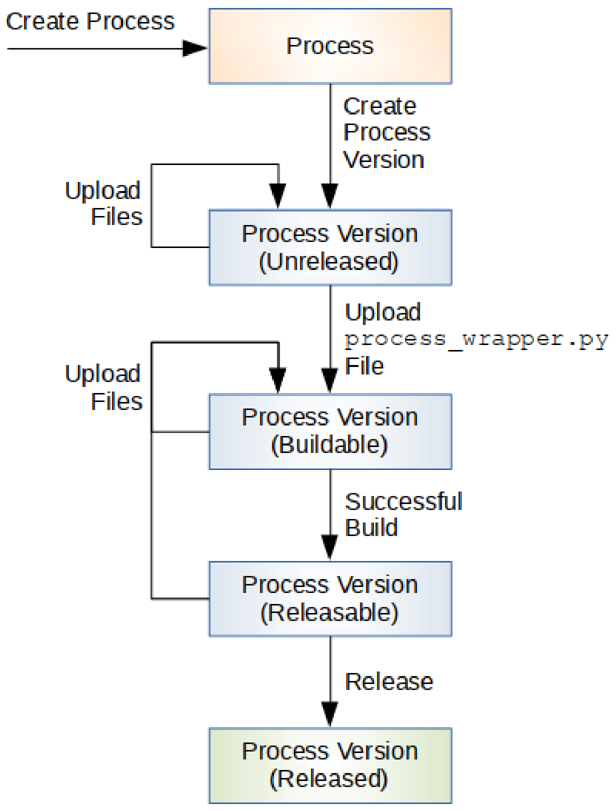

Create Process
Process
Create Process Version
Upload Files
Process Version (Unreleased)
Upload process_wrapper.py File
Upload Files
Process Version (Buildable)
Successful Build
Process Version (Releasable)
Release
Process Version (Released)

Figure 27 – Process Development Lifecycle

At any time a process may be shared (with all its existing and future versions) with other platform users by adding it to one or more workspaces. Instructions to do so are provided in section 2.5.9.

The following sections further describe each of the process management tasks.

2.5.2 Processes Management Page

The Processes Management Page, titled **Processes**, gives access to the tools for creating, configuring and sharing processes.

As can be seen on Figure 28, the page contains the following elements:

- A table of existing processes (accessible by the authenticated user).
- Each process is prefixed with the name of its owner that is the user who has created it. Different user names may be present in the list as processes can be shared among users (see section 2.5.9).
- A field for applying a textual filter on the table
- A New process button for creating a new process

Click on a process name to navigate to the Process Management Page as described in the next section.

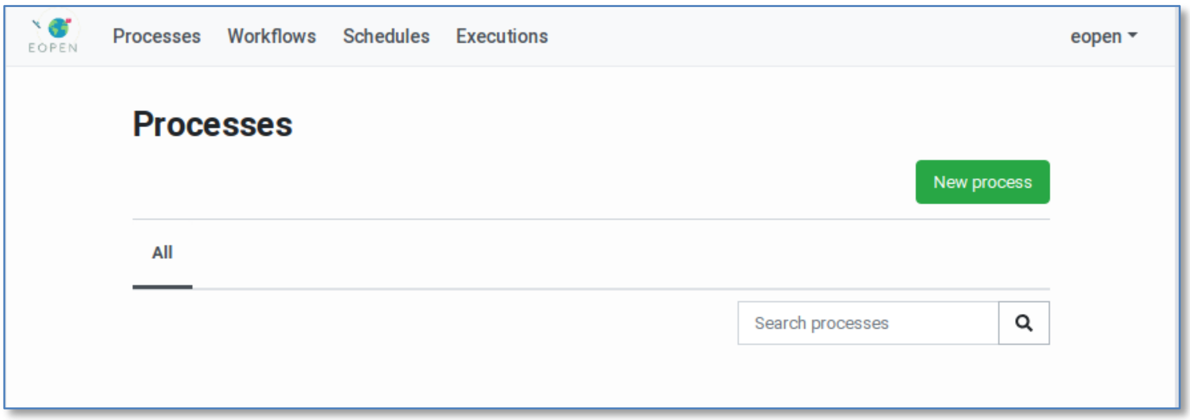


Figure 28 – Processes Management Page

2.5.3 Creation of a New Process

Clicking on the New process button reveals a popup dialog box which asks for the name of the new process (see Figure 29). The process name is a free text that will be used to identify the process in the user interface. At the same time the name is entered, a "slugified" version of it is generated automatically and displayed in a second input field. It is in principle not necessary to edit this generated identifier but should it be necessary, care must be taken to enter an identifier that only contains lowercase characters, dashes and digits.

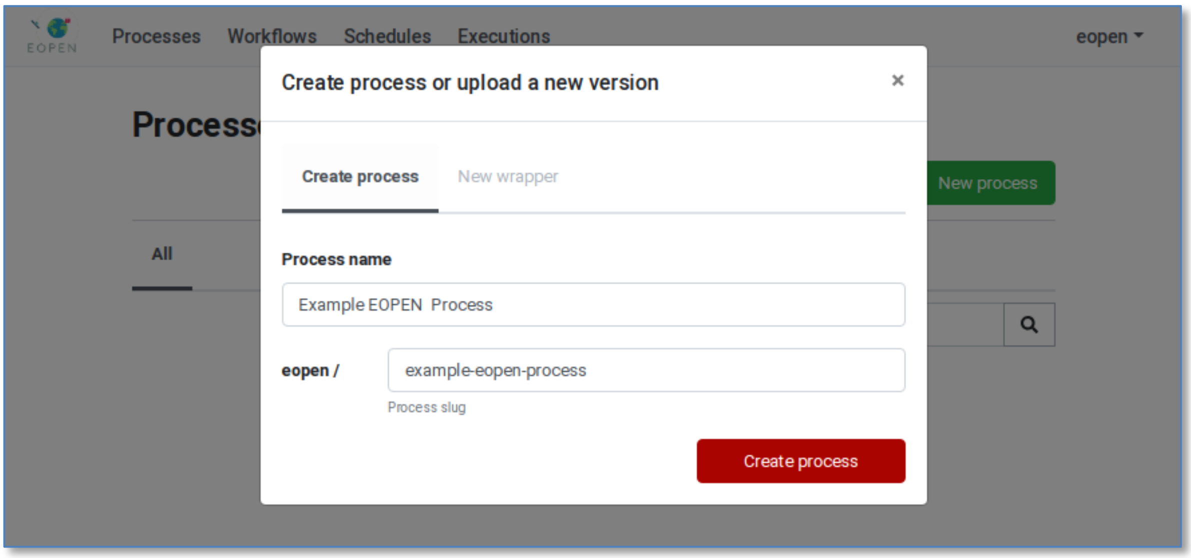


Figure 29 – Creation of a new Process

Enter valid values then click on the Create process button to create the process. You are automatically redirected to the Process Management Page:

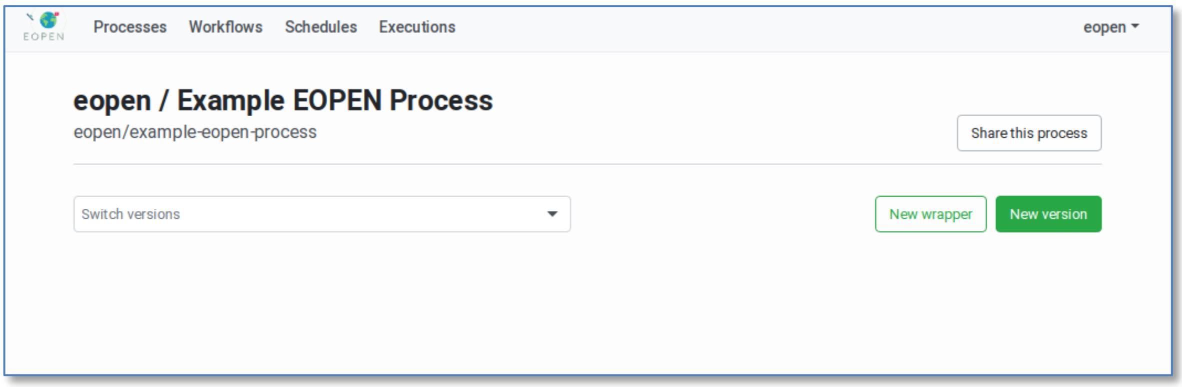


Figure 30 – Process Management Page

On the screen, the process name is always prefixed with the name of its owner.

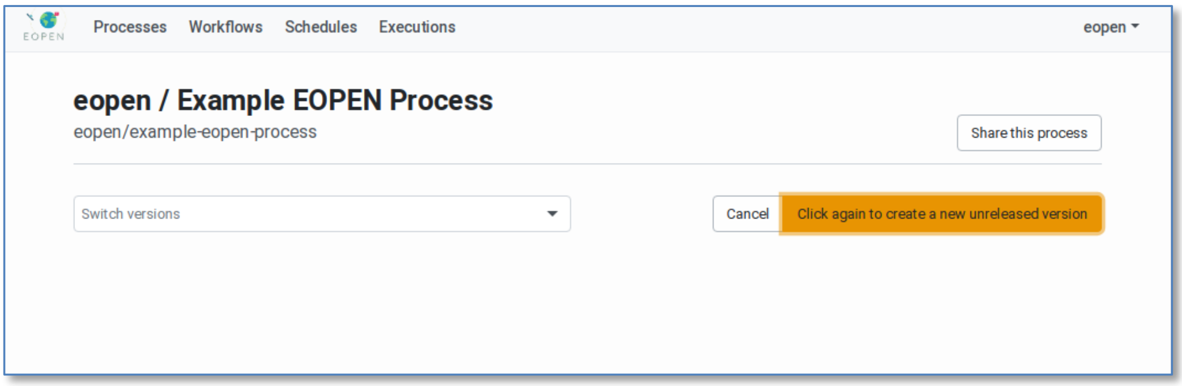
The Process Management Page also contains the following elements:

- A Share this process button for configuring in which workspaces the process should be accessible (see section 2.5.9).
- A New wrapper button for generating a process wrapper script (see section 2.5.5).
- A New version button for creating a new version of the process (see section 2.5.4).
- The currently associated workspaces (not displayed if the process is not shared)
- A drop-down list with the existing process versions. Selecting a version in the list reveals information about the version as well as buttons for managing that version, as will be explained in the next section.

2.5.4 Creation of a new Process Version

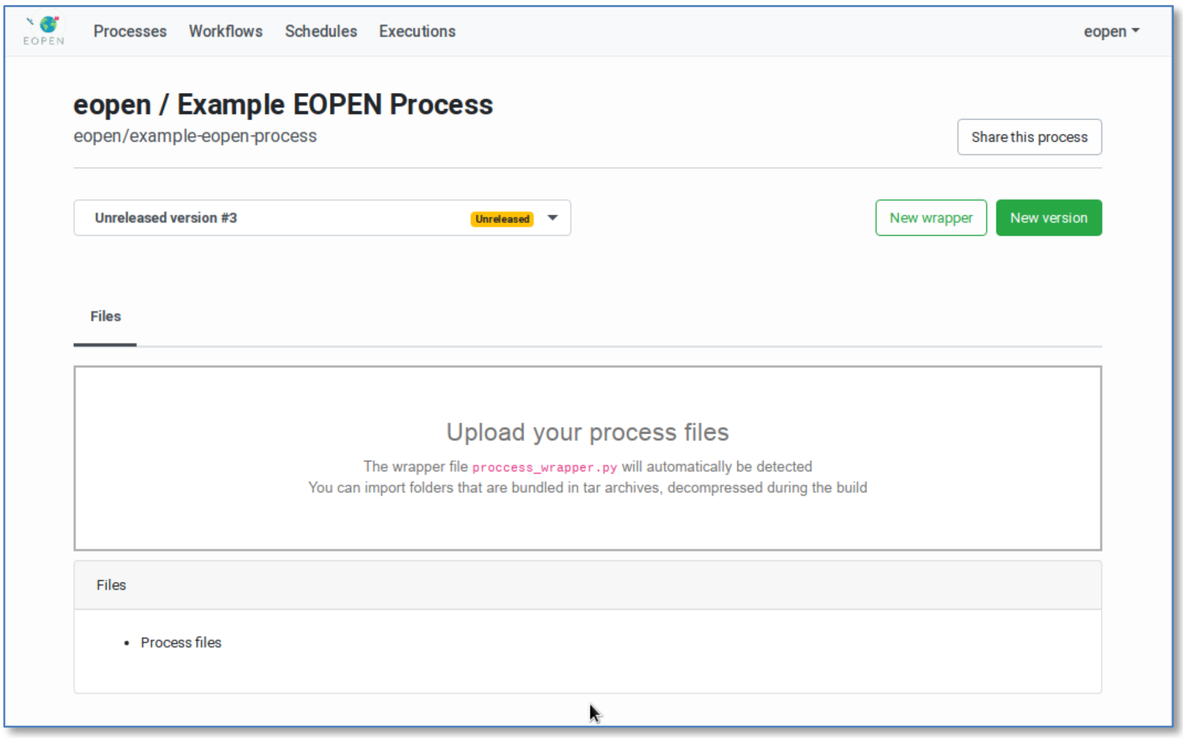
In order to create a new process version, navigate to the related Process Management Page. The page includes the list of existing Process Versions in a drop-down list and a New version button. Click on this button once reveals a Click again … button. Click on it to confirm and start working on a new process version.

As shown on Figure 32, the process version has the status “Unreleased”. The page now shows an area for uploading the process version implementation files. Its usage is described in section 2.5.6.



EOPEN
Processes
Workflows
Schedules
Executions
eopen
eopen / Example EOPEN Process
eopen/example-eopen-process
Share this process
Switch versions
Cancel
Click again to create a new unreleased version

Figure 31 – Process Management Page with New Version Confirmation Button



The wrapper file proccess_wrapper.py will automatically be detected
You can import folders that are bundled in tar archives, decompressed during the build

Figure 32 – Process Management Page with Selected Version

2.5.5 Generation of a Process Wrapper Script

For each process version to be imported in the platform, it is necessary to generate a corresponding process wrapper script. This script acts as an adapter between the platform and the actual process implementation.

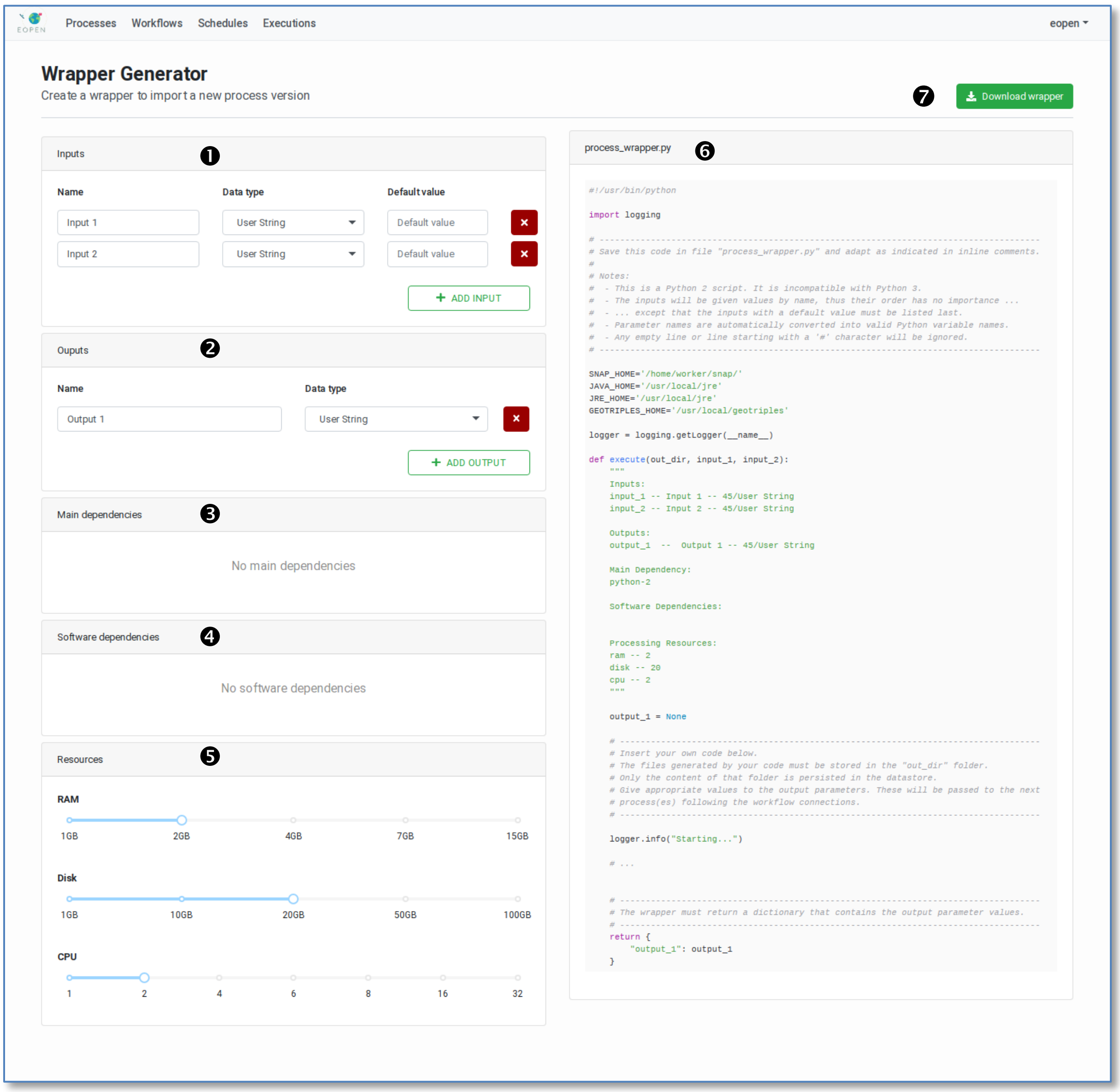
The creation of a wrapper script is facilitated by the Process Wrapper Script Generation page which may be accessed by selecting a particular process version and clicking on the New wrapper button.

The page, represented on Figure 33, allows generating a preliminary version of the script. This must be downloaded and edited locally to include the call to the process algorithm (or to include the algorithm itself). The input parameters received by the wrapper function must be passed to the algorithm and the algorithm outputs must be returned by the wrapper function.

Passing the input and output parameters must be performed in the appropriate manner, that is, according to the rules of the Python language.

The Process Wrapper Script Generation page is divided in two parts:

- The left panel is occupied by a form that allows configuring the process. In particular, it allows declaring the list of input and output parameters, the software dependencies and the hardware dependencies.
- The right panel contains the generated wrapper script. This is dynamically updated each time a modification is applied in the form on the left. For example, when a new input parameter is added in the form, this is inserted as an input to the `execute` functions, and when a new output parameter is added, a corresponding variable is created and initialised in the function, and included in the returned dictionary.



Name	Data type	Default value
Input 1	User String	Default value
Input 2	User String	Default value

Name	Data type
Output 1	User String

No main dependencies

No software dependencies

RAM: 1GB, 2GB, 4GB, 7GB, 15GB

Disk: 1GB, 10GB, 20GB, 50GB, 100GB

CPU: 1, 2, 4, 6, 8, 16, 32

```python
#!/usr/bin/python

import logging

# ---------------------------------------------------------------------------------------
# Save this code in file "process_wrapper.py" and adapt as indicated in inline comments.
#
# Notes:
#  - This is a Python 2 script. It is incompatible with Python 3.
#  - The inputs will be given values by name, thus their order has no importance ...
#  - ... except that the inputs with a default value must be listed last.
#  - Parameter names are automatically converted into valid Python variable names.
#  - Any empty line or line starting with a '#' character will be ignored.
# ---------------------------------------------------------------------------------------

SNAP_HOME='/home/worker/snap/'
JAVA_HOME='/usr/local/jre'
JRE_HOME='/usr/local/jre'
GEOTRIPLES_HOME='/usr/local/geotriples'

logger = logging.getLogger(__name__)

def execute(out_dir, input_1, input_2):
    """
    Inputs:
    input_1 -- Input 1 -- 45/User String
    input_2 -- Input 2 -- 45/User String

    Outputs:
    output_1  --  Output 1 -- 45/User String

    Main Dependency:
    python-2

    Software Dependencies:


    Processing Resources:
    ram -- 2
    disk -- 20
    cpu -- 2
    """

    output_1 = None

    # ------------------------------------------------------------------------------------
    # Insert your own code below.
    # The files generated by your code must be stored in the "out_dir" folder.
    # Only the content of that folder is persisted in the datastore.
    # Give appropriate values to the output parameters. These will be passed to the next
    # process(es) following the workflow connections.
    # ------------------------------------------------------------------------------------

    logger.info("Starting...")

    # ...


    # ------------------------------------------------------------------------------------
    # The wrapper must return a dictionary that contains the output parameter values.
    # ------------------------------------------------------------------------------------
    return {
        "output_1": output_1
    }
```

Figure 33 – Process Wrapper Script Generation Page

The Process Wrapper Script Generator page displays the following elements:

❶	Definition of the input parameters. Click on the ADD INPUT button to declare a new input parameter. Give a name and optionally a default value to each input in the list and associate them to a data type.
❷	Definition of the output parameters. Click on the ADD OUTPUT button to declare a new output parameter. Give a name to each output in the list and associate them to a data type.
❸	Select in this panel the main software product required to run the algorithm. For example, select "R Interpreter and Libraries" if at least part of the algorithm is implemented in the R scripting language, or select "SNAP + Sentinel Toolbox v7.0" if the algorithm makes use of the SNAP command line tools (including GPT and Snappy).
❹	Select here the additional software packages your algorithm depends on. Python 2 is install by default in all process Docker images. Several entries may be selected but, for example, it doesn't really make sense to install more than one version of the Java runtime environment. The selected packages will be installed in the process Docker image at import time. The amount of selected dependencies thus impacts the time required to build these images.
❺	Indicate here the minimum amount of hardware resources required to run the process. The process will not be deployed and executed in a node that has less than the required resources available. If more resources than required are available (e.g. 4 CPUs required but 8 available), the process will have the possibility to use them.
❻	The right half of the page shows the dynamically generated process wrapper template. This is updated automatically when new values are entered or selected in the form on the left.
❼	The Download wrapper button triggers a download of the process wrapper template. This is named "**`process_wrapper.py`**" by default. Depending on the Web browser configuration, the download happens automatically or the target location is asked at first.

Enter the necessary information in the form then click on Download wrapper to save the generated process wrapper template next to your algorithm files (if any).

Important: The name of the file (**`process_wrapper.py`**) must be preserved otherwise it will not be recognized as a wrapper script at import time.

Edit the "`process_wrapper.py`" file and add within the "`execute`" function the Python 2 code that takes the function input values, run your algorithm, and returns the execution results. If the code of the algorithm is short enough, it may be directly integrated within the "`execute`" function.

When this is done, the algorithm files and the "`process_wrapper.py`" file should be tested locally (see section 2.5.10.1) then uploaded in the platform. These operations are described in the next sections.

2.5.6 Upload of the Process Version Implementation Files

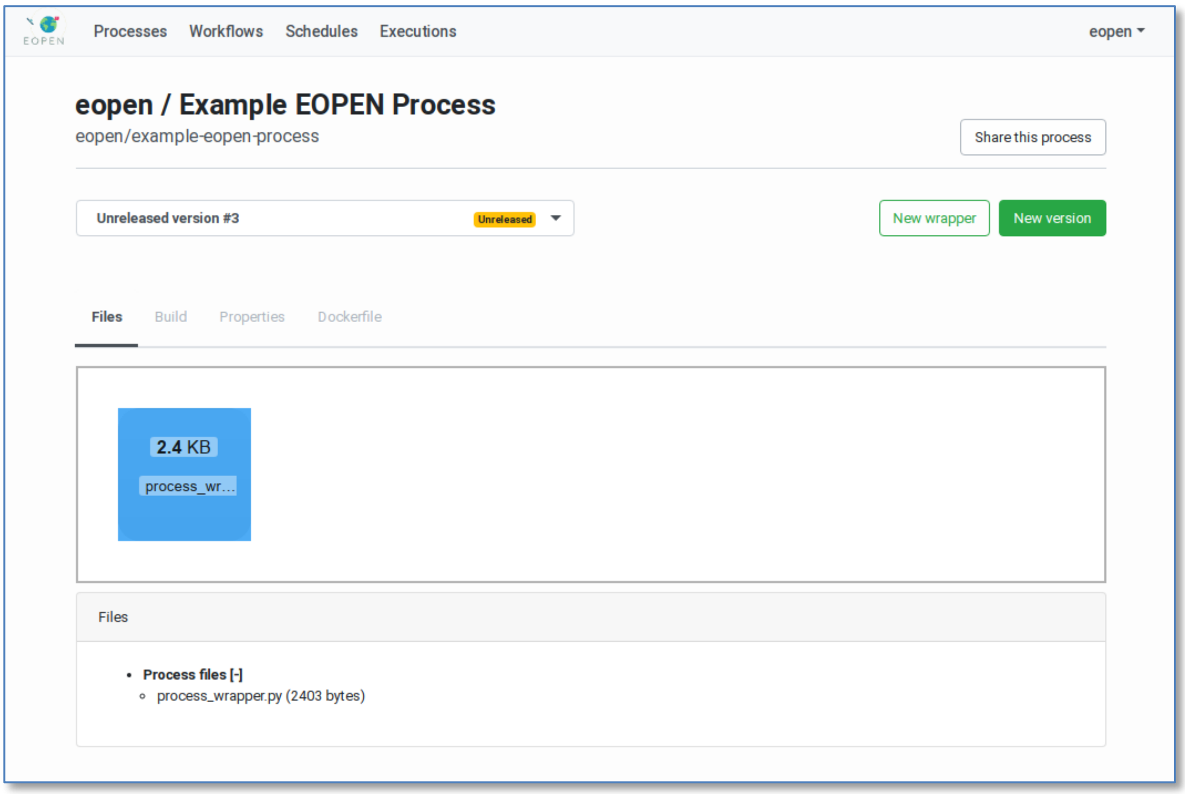
When a process version is selected in the Process Management Page the page displays a panel titled “Files” (see Figure 32). The panel contains a "drop-off" zone that allows to drag and drop the process version implementation files directly on the page. Alternatively, clicking on the zone opens a dialog box that allows navigating and selecting the files to upload.

Each time one or more files are dropped or selected for upload, these are sent to the server where they are analysed. If one of these files is named `process_wrapper.py` and contains a process wrapper script, this is parsed and the process properties extracted. A Docker image build file (Dockerfile) is generated using this information.

Note: Several files, organised in a folder hierarchy may be uploaded as well. Instructions to do so are provided in section 2.5.10.9.

When a valid `process_wrapper.py` file is uploaded, possibly with additional implementation files, new tabs become available:

- Build: Use this tab to package the files and release the process version in the platform as explained in sections 2.5.7 and 2.5.8 (Figure 35).
- Properties: Use this tab to visualise the process version metadata (encoded in JSON) as extracted from the `process_wrapper.py` file (Figure 36).
- Dockerfile: Use this tab to inspect the Dockerfile generated according to the process properties and more specifically the software dependencies (Figure 37).



eopen / Example EOPEN Process

eopen/example-eopen-process

Unreleased version #3 Unreleased

Files

- Process files [-]
  - process_wrapper.py (2403 bytes)

Figure 34 – Process Version showing the uploaded files

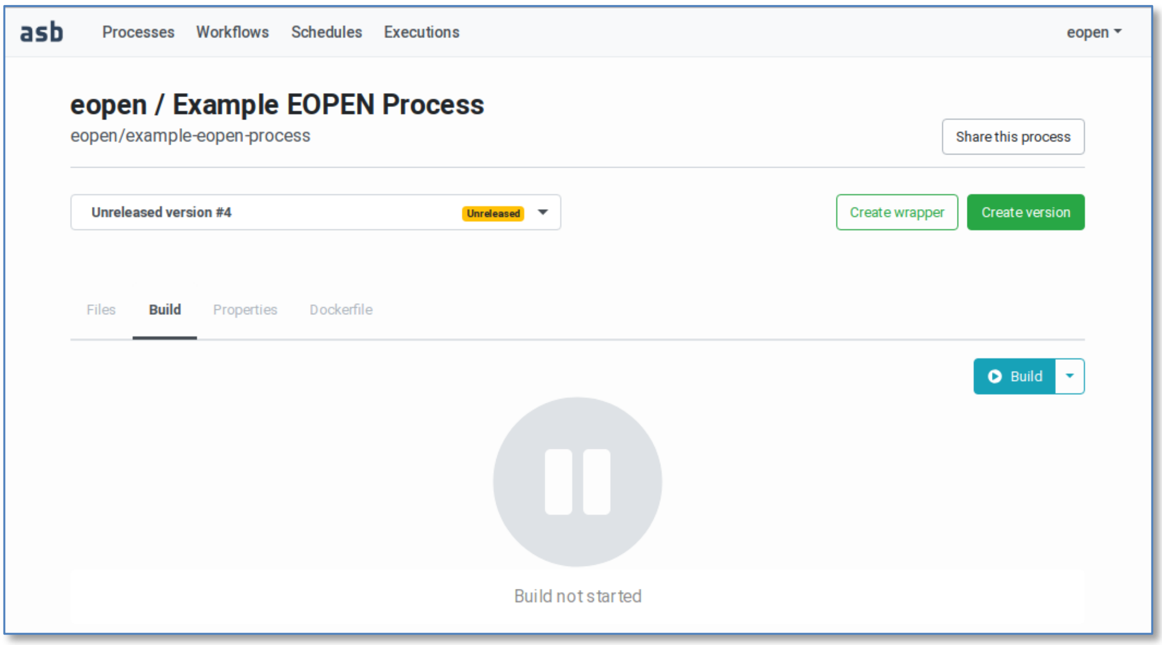
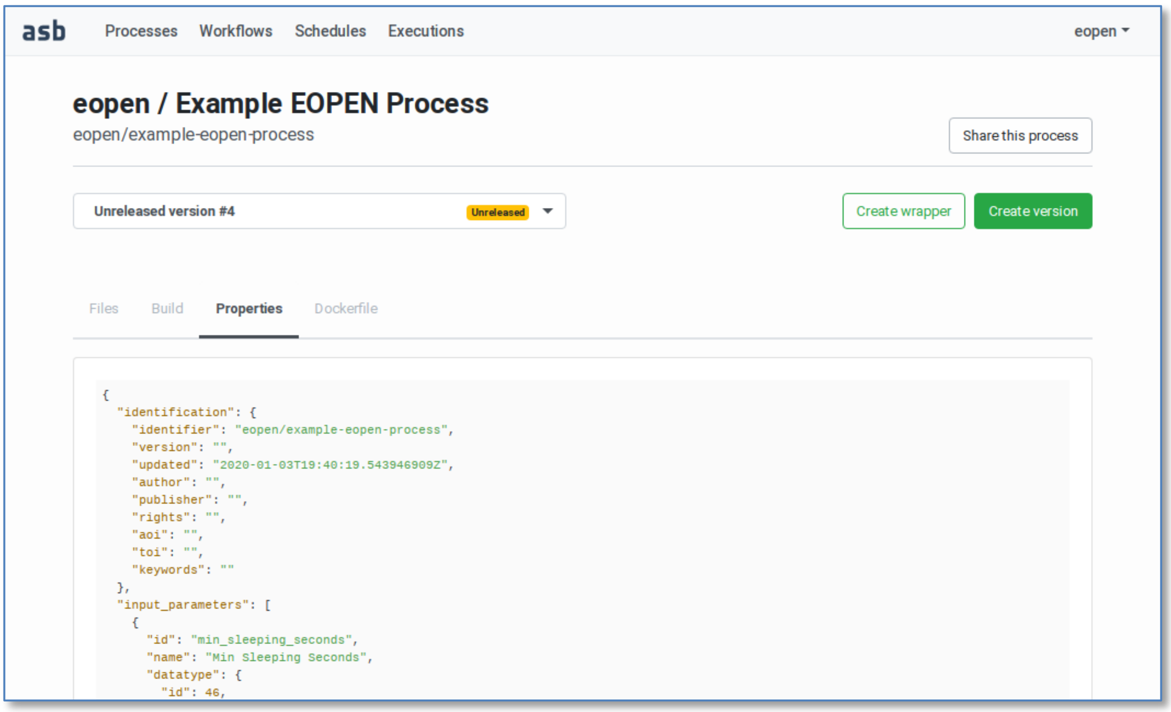
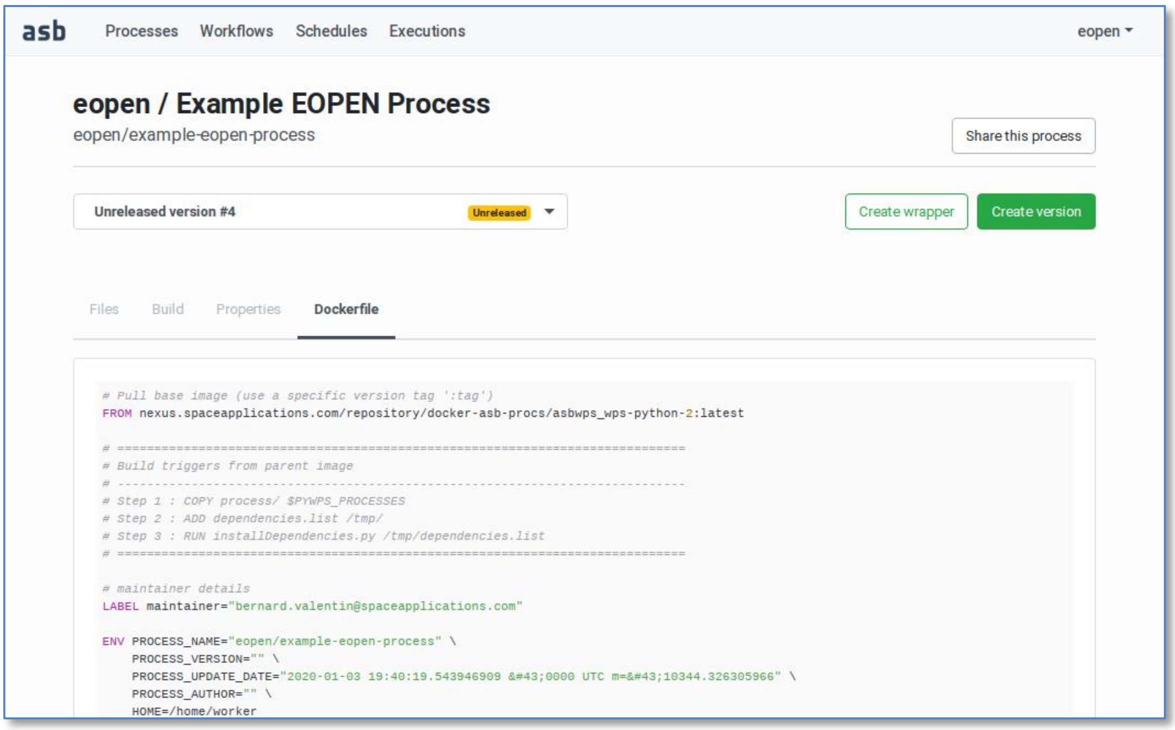


Figure 35 – Process Version showing the Build panel



```
{
  "identification": {
    "identifier": "eopen/example-eopen-process",
    "version": "",
    "updated": "2020-01-03T19:40:19.543946909Z",
    "author": "",
    "publisher": "",
    "rights": "",
    "aoi": "",
    "toi": "",
    "keywords": ""
  },
  "input_parameters": [
    {
      "id": "min_sleeping_seconds",
      "name": "Min Sleeping Seconds",
      "datatype": {
        "id": 46,
```

Figure 36 – Process Version showing the process properties (truncated)



```
# Pull base image (use a specific version tag ':tag')
FROM nexus.spaceapplications.com/repository/docker-asb-procs/asbwps_wps-python-2:latest

# ===========================================================================
# Build triggers from parent image
# ---------------------------------------------------------------------------
# Step 1 : COPY process/ $PYWPS_PROCESSES
# Step 2 : ADD dependencies.list /tmp/
# Step 3 : RUN installDependencies.py /tmp/dependencies.list
# ===========================================================================

# maintainer details
LABEL maintainer="bernard.valentin@spaceapplications.com"

ENV PROCESS_NAME="eopen/example-eopen-process" \
    PROCESS_VERSION="" \
    PROCESS_UPDATE_DATE="2020-01-03 19:40:19.543946909 &#43;0000 UTC m=&#43;10344.326305966" \
    PROCESS_AUTHOR="" \
    HOME=/home/worker
```

Figure 37 – Process Version showing the generated Dockerfile (truncated)

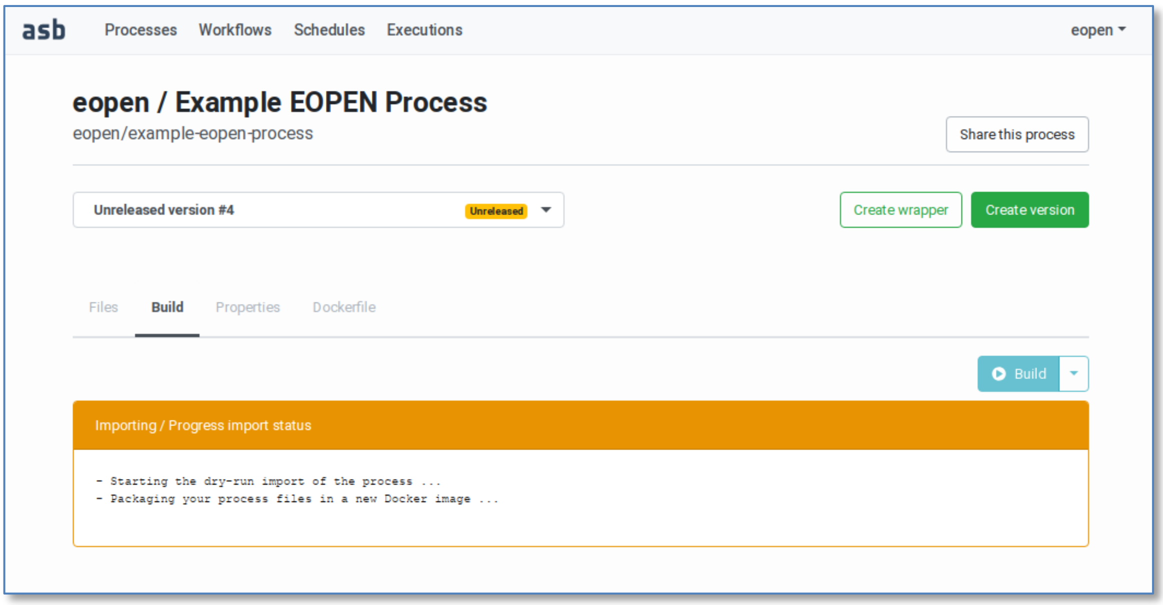
2.5.7 Building the Process Version

To build a new process version, navigate to the related Process Management page, select the version to build in the drop-down list then click on the “Build” tab. The build panel is then displayed as shown on Figure 35.

Note that this tab is only accessible if a valid process wrapper script has been uploaded, as explained above.

The “Build” tab contains a Build button. Clicking on it starts a build and a release dry-run. As can be seen on Figure 38, the page displays messages that inform about the progress of the dry-run steps. The messages are pushed from the server to the browser and thus appear automatically in real-time.

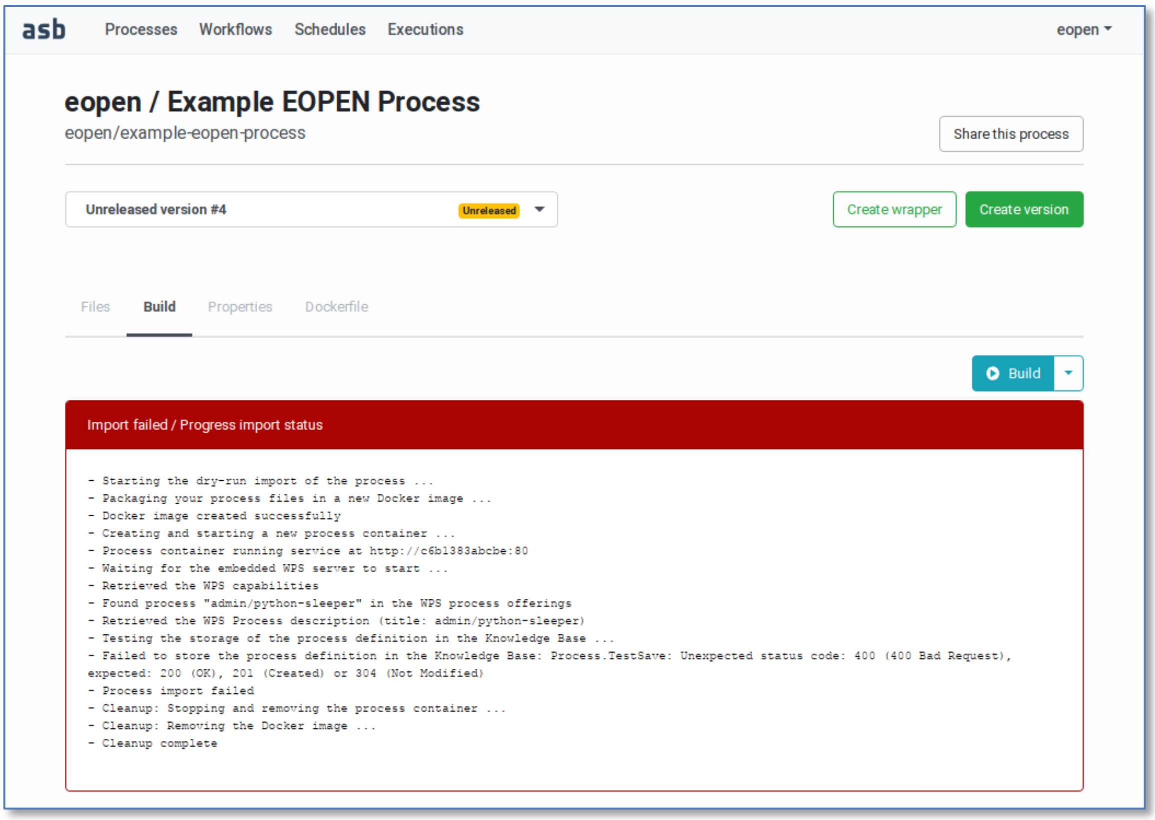
The build operations may take some time, varying with the amount of software dependencies selected in the Process Wrapper Script Generation page. Each additional software dependency represents one or more installation operations to be added in the build script of the target Docker image.



```
- Starting the dry-run import of the process ...
- Packaging your process files in a new Docker image ...
```

Figure 38 – Building a Process Version (on-going build)

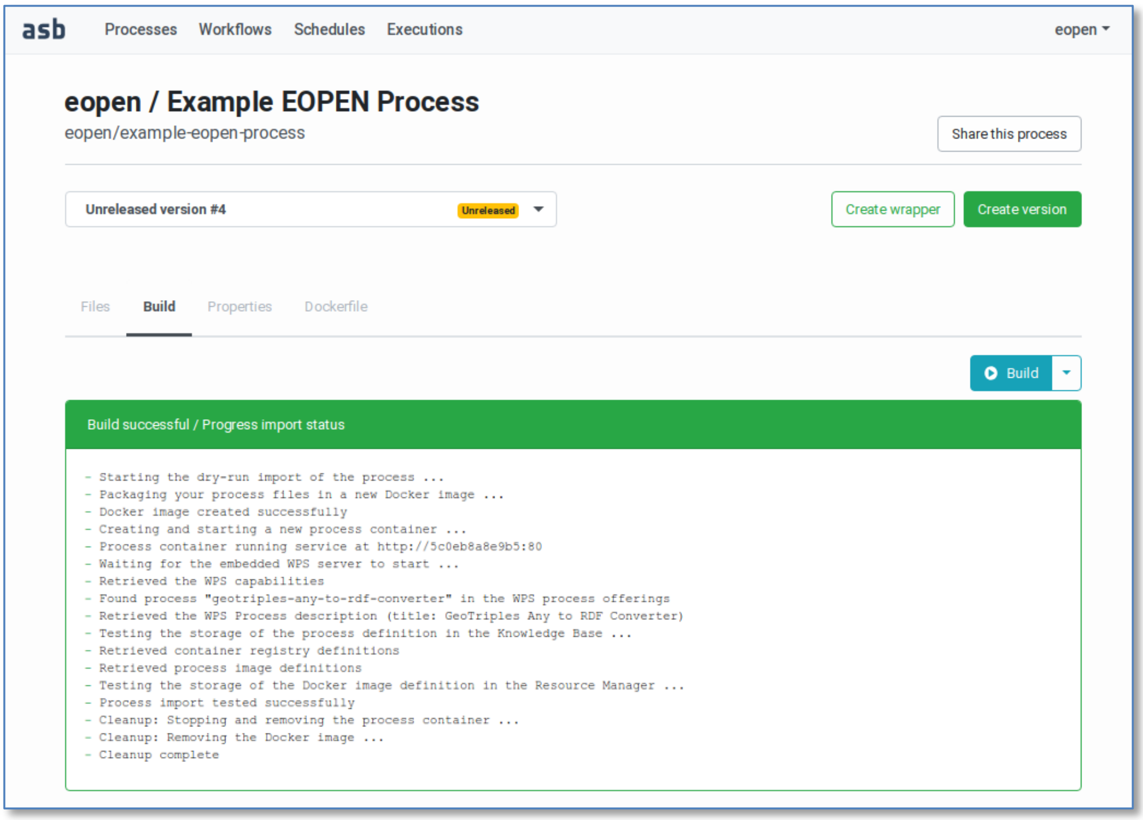
If the build or the release dry-run fails, the panel turns red and a description of the error is displayed, as shown on Figure 39:



```
- Starting the dry-run import of the process ...
- Packaging your process files in a new Docker image ...
- Docker image created successfully
- Creating and starting a new process container ...
- Process container running service at http://c6b1383abcbe:80
- Waiting for the embedded WPS server to start ...
- Retrieved the WPS capabilities
- Found process "admin/python-sleeper" in the WPS process offerings
- Retrieved the WPS Process description (title: admin/python-sleeper)
- Testing the storage of the process definition in the Knowledge Base ...
- Failed to store the process definition in the Knowledge Base: Process.TestSave: Unexpected status code: 400 (400 Bad Request),
expected: 200 (OK), 201 (Created) or 304 (Not Modified)
- Process import failed
- Cleanup: Stopping and removing the process container ...
- Cleanup: Removing the Docker image ...
- Cleanup complete
```

Figure 39 – Building a Process Version (failed build)

If the dry-run import is successful, a green panel is displayed, as shown on Figure 40:



```
- Starting the dry-run import of the process ...
- Packaging your process files in a new Docker image ...
- Docker image created successfully
- Creating and starting a new process container ...
- Process container running service at http://5c0eb8a8e9b5:80
- Waiting for the embedded WPS server to start ...
- Retrieved the WPS capabilities
- Found process "geotriples-any-to-rdf-converter" in the WPS process offerings
- Retrieved the WPS Process description (title: GeoTriples Any to RDF Converter)
- Testing the storage of the process definition in the Knowledge Base ...
- Retrieved container registry definitions
- Retrieved process image definitions
- Testing the storage of the Docker image definition in the Resource Manager ...
- Process import tested successfully
- Cleanup: Stopping and removing the process container ...
- Cleanup: Removing the Docker image ...
- Cleanup complete
```

Figure 40 – Building a Process Version (successful build)

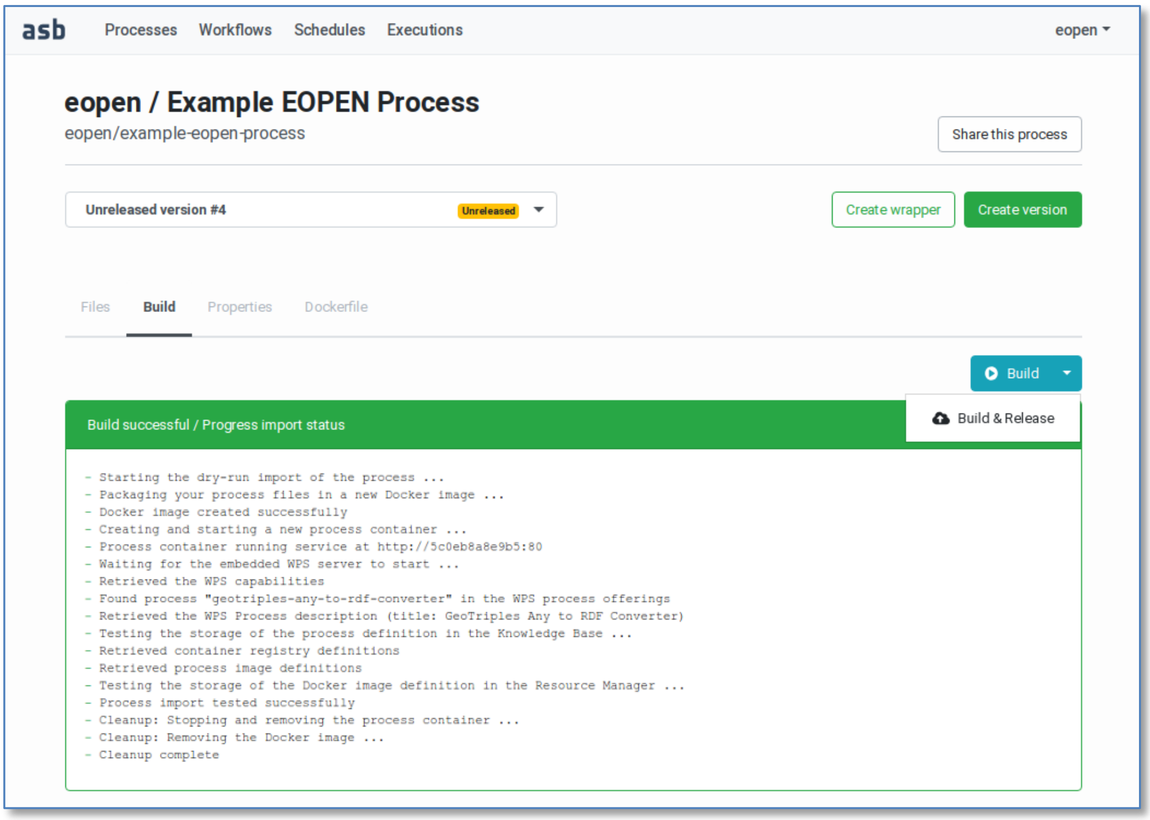
Upon successful build, the status of the Process Version changes from “Buildable” to “Releasable”. This means the Process Version and its implementation files are ready to be imported in the platform and be integrated in Workflows.

2.5.8 Releasing a Process Version

A process version with a valid wrapper script and which successfully passed the build and release dry-run is “Releasable”. At this time, it is still possible to upload new implementation files (or new versions of existing implementation files). Doing so “downgrades” the process version status back to “Buildable” as a new dry-run is necessary to ensure the process version and its implementation files are valid.

To release a new process version, navigate to the related Process Management page, select the version to release in the drop-down list then click on the “Build” tab.

The “Build” tab contains a Build button and an associated menu, as shown on Figure 41. Expand the menu and select the Build & Release entry. A build is started again and if successful the process version is imported and registered in the platform. Its status becomes “Released” and from now on it is not possible anymore to modify its implementation files.



```
- Starting the dry-run import of the process ...
- Packaging your process files in a new Docker image ...
- Docker image created successfully
- Creating and starting a new process container ...
- Process container running service at http://5c0eb8a8e9b5:80
- Waiting for the embedded WPS server to start ...
- Retrieved the WPS capabilities
- Found process "geotriples-any-to-rdf-converter" in the WPS process offerings
- Retrieved the WPS Process description (title: GeoTriples Any to RDF Converter)
- Testing the storage of the process definition in the Knowledge Base ...
- Retrieved container registry definitions
- Retrieved process image definitions
- Testing the storage of the Docker image definition in the Resource Manager ...
- Process import tested successfully
- Cleanup: Stopping and removing the process container ...
- Cleanup: Removing the Docker image ...
- Cleanup complete
```

Figure 41 – Releasing a Process Version

Once release, a process version may be selected and integrated in processing Workflows, as described in section 2.6.2, below.

2.5.9 Process Sharing

By default, a Process is only visible and usable by its owner, that is, the user who created it.

In order to share a Process with other platform users, this must be added in a workspace accessible by these users (that is, a workspace in which they have a role).

In the following example, user “eopen” wants to share his Process “Example EOPEN Process” with the users who are given access to workspace “EOPEN”.

As can be seen on Figure 42, the process is not yet assigned to any workspace. To do this, click on the Share the process button. A popup dialog box appears. This allows selecting the workspace(s) the process must be assigned to. Workspaces must be selected in a drop-down list. Once selected, a workspace may be removed by clicking on its “X” icon. The sequence of operations is depicted in Figure 43.

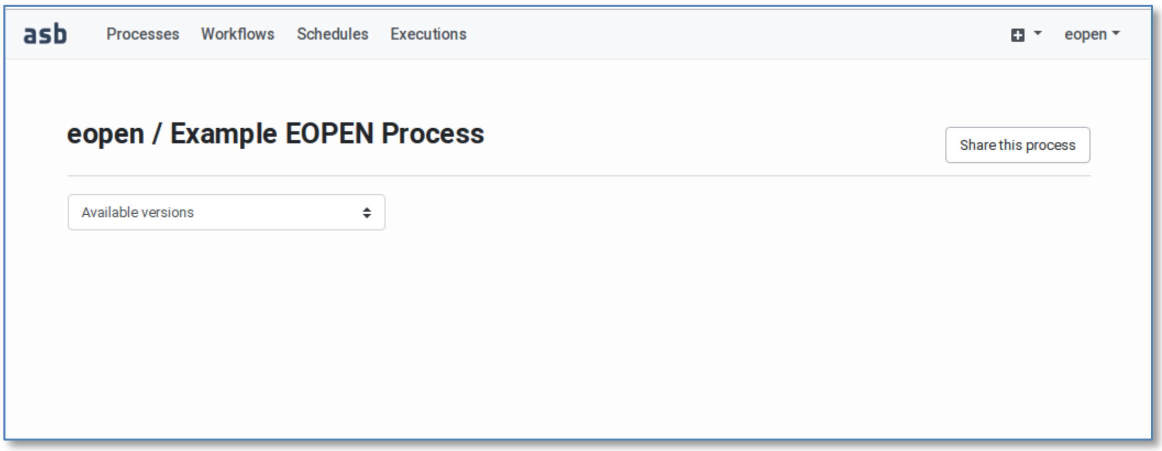


Figure 42 – Process Management Page

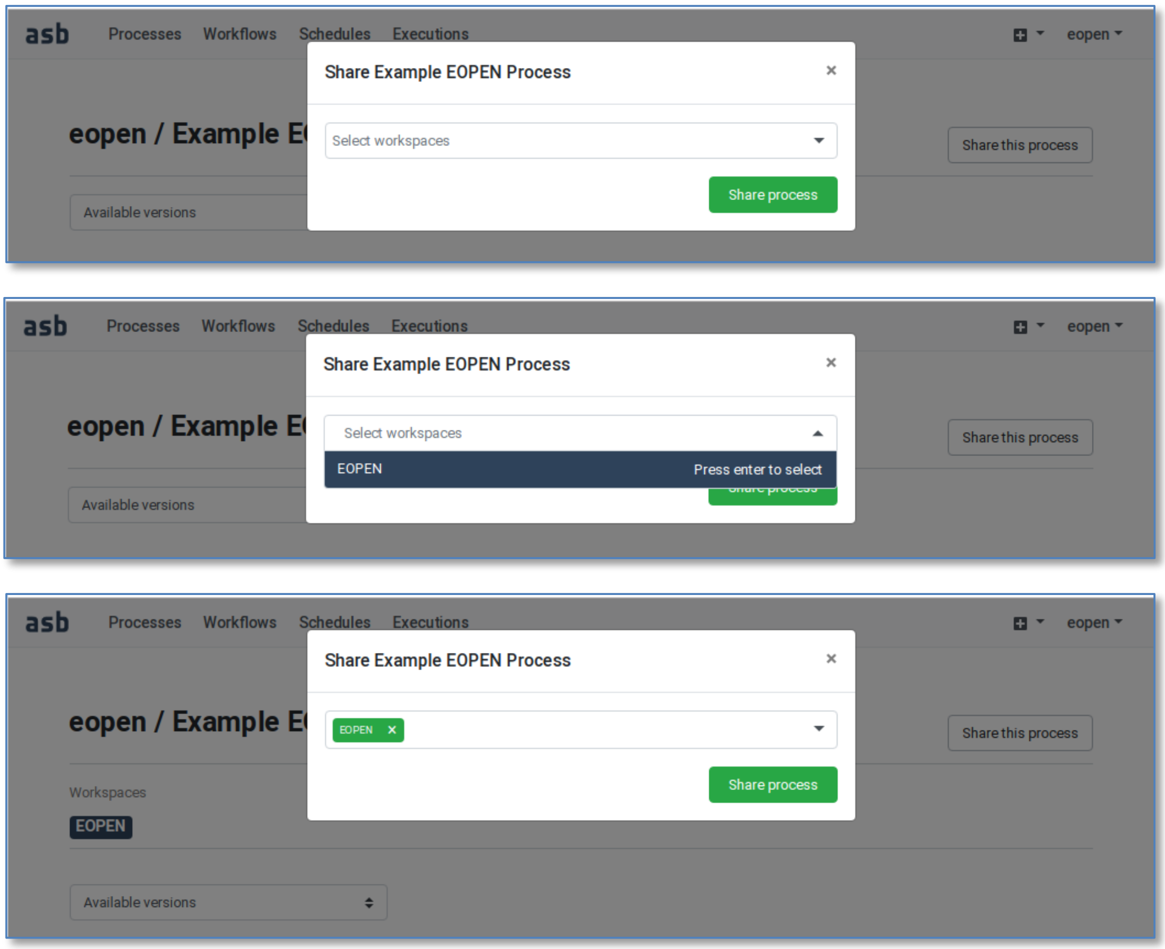


Figure 43 – Process Sharing Operations

To cancel the changes, click on the “X” icon in the top-right corner or simply click outside the dialog box. Click on the Share process button to apply the changes and close the box.

2.5.10 Process Implementation Guidelines

The following sections provide hints and guidelines for implementing processes. The tool for building new process versions is not currently verbose in describing what is causing an error during the actual import operations. The guidelines also helps indicating what could have been wrong in case of error.

2.5.10.1 Testing Processes Off-line

The import mechanism (during the dry-run and the actual import) includes the generation of a Docker image, the instantiation and execution of an instance of it (as a container), and the verification that the imported process is present in the offerings on the embedded OGC WPS service. This requires the `process_wrapper.py` file to be imported and parsed by the Python interpreter. If the Process Import Tool complains that the process cannot be found, the most probable cause is that the process wrapper file could not be imported. This may be due to a syntax issue (such as invalid indentation), or the import of a missing library or module.

It is thus advised, in order to prevent most of the errors that may occur at import time, to at first try to import and execute (if the dependencies are available), the wrapper code locally, in a controlled environment.

Example of local execution:

```
Python 2.7.14 (default, Oct 12 2017, 15:50:02) [GCC] on linux2
Type "help", "copyright", "credits" or "license" for more information.
>>> from process_wrapper import execute
>>> execute('/tmp', 'ignored')
{'events': {u'events': []}}
```

2.5.10.2 All Input Parameters are Strings

The Process Import Tool requires each input and output parameter to be associated to a data type. This data type is used by the platform to verify whether the inter-connected parameters in the workflows are compatible or not. For example, the Workflow Editor will allow connecting two parameters of the same type (object, string, date, etc.) or an output of type string with an input of type object (as a string is an object), but not an output of type object with an input of type string (as an object is not necessarily a string).

In case of doubt, selecting "User String" is a safe default choice.

The data type of the process parameters is however not used in the processes themselves. Concretely, all the inputs to the `execute(…)` function in the process wrapper module are passed as strings.

It is up to the developer to convert (in a safe manner) the input values to their expected datatype.

For example:

```
# Testing the type of a variable
value_type = type(any_value)
# Convert string to integer
int_value = int(string_value)
# Convert string value to float
float_value = float(string_value)
# Convert any Python structure (including arrays and dictionaries)
# Note: this is potentially dangerous at string_value is interpreted
parsed_value = eval(string_value)
```

2.5.10.3 Importing Python Libraries

The process wrapper module may require additional libraries and modules to be imported depending on the processing needs. As the Python language permits it, the import statements may be added either in the main context (i.e. at the top of the file according to the official recommendations), or within code blocs.

Importing at the top of the file permits to verify that the imported element (library, module, function, etc.) is indeed available within the Docker image. If the `import` statement is located, for example, within the `execute(…)` function, this will not be evaluated at process import time but when the process will be deployed and executed during a workflow execution. In this case potentially missing dependencies will be detected at execution time instead of process import time.

2.5.10.4 Importing and Using GDAL Libraries

Note about GDAL libraries: in the recent versions of the GDAL Python bindings, direct import of the GDAL libraries has been removed. This is shortly explained here: https://pypi.org/project/GDAL/. As of writing this guide, GDAL version 2.4.0 is installed when the dependency is selected in the Process Import Tool.

The following code fragment shows the proper way to import GDAL libraries that is through the `osgeo` package:

```
# Before:
#import gdal
#from gdalconst import *
#from osgeo import osr

# Now:
from osgeo import gdal
from osgeo.gdalconst import *
from osgeo import osr
```

2.5.10.5 Using SNAP 7 Tools GPT and Snappy

In this second EOPEN platform prototype the version of the Sentinel Application Platform SNAP (https://step.esa.int/main/toolboxes/snap/) has been upgraded from version 6 to version 7. This release uses a new version of the Java virtual machine that has better compliancy with the containerisation technology.

The version of SNAP available at the time this document has been produced is 7.0.0 (22.07.2019 13:30 UTC) originating from: https://step.esa.int/main/download/snap-download/

To use SNAP 7 in a process, select *SNAP Sentinel-1/2/3 Toolbox v7.0* + *Snappy* as Main Dependency in the Process Wrapper Script Generation page. This translates into the following entry in the wrapper script:

```
Main Dependency:
snap_sen_tbx-7.0
```

The use of GPT and Snappy in SNAP version 7 remains unchanged compared to version 6.0. An example process wrapper script that uses GPT is provided in Appendix D.1, page 93.

2.5.10.6 Using the Local Folder

The files that are imported via the Process Import Tool are located in folder `/var/www/wps/processes` in the Docker images. This is not the working folder of the Python interpreter that runs the OGC WPS service which means trying to access a local file from a Python script without providing at least a path fragment will not work.

For example, consider a file `settings.json` uploaded together with `process_wrapper.py` and loaded by the latter. The following code will fail because the JSON file cannot be found:

```
# Read process settings from JSON file
with open('settings.json') as settings_file:
  data = json.load(settings_file)
```

The following error is raised at execution time:

```
IOError: [Errno 2] No such file or directory: 'settings.json'
```

The absolute path to the file must be included, as follows:

```
# Read process settings from JSON file
with open('/var/www/wps/processes/settings.json') as settings_file:
  data = json.load(settings_file)
```

Note that this absolute path is also available in environment variable `WPS_PROCESSES`.

2.5.10.7 Using the `out_dir` Folder

The `execute(…)` function defined in each process wrapper receives an `out_dir` parameter. For example:

```
def execute(out_dir, startdate, enddate, writelogfile='False'):
  pass
```

This parameter is given the absolute path to the folder whose content is persisted after the completion of the process. Any file or folder located outside this folder will be lost.

`out_dir` must be used to save the files that are needed by the processes connected downstream in the workflow. In that case, the process that stores a file must output its path (and file name as appropriate) and pass this value to the next processes through connected parameters.

Please note that the path is edited automatically and is not the same inside and outside the processes execution environment. It is thus important to pass them through output/input parameter connections.

Files stored in `out_dir` are accessible by the users after the completion of the related workflow through the Execution Report page, as explained in section 2.6.7, page 81.

2.5.10.8 Using the Public (Shared) Volume

The files downloaded or generated by a process are only accessible by the other processes of the same workflow execution (and by the users via the Execution Report pages). If one or more files need to be read by other workflows, they must be stored within a shared volume provided for that purpose. This volume is mounted on `/data/public` in the process execution environment.

The volume does not reproduce the `processor-run-xxx/wps-run-yyy` folder hierarchy as it is the case when using the `out_dir` value (see Figure 63, page 82). Any process can read and write files within any folder and sub-folder in the volume.

Although it is not mandatory, it may be good practice to organise the files in sub-folders for example depending on their type (Sentinel data, in-situ data, Level 1, Level 2, water mask, etc.) or the context in which they have been downloaded or generated. The creation of the folder hierarchy is the responsibility of the processes that produce or consume these files. The path to the files may be transmitted through connected parameters (between processes of the same workflow), provided as workflow input parameter, or agreed between the process developers.

2.5.10.9 Importing a Folder Hierarchy

As explained in section 2.5.10.6 all the files imported using the Web interface of the Process Import Tool are located in the same folder in the generated Docker image (in `/var/www/wps/processes`). Archive files (`tar` and `tar.gz` files) may also be uploaded for importing a big amount of files or a folder hierarchy as these are automatically unpacked in the generated Docker images.

For example, importing a `tar` file with the following content:

```
appfiles/__init__.py
appfiles/utils.py
```

allows importing the `appfiles/utils.py` module in a process wrapper as follows:

```
# Importing the whole utils module
from appfiles import utils
# Importing a particular function
From appfiles.utils import utility_function
```

This mechanism is not limited to Python packages. Any files required by the process may be included in the Docker image using `tar` file.

2.5.10.10 Using the Python Logger

The Python `logging` module is configured to store in a file the log traces generated by the process modules. Each executed process generates a log file that is made available in the corresponding `logs` folder accessible through the Execution Report pages.

By default, the logging level is set to `DEBUG`. This may be changed programmatically as shown in the example, below.

Use the Python logger in the usual manner, as follows:

```
import logging
logger = logging.getLogger(__name__)
# Change the loggging level, if necessary
logger.set….
# Log info, warning, error, debug messages
logger.info('Execution started')
logger.warning('Something may be wrong')
logger.error('Something went wrong')
logger.debug('Received the following data from the service: %s', data)
```

Should it be necessary, the advanced functions of the `logging` module may be used as described in the Python documentation: https://docs.python.org/2.7/library/logging.html.

2.5.10.11 Main versus Software Dependencies

The Process Wrapper Template Generator page of the Process Import Tool allows selecting a Main Dependency as well as a number of Software Dependencies. Because the software dependencies are installed in the Docker images at the process import time, the complete operation may last several minutes. And the more individual software dependencies are selected, the longer is the Docker image building step.

To mitigate this, a number of "main dependencies" are proposed. Each of these correspond to a pre-built Docker image that already contains a number of software packages and that may be used as parent for the process image.

For example, selecting the "*SNAP Sentinel-1/2/3 Toolbox v7.0 + Snappy*" image allows saving the time to download, install and update the SNAP software in the process image. The same applies to the "*R interpreter and libraries*" image which already contains all the tools necessary for executing R scripts.

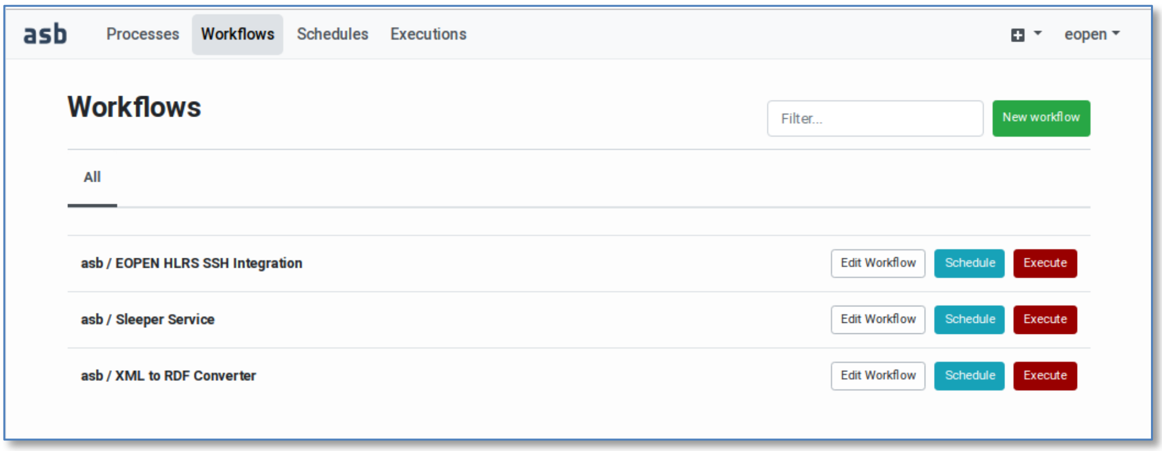
2.6 Workflows Management

Selecting the Workflows tab in the header leads you to the Workflows Management page. As shown on Figure 44, the page shows in a table your own workflows as well as the workflows you are allowed to access, depending on the workspaces configuration (as explained in section 2.6.8 “Workflow Sharing”).

An input field located above the table allows filtering the workflows. Next to it, a New workflow button allows creating a new workflow (as described in the next section).

Each row in the table includes the following elements:

- The owner (creator) of the workflow
- The workflow name
- An Edit Workflow button leading to the Workflow Editor (see section 2.6.2)
- A Schedule button for configuring unattended execution(s) in the future (see section 2.6.5)
- A Execute button for initiating an on-demand (immediate) execution (see section 2.6.4)



asb / EOPEN HLRS SSH Integration — Edit Workflow | Schedule | Execute

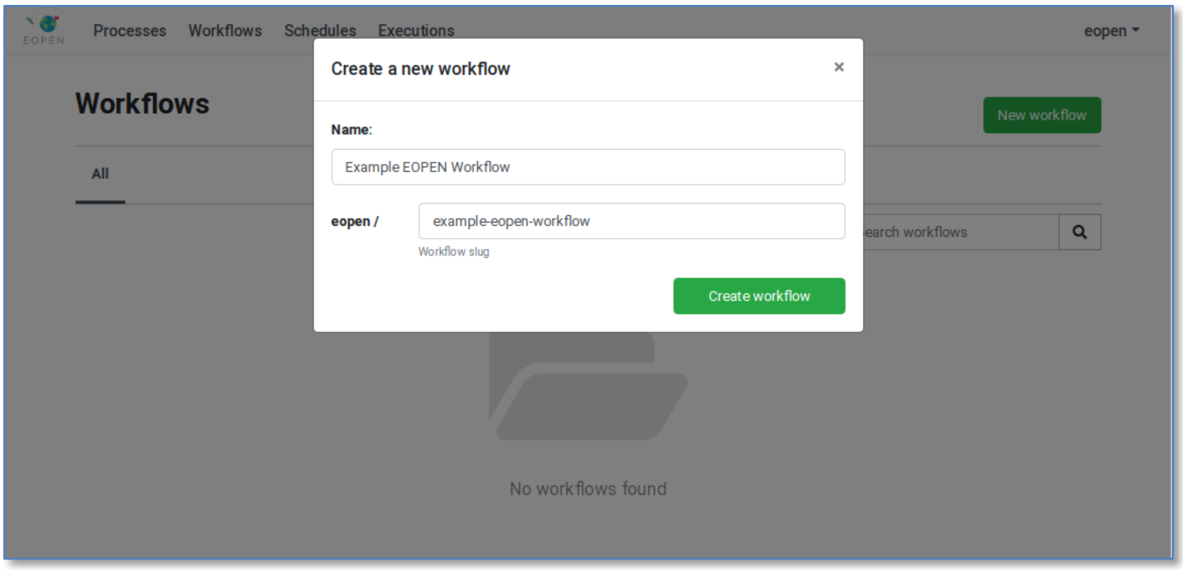
asb / Sleeper Service — Edit Workflow | Schedule | Execute

asb / XML to RDF Converter — Edit Workflow | Schedule | Execute

Figure 44 – Workflows Management Page

2.6.1 Creation of a New Workflow

Clicking on the New workflow button reveals a popup dialog box which asks for the name of the new workflow (see Figure 45). The workflow name is a free text that will be used to identify the workflow in the user interface. At the same time the name is entered, a "slugified" version of it is generated automatically and displayed in a second input field. It is in principle not necessary to edit this generated identifier but should it be necessary, care must be taken to enter an identifier that only contains lowercase characters, dashes and digits.



Create a new workflow

Name: Example EOPEN Workflow

eopen / example-eopen-workflow

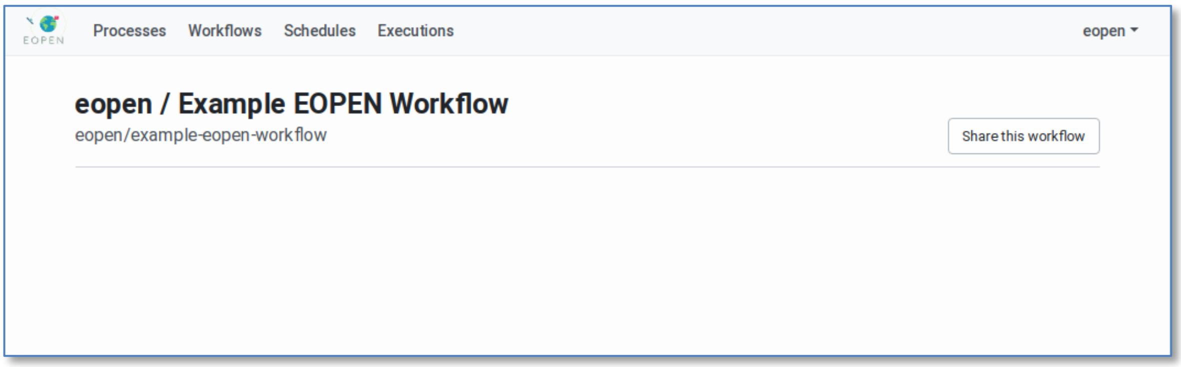
Workflow slug

Create workflow

Figure 45 – Creation of a new Workflow

Enter the requested information then click on the Create workflow button. You are automatically redirected to the Workflow Management Page (see Figure 46).

On the screen, the workflow name is always prefixed with the name of its owner (creator).



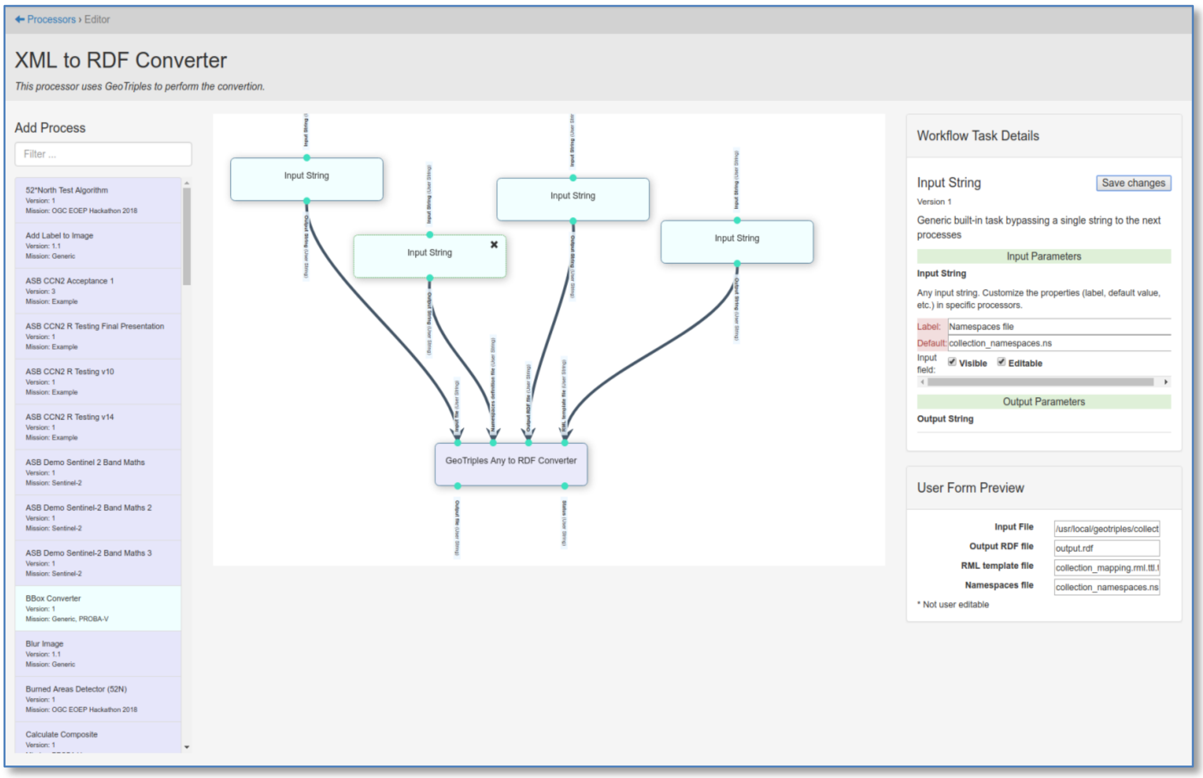
eopen / Example EOPEN Workflow

eopen/example-eopen-workflow

Figure 46 – Workflow Management Page

2.6.2 Workflow Editing

Workflows created as described in the previous sections cannot be executed as they do not include any process yet. In order to configure a workflow, navigate to the Workflows Management Page, identify the workflow to be edited, then click on its associated Edit Workflow button. Doing so reveals the Workflow Editor, as shown on Figure 47.



XML to RDF Converter

This processor uses GeoTriples to perform the convertion.

Add Process

Filter ...

52°North Test Algorithm
Version: 1
Mission: OGC EOEP Hackathon 2018

Add Label to Image
Version: 1.1
Mission: Generic

ASB CCN2 Acceptance 1
Version: 3
Mission: Example

ASB CCN2 R Testing Final Presentation
Version: 1
Mission: Example

ASB CCN2 R Testing v10
Version: 1
Mission: Example

ASB CCN2 R Testing v14
Version: 1
Mission: Example

ASB Demo Sentinel 2 Band Maths
Version: 1
Mission: Sentinel-2

ASB Demo Sentinel-2 Band Maths 2
Version: 1
Mission: Sentinel-2

ASB Demo Sentinel-2 Band Maths 3
Version: 1
Mission: Sentinel-2

BBox Converter
Version: 1
Mission: Generic, PROBA-V

Blur Image
Version: 1.1
Mission: Generic

Burned Areas Detector (52N)
Version: 1
Mission: OGC EOEP Hackathon 2018

Calculate Composite
Version: 1

Workflow Task Details

Input String — Save changes

Version 1

Generic built-in task bypassing a single string to the next processes

Input Parameters

Input String

Any input string. Customize the properties (label, default value, etc.) in specific processors.

Label: Namespaces file
Default: collection_namespaces.ns
Input field: ✓ **Visible** ✓ **Editable**

Output Parameters

Output String

User Form Preview

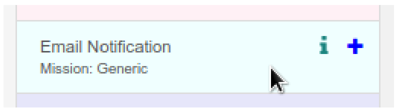
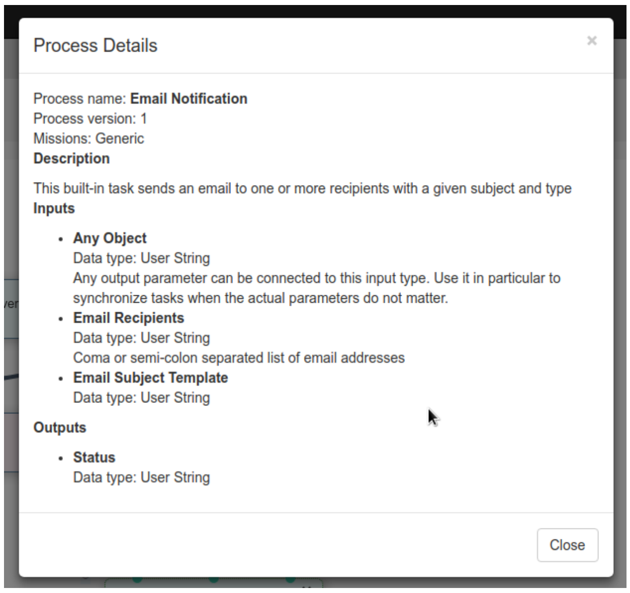
Input File	/usr/local/geotriples/collect
Output RDF file	output.rdf
RML template file	collection_mapping.rml.ttl.t
Namespaces file	collection_namespaces.ns

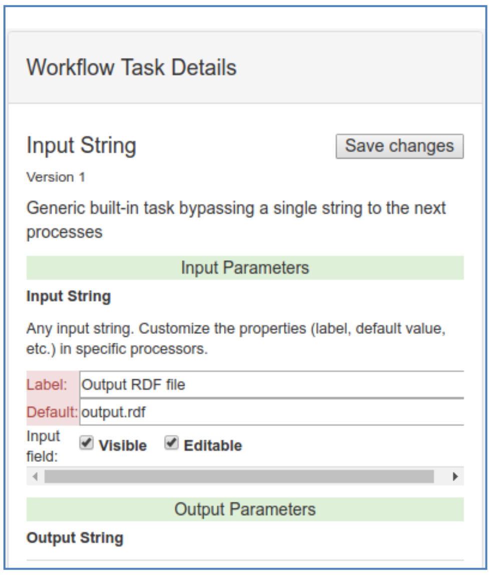
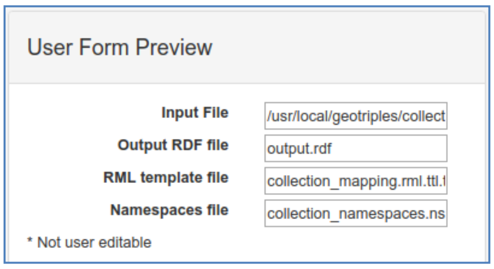
* Not user editable

Figure 47 – Workflow Editor

The Workflow Editor displays the following elements:

❶	Workflow identifier and version
❷	Use this search box to filter the list of available processes

❸	List of available processes. A colour code is used to make a distinction between the processes implemented as snippets (e.g. Python functions embedded in the workflow engine), processes implemented as OGC WPS processes, and processes that have a special purpose such as the Splitter and the Joiner tasks. Moving the mouse pointer on an entry in the process list reveals two icons:  Email Notification Mission: Generic
	• Click on the "i" icon to open a modal dialog box that provides detailed information about the process and its parameters:  Process Details Process name: **Email Notification** Process version: 1 Missions: Generic **Description** This built-in task sends an email to one or more recipients with a given subject and type **Inputs** • **Any Object** Data type: User String Any output parameter can be connected to this input type. Use it in particular to synchronize tasks when the actual parameters do not matter. • **Email Recipients** Data type: User String Coma or semi-colon separated list of email addresses • **Email Subject Template** Data type: User String **Outputs** • **Status** Data type: User String Close • Click on the "+" icon to add a new instance of this process in the canvas.
❹	Workflow design canvas. Selected processes appear in the upper-left corner of the canvas. Use the mouse to drag them to the appropriate location. The canvas height adapts automatically to show the full height of the workflow. Use the mouse to connect a process output parameter to the input parameter of another process. The editor verifies automatically whether the connected parameters are compatible, that is, if the output parameter data type is the same or a sub-type of the input parameter data type. If the parameters are not compatible, the editor displays an error and the connection is not realized. To remove a connection, use the mouse to drag the arrow end to a location in the canvas where there is not parameter to attach. To remove a process instance from the canvas, select this instance and click on the "x" icon located in its upper-right corner. A confirmation is asked before proceeding with the actual deletion. The vertical arrangement of the processes has an impact on the user parameterization form: The form list the unconnected inputs according to the vertical position of the corresponding processes. Any change made in the canvas (process positioning, connection creation and removal) is automatically saved in the Knowledge Base.

❺	Process details panel showing the inputs/outputs of the selected process. Each process input parameter has a label, default value, visibility flag and "editability" flag configured in its generic definition. In the context of a specific workflow, or a specific instance of the process in a workflow, the default properties may not be appropriate. The form located in the process details panel allows customizing the above properties for each process instance included in the workflow. It is for example possible to change the label of an input parameter that is then displayed in the user parameterization form. It is also possible to give a custom default value to an input parameter and prevent the user to change it (unchecking the Editable flag) or even hiding the parameter completely (unchecking the Visible flag). Altered parameters are highlighted in pink. Click on the Save changes button to persist the changes. The User Form Preview is then updated to reflect the custom parameter properties.  Workflow Task Details Input String Save changes Version 1 Generic built-in task bypassing a single string to the next processes Input Parameters **Input String** Any input string. Customize the properties (label, default value, etc.) in specific processors. Label: Output RDF file Default: output.rdf Input field: ✓ **Visible** ✓ **Editable** Output Parameters **Output String**
❻	The User Form Preview panel shows a preview of the user parameterization form. It uses the vertical order of the processes in the canvas to sort the form fields. It also takes into account the generic and the altered parameter properties (label, default value, etc.) to generate the form.  User Form Preview **Input File** /usr/local/geotriples/collect **Output RDF file** output.rdf **RML template file** collection_mapping.rml.ttl. **Namespaces file** collection_namespaces.ns * Not user editable

When the workflow is configured it may be executed manually using the Workflows Management Page. This is described in the next section.

2.6.3 Workflow Configuration Guidelines

The EOPEN Platform comes with built-in functions that may be integrated in the workflows to obtain specific behaviours. Functions and processes are selected and integrated within workflows in exactly the same manner. The only visible difference in the editor is the background colour: functions are coloured in light blue and processes in light purple.

The following sections describe the purpose of the built-in functions and provide hint for their usage.

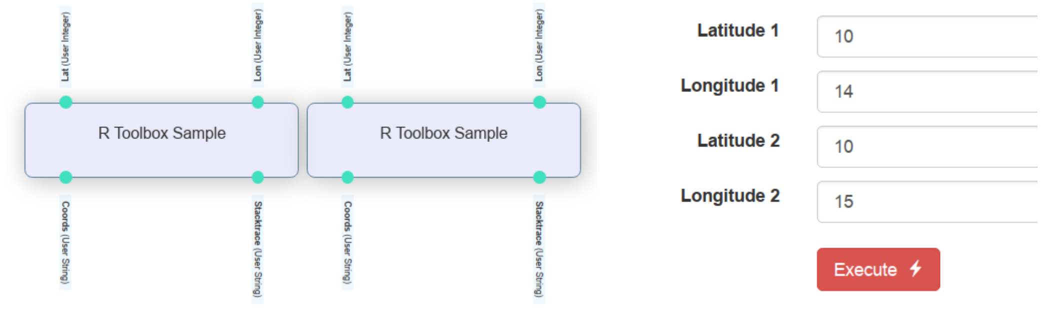
2.6.3.1 Inputs De-duplication using Pass-Through Functions

The workflow parameterisation forms are dynamically generated and contain an input field for each input parameter in the workflow graph that:

- is not connected to an output parameter of an upstream function or process
- and is not configured as hidden (i.e. un-checking the Visible flags in the workflow editor).

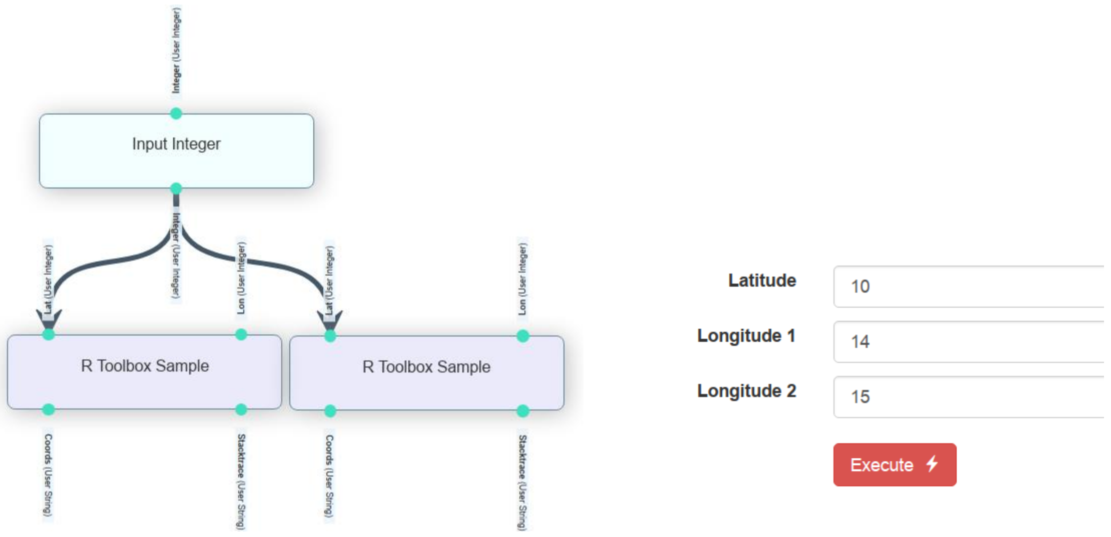
If the workflow contains several processes that expect the same value, this leads to a parameterisation form in which the user will have to provide the same value several times. To avoid this situation, "pass-through" built-in functions may be used to pass without modification the value given to their unique input parameter to one or more functions or processes connected downstream.

In the following example two sample processes receive a latitude and a longitude value. If the two processes are not receiving their inputs from upstream elements, the parameterization form will include four inputs, as depicted on Figure 48. If, for any reason, the two sample processes must be applied on the same latitude value, it is neither safe nor handy to ask the user to provide the same value twice in the form. In this case, it is preferred to add a pass-through function (of type integer in this example) that allows giving the same value to the two input parameters. The result, as shown on Figure 49, is a parameterization form with only three input fields which guarantees the only latitude value will be received by the two processes connected downstream.



Latitude 1	10
Longitude 1	14
Latitude 2	10
Longitude 2	15

Figure 48 – Workflow and parameterization form with duplicated "Latitude" fields



Latitude	10
Longitude 1	14
Longitude 2	15

Figure 49 – Workflow and parameterization form with de-duplicated "Recipients" field

2.6.3.2 Value Producers (Generators)

Value producers are built-in functions that generate values that depend on the execution time and context. For example, a generator function may be used to generate a date range that starts at some point in the past or the future (offset) and spans a given amount of days (duration).

This is particularly helpful when the execution of a workflow is scheduled at regular interval and at each execution a new date range must be processed.

Figure 50, below, shows an example of execution of a workflow that includes a *Date Range Producer* function for generating a date range dynamically. In the example, the execution occurs on May 11th, 2017. The generated date range covers the last 5 days (date offset = -6, date span = 5).

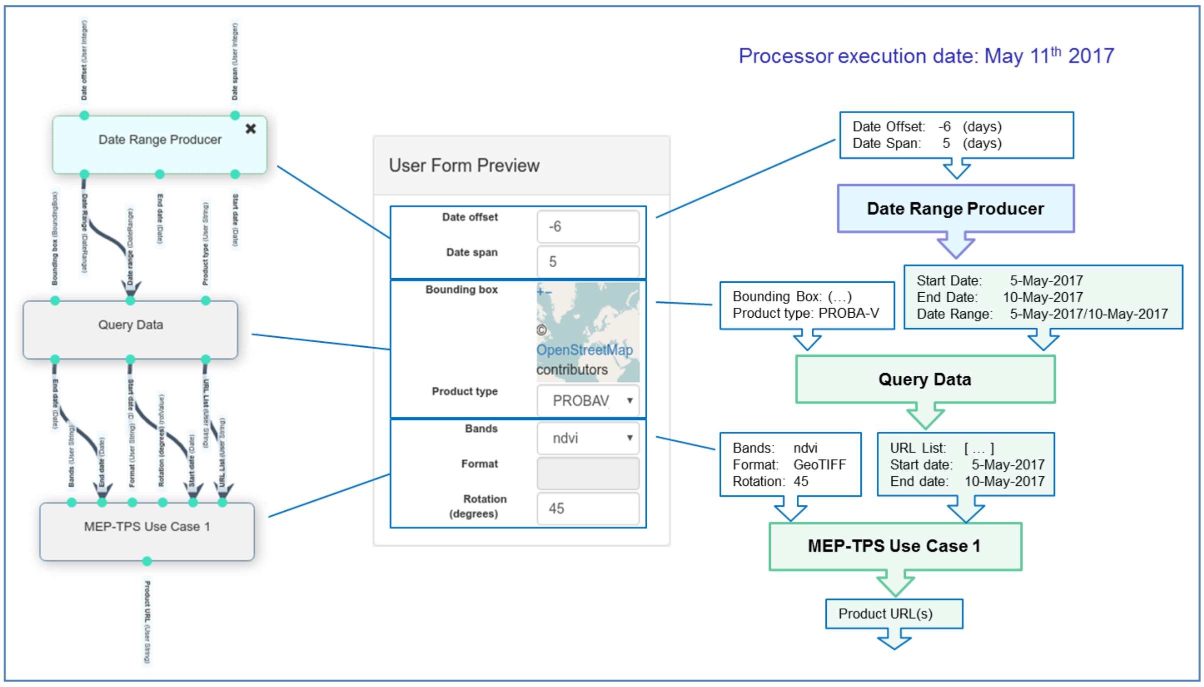


Figure 50 – Example workflow execution including a *Date Range Producer* function

2.6.3.3 Comparators

A *Comparator* is a built-in workflow function that applies a comparison operator on two input values and outputs a value that indicates whether the comparison is `True` or `False`.

The comparison operator must be chosen within a list of allowed values which depends on the type of the inputs. Available string comparators are "`equals`", "`startswith`", "`endswith`" and "`matches`".

The values to compare may come from an output of a process executed upstream or, if not connected, be provided manually via the workflow parameterization form. As usual, default values may also be provided in the workflows editor. The input values are passed through as outputs and can thus be further connected with downstream functions and processes.

In addition to the two output values that replicate the compared values, a "result" output indicates if the outcome of the comparison is `True` or `False`, and a “not_result” output indicates exactly the opposite.

2.6.3.4 Conditional Branching

A workflow branch that must be executed conditionally must be connected downstream a *Conditional Start* function. This function receives an "execute" parameter which, when given the value "False" provokes the downstream functions and processes to be skipped (without producing an error).

Because the skip/no-skip decision is controlled by a "stringified" boolean value ("`True`" or "`False`") it may be necessary to connect that input parameter to a *Comparator* function upstream to implement the following scenario:

1. Use the *Comparator* to verify, for example, that a string matches a regular expression and output the comparison result as a boolean value.
2. Connect a *Conditional Start* after the *Comparator* to execute the workflow branch only if the comparison is positive.

The example workflow fragment represented in Figure 51 applies this scenario.

At execution time, the *String Comparator* receives the following inputs:

- **Input 1**: "S1A_IW_GRDH_1SDV_20190401T051844_20190401T051909_026592_02FB56_1AF1"
- **Comparator**: "matches"
- **Input 2**: ".*S1.*"

Because Input 1 matches the regular expression provided in Input 2, the function outputs the value "True" that is communicated to the *Conditional Start* function.

In this example, the *Conditional Start* function receives the following inputs (all values received from the *Comparator*):

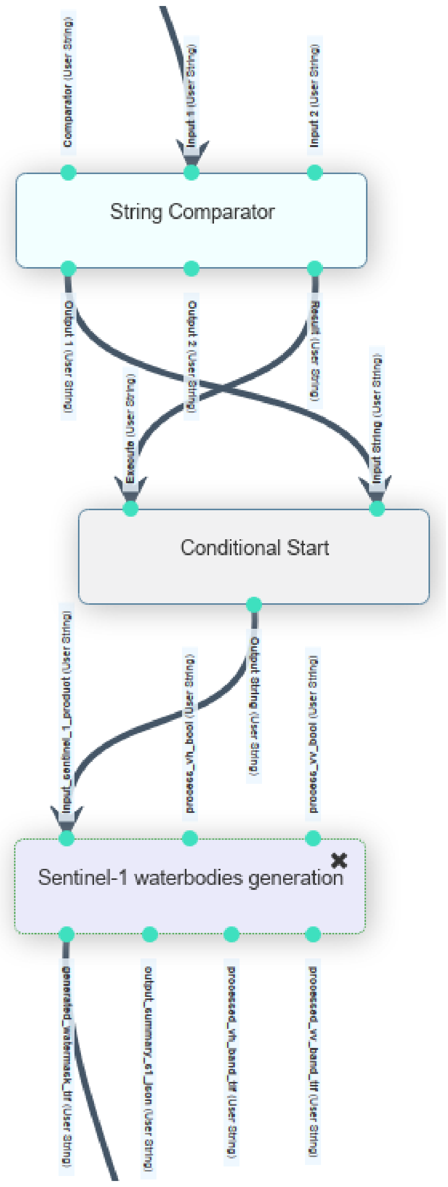
- **Input String**: "S1A_IW_GRDH_1SDV_20190401T051844_20190401T051909_026592_02FB56_1AF1"
- **Execute**: "True"

Because the Execute parameter receives "True", the function outputs the value of Input String and the execution flow continues to the next process.

The *Sentinel-1 waterbodies generation* process receives the scene ID as input.

Comparator and *Conditional Start* functions may be included in different places in a workflow to implement conditional branching in parallel fragments.

Functions and Processes that have been skipped during the execution of a workflow are coloured in pink in the Execution Report pages, as exemplified in Figure 52, below.


Comparator (User String)
Input 1 (User String)
Input 2 (User String)
String Comparator
Output 1 (User String)
Output 2 (User String)
Result (User String)
Execute (User String)
Input String (User String)
Conditional Start
Output String (User String)
input_sentinel_1_product (User String)
process_vh_bool (User String)
process_vv_bool (User String)
Sentinel-1 waterbodies generation
generated_watermask_tif (User String)
output_summary_s1_json (User String)
processed_vh_band_tif (User String)
processed_vv_band_tif (User String)
Figure 51 – Example conditional workflow fragment

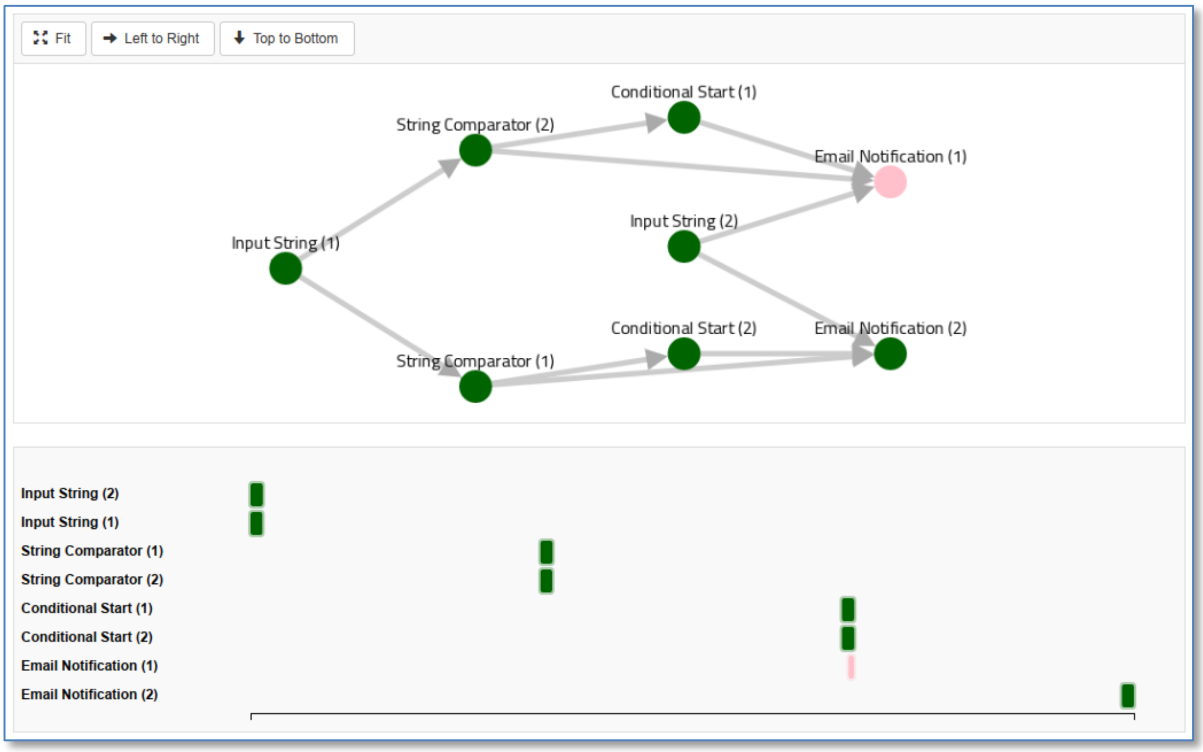


Figure 52 – Example skipped process in an Execution Report

In order to limit the propagation of the skipped functions and processes downstream, a *Conditional End* function is also available. This is in particular useful when two or more branches which are executed conditionally join again after the conditional fragments.

Figure 53 shows the schema of a workflow that uses *Conditional Start* and *Conditional End* to execute workflow fragments (represented by *Process B1* and *Process B2*) conditionally but still pursuing the execution afterwards (*Process C*).

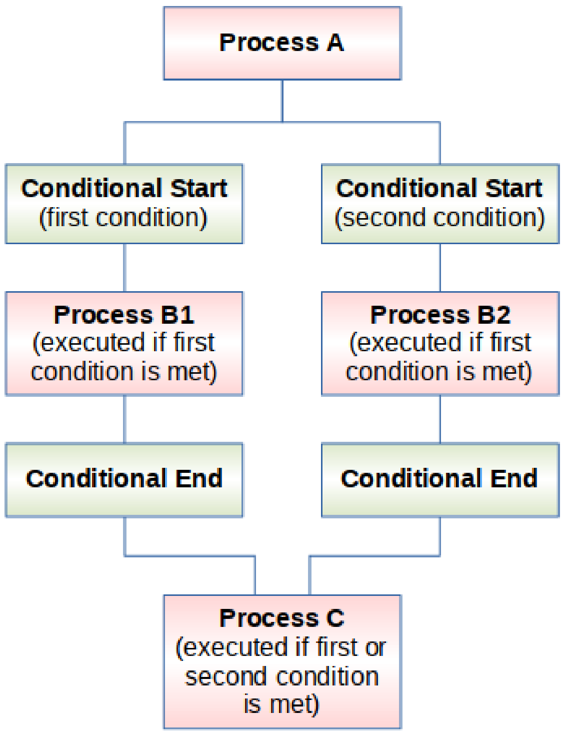

Process A
Conditional Start (first condition)
Conditional Start (second condition)
Process B1 (executed if first condition is met)
Process B2 (executed if first condition is met)
Conditional End
Conditional End
Process C (executed if first or second condition is met)

Figure 53 – Workflow graph with bound conditional branches

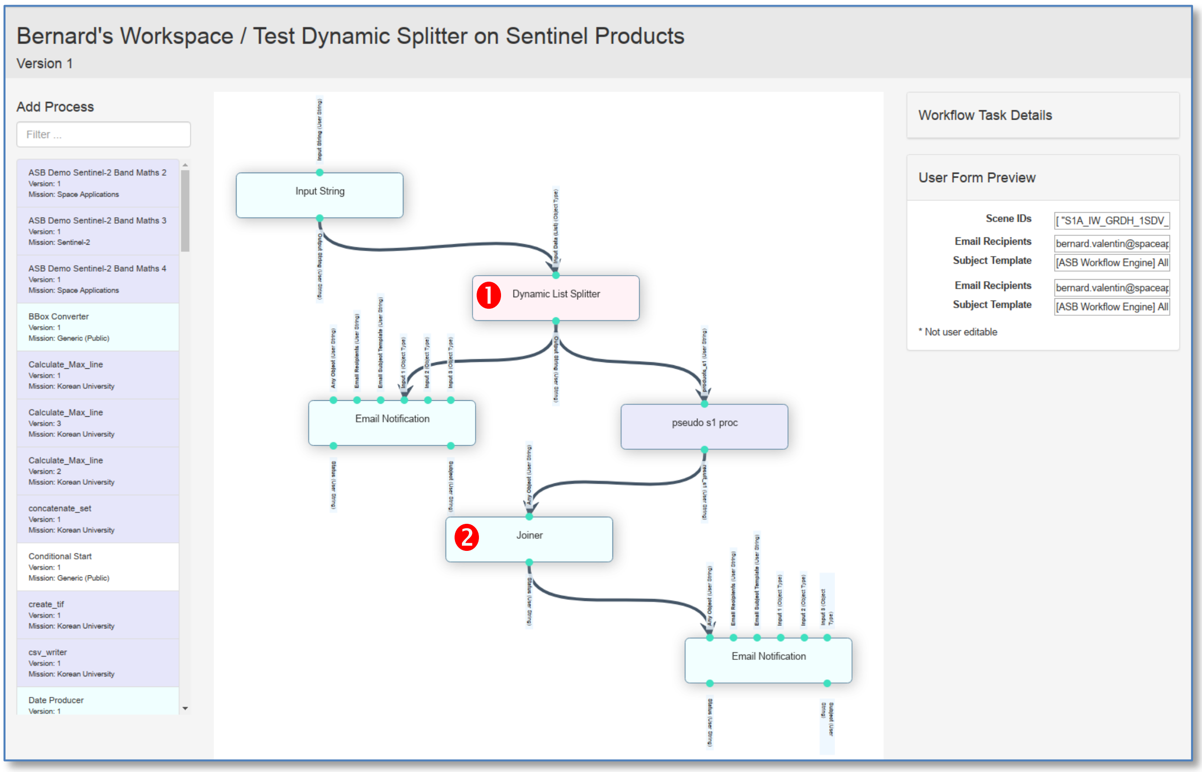
2.6.3.5 Parallel Processing using a Dynamic List Splitter

The *Dynamic List Splitter* built-in function provides a means for executing a series of tasks on every element of a list, independently and simultaneously, up to the limits of the processing resources.

The Splitter must receive a JSON array through its only input parameter. It has a single output which represents an entry of the array that must be connected to the workflow fragment to be parallelised.

At the other end of the "parallelisable" workflow fragment, a *Joiner* function must be inserted to act as a synchronisation point: it waits for all the workflow fragment instances to be completed before scheduling its downstream processes.

To benefit from this feature at execution time, it is thus necessary to build the workflow appropriately. Figure 54 represents a workflow being edited in the Workflow Editor. See section 2.6.2 above for a general description of the Editor.


Bernard's Workspace / Test Dynamic Splitter on Sentinel Products
Version 1
Add Process
Filter ...
ASB Demo Sentinel-2 Band Maths 2 Version: 1 Mission: Space Applications
ASB Demo Sentinel-2 Band Maths 3 Version: 1 Mission: Sentinel-2
ASB Demo Sentinel-2 Band Maths 4 Version: 1 Mission: Space Applications
BBox Converter Version: 1 Mission: Generic (Public)
Calculate_Max_line Version: 1 Mission: Korean University
Calculate_Max_line Version: 3 Mission: Korean University
Calculate_Max_line Version: 2 Mission: Korean University
concatenate_set Version: 1 Mission: Korean University
Conditional Start Version: 1 Mission: Generic (Public)
create_tif Version: 1 Mission: Korean University
csv_writer Version: 1 Mission: Korean University
Date Producer Version: 1
Input String
Dynamic List Splitter
Email Notification
pseudo s1 proc
Joiner
Email Notification
Workflow Task Details
User Form Preview

Scene IDs	["S1A_IW_GRDH_1SDV_
Email Recipients	bernard.valentin@spaceap
Subject Template	[ASB Workflow Engine] All
Email Recipients	bernard.valentin@spaceap
Subject Template	[ASB Workflow Engine] All

* Not user editable

Figure 54 – Workflow Editor

To create a parallelisable workflow fragment, create a workflow as represented in Figure 47:

1. Insert in the canvas the processes to be executed before the split and connect them appropriately.
2. One of the above processes must output a list of strings. Add the Dynamic List Splitter process in the canvas (see ❶ in the figure) and connect the process output parameter to the splitter input parameter.
3. Insert the processes to be executed for each entry in the list and connect them appropriately.
4. Connect the Dynamic List Splitter only output parameter to the process input parameter that must receive the list entry to be processed.
5. Add the Joiner process (see ❷ in the figure) and connect its output of the last process to its only input.
6. Insert the processes to be executed after the parallelized workflow fragment and connect them appropriately. The first of these processes must be connected to the Joiner only output parameter.

The workflow must comply with the following rules to be valid:

1. A workflow may only contain one pair of Splitter / Joiner functions.
2. No other connection than the one traversing the Splitter process are allowed between the processes located before and after the Splitter process. The example on the left side of Figure 55 is thus invalid and will not be executed successfully. The faulty connection is identified with the interdiction icon.

3. No other connection than the one traversing the Joiner process are allowed between the processed located before and after the Joiner process. The example on the right side of Figure 55 is thus invalid and will not be executed successfully. The faulty connection is identified with the interdiction icon.

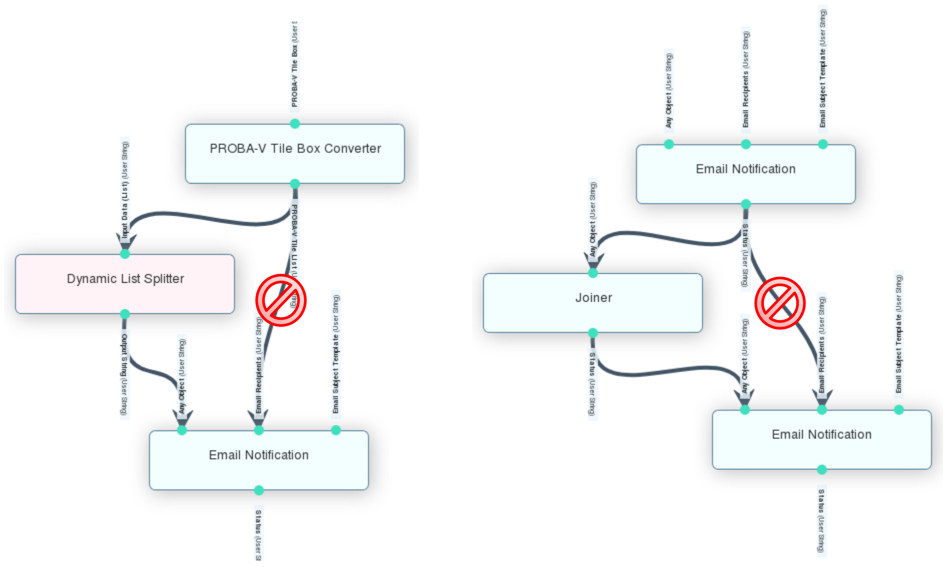
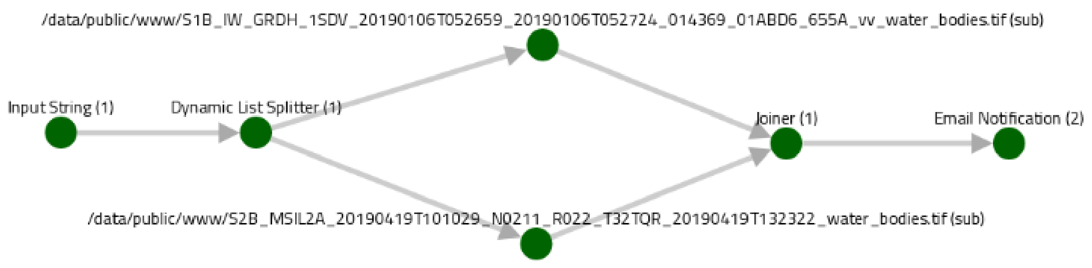


Figure 55 – Examples of Invalid Connections when using Splitter and Joiner functions

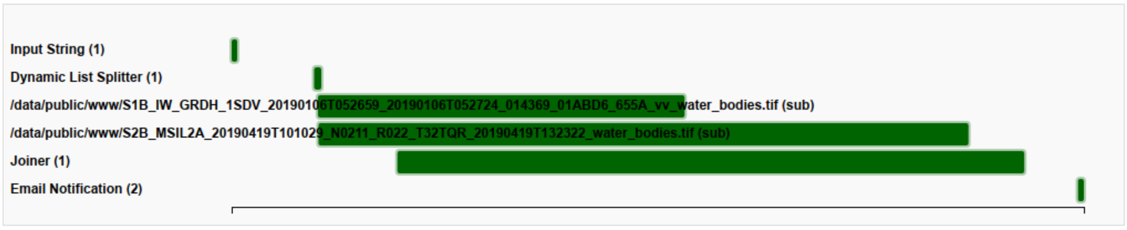
When the execution of such a workflow is complete, the Execution Report page displays information about the multiple execution of the workflow fragment. In particular in the "Execution Time and Status" section:

- The graphical version of the workflow represents each workflow fragment execution as a separate process whose label is the processed item:



/data/public/www/S1B_IW_GRDH_1SDV_20190106T052659_20190106T052724_014369_01ABD6_655A_vv_water_bodies.tif (sub)
Input String (1)
Dynamic List Splitter (1)
Joiner (1)
Email Notification (2)
/data/public/www/S2B_MSIL2A_20190419T101029_N0211_R022_T32TQR_20190419T132322_water_bodies.tif (sub)

- Similarly, the Gantt chart lists the workflow fragment executions as processes and shows their start and end time on the timeline.



Note: The Joiner appears to start shortly after each workflow fragment. It is actually the case as its role is to wait for all the executions to be completed before passing the execution flow to its downstream processes.

Data files generated within the parallelized workflow fragments are available in the datastore within folder with a "`_child`" suffix.

2.6.3.6 Email Notifications

The "Email Notification" built-in function allows sending emails to selected recipients at different steps of the execution of a workflow. As the function may be connected after any other function or process in a workflow it is mostly used to announce the completion of a processing and if applicable the availability of new products. This is however not a limitation.

Note that the subject of the emails is customizable but not their body.

The input parameters allow specifying the list of recipients and customizing the subject of the message:

- **Any**: Connect any output parameter to this input parameter allows to control at what time in the processing chain the notification must be issued. This is usually not needed as in general connecting to one or more of the "Input Object" parameters (see below) is sufficient.
- **Recipients**: The comma or semicolon-separated list of email addresses the notification must be sent to.
- **Subject Template**: A one-line string that will be used to generate the email subject. The stringified version of one or more of the "Input Object" parameters may be included using the <1> notation where the digit is the number of the input. Use the <input:begin:end> notation to insert a substring of an input value (e.g. <1:17:32> inserts the substring between position 17 and 32 from input 1).
- **Input Object 1**, **2** and **3**: Values given to these parameters (or a substring of these) may be included in the email subject using the template string given to the "Subject Template" parameter. They are also inserted in full in the email body as shown in the example below. These parameters are generally used to give information about the products that have just be generated (name and other attributes).

The function produces the following output parameters:

- **Email Subject**: The email subject string as generated using the subject template and the input object values.
- **Status**: The string "`success`". If something goes wrong in the function, the workflow fails.

Example email generated by this function:

Subject (on a single line):

```
[EOPEN] New Layer Published:
S1B_IW_GRDH_1SDV_20190106T052659_20190106T052724_014369_01ABD6_655A_vv_water_bodies
```

Message:

```
Notification Type: Default
Dag ID: 2019_05_08_16_03_00_973273z_publish_geotiff_example_child
Dag Run Owner: asb/admin
Execution date and time: 2019-05-08 16:05:33.168545+00:00
Start date and time: 2019-05-08 16:05:33.438319+00:00
Notification data:
 • S1B_IW_GRDH_1SDV_20190106T052659_20190106T052724_014369_01ABD6_655A_vv_water_bodies
```

2.6.3.7 Mattermost Notifications

The *Mattermost Notification* built-in function allows issuing a message through a Mattermost channel. All the users registered on that channel will instantly receive the notification. This allows, for example, sending updates when a product has become available or alerts when an event has been detected.

At execution time, the function issues an HTTP request to the Mattermost application. The HTTP end-point must be configured as an Incoming WebHook. Instructions for configuring and using Incoming WebHooks in Mattermost may be found in the following Web pages:

- https://docs.mattermost.com/developer/webhooks-incoming.html
- https://developers.mattermost.com/integrate/incoming-webhooks/

The text of the message is built using a template string similarly to the email subjects described in the previous section.

The *Mattermost Notification* function takes the following input parameters:

- **Any Object**: Connect any output parameter to this input parameter allows to control at what time in the processing chain the notification must be issued. This is usually not needed as in general connecting to one or more of the "Input Object" parameters (see below) is sufficient.
- **WebHook URL**: The end-point URL of the Incoming WebHook configured in Mattermost. For example: http://<domain-or-ip>:<port>/hooks/xxxbfij1wphfdyp56stdjr52hh
- **Channel**: The Mattermost channel on which the message must be posted. The following channels exist in the EOPEN Platform prototype: *flood-events*, *snow-cover* and *food-security*.
- **Message Template**: A one-line string that will be used to generate the notification message. The stringified version of one or more of the "Input Object" parameters may be included using the <1> notation where the digit is the number of the input. Use the <input:begin:end> notation to insert a substring of an input value (e.g. <1:17:32> inserts the substring between position 17 and 32 from input 1).
- **Input Object 1**, **2** and **3**: Values given to these parameters (or a substring of these) may be included in the notification message using the template string given to the "Message Template" parameter.

The function outputs the **Response** of the HTTP request, which should be "OK" and a **Success** boolean "True" or "False".

2.6.3.8 Publish Geospatial Data in GeoServer

The *Publish on GeoServer* process allows publishing GeoTIFF and Shapefile products as layers in a GeoServer instance. The process creates a new *Store* and a new *Layer* using the geospatial data file, the name and the style given as input parameters.

The behaviour of the process can be configured using two input flags:

- Setting *fail_on_geoserver_error* and *overwrite_if_exists* inputs to *True* will automatically overwrite the layer with the same name if it exists.

- Setting *fail_on_geoserver_error* and *overwrite_if_exists* inputs to *False* will publish the new layer only if it does not already exist. If it already exists, the new layer will not be published and no error will be reported.

The input parameters that must be provided to the process are the following:

- **GeoServer URL**: Base URL of GeoServer instance.
  Example: `http://192.168.1.1:8080/geoserver`
- **GeoServer Workspace**: GeoServer Workspace in which the store and layer must be created. The workspace must already exist in GeoServer. The workspace "`EOPEN`" must be used in the EOPEN platform.
- **Path to data file**: Filepath of the GeoTIFF or Shapefile file to publish. The file must be accessible to GeoServer through one of the following folders: auxiliary or public.
  Example:
  `/data/public/www/S2B_MSIL2A_20190419T101029_20190419T132322_water_bodies.tif`
  `/data/public/www/S2B_MSIL2A_20190906T101029_N0213_R022_T32TQR_water_bodies.shp`
- **Tags to apply on the layer: Coma-separated list of tags / keywords to store with the new layer. This helps filtering and searching for layers with GIS clients that support them.**
- **Style**: Style available in GeoServer to be applied to the new layer.
  Format: "<Workspace>:<Style>". Example: `EOPEN:WaterBodies`
- **Fail on GeoServer Error**: If `True`, an error will be raised if GeoServer returns a status code >= 300. Possible values are `True` and `False`.
- **Overwrite If Exists**: If `True`, the process will remove layer and store corresponding to the name input, if they exist. Possible values are `True` and `False`.

The process outputs the following information:

- **GeoServer Store**: Name of the created store. This is the base name of the input file.
- **GeoServer Layer**: Name of the created layer. This is the base name of the input file.

2.6.3.9 Generic Template Renderer (New)

The *Template Renderer* function allows generating any piece of text using an input template and the data to insert in the template. The template text must comply with the Jinja2 syntax, see: https://palletsprojects.com/p/jinja/.

The function may be used to convert, crop, or concatenate strings, for example between processes that do not use the same string structures.

For example:

- to append an time to an ISO data:
  `2019-12-24  =>  2019-12-24T00:00:00`
- to crop a string:
  `2019-12-24T12:43:23Z  =>  2019-12-24`

It may also be used to generate a text to be stored in an output file or sent through a communication channel such as emails (see section 2.6.3.6) and Mattermost (see section 2.6.3.7).

The following operational workflow executes the event detection in tweets data process then generates two texts: the first one is sent by email while the second one is sent through Mattermost.

When executed, the following data flows through the graph (note: line breaks have been added to increase the readability):

- The output of the *Event Detection* process is a Python dictionary::

```
{u'events': [
    {u'useCase': u'EnglishFloods', u'score': 1.56,
     u'epoch_timestamp': 1578133493565, u'change': u'91%'},
    {u'useCase': u'EnglishFood', u'score': 0.32,
     u'epoch_timestamp': 1578133497885, u'change': u'-19%'},
    {u'useCase': u'EnglishSnow', u'score': 0.58,
     u'epoch_timestamp': 1578133501892, u'change': u'-34%'},
    {u'useCase': u'FinnishSnow', u'score': 0.43,
     u'epoch_timestamp': 1578133505873, u'change': u'26%'},
    {u'useCase': u'GreekFloods', u'score': 0.94,
     u'epoch_timestamp': 1578133509851, u'change': u'112%'},
    {u'useCase': u'GreekSnow', u'score': 0.23,
     u'epoch_timestamp': 1578133513829, u'change': u'-48%'},
    {u'useCase': u'ItalianFloods', u'score': 0.2,
     u'epoch_timestamp': 1578133517814, u'change': u'-43%'},
    {u'useCase': u'KoreanFood', u'score': 0.26,
     u'epoch_timestamp': 1578133521795, u'change': u'-100%'}
  ]
}
```

- The *Template Renderer* function on the left receives the Python dictionary and a Jinja2 template for rendering the data into a fragment of HTML document. This document will then be sent by email to selected recipients.
- Jinja2 template:

```
Detected events<br/><ul>{% for event in input1.events %}
<li><b>{{event.useCase}}</b>: score={{event.score}},
time={{datetime.fromtimestamp(event.epoch_timestamp/1000.0).strftime('%Y-%m-%d
%H:%M:%S')}}, change={{event.change}}
</li>{% endfor %}</ul>
```

- Generated HTML document fragment:

```
Detected events<br/><ul>
<li><b>EnglishFloods</b>: score=1.56, time=2020-01-04 11:24:53, change=91%</li>
<li><b>EnglishFood</b>: score=0.32, time=2020-01-04 11:24:57, change=-19%</li>
<li><b>EnglishSnow</b>: score=0.58, time=2020-01-04 11:25:01, change=-34%</li>
<li><b>FinnishSnow</b>: score=0.43, time=2020-01-04 11:25:05, change=26%</li>
<li><b>GreekFloods</b>: score=0.94, time=2020-01-04 11:25:09, change=112%</li>
<li><b>GreekSnow</b>: score=0.23, time=2020-01-04 11:25:13, change=-48%</li>
<li><b>ItalianFloods</b>: score=0.2, time=2020-01-04 11:25:17, change=-43%</li>
<li><b>KoreanFood</b>: score=0.26, time=2020-01-04 11:25:21, change=-100%</li>
</ul>
```

- The second *Template Renderer* function receives with the same Python dictionary a Jinja2 template for rendering the data into a Markdown text. This document will then be sent through Mattermost.
- Jinja2 template:

```
Events detected in tweets:{% for event in input1.events %}
* **{{event.useCase}}**: score={{event.score}},
time={{datetime.fromtimestamp(event.epoch_timestamp/1000.0).strftime('%Y-%m-%d
%H:%M:%S.%f')}}, change={{event.change}}{% endfor %}
```

- Generated Markdown text:

```
Events detected in tweets:
* **EnglishFloods**: score=1.56, time=2020-01-04 11:24:53.565000, change=91%
* **EnglishFood**: score=0.32, time=2020-01-04 11:24:57.885000, change=-19
* **EnglishSnow**: score=0.58, time=2020-01-04 11:25:01.892000, change=-34%
* **FinnishSnow**: score=0.43, time=2020-01-04 11:25:05.873000, change=26%
* **GreekFloods**: score=0.94, time=2020-01-04 11:25:09.851000, change=112%
* **GreekSnow**: score=0.23, time=2020-01-04 11:25:13.829000, change=-48%
* **ItalianFloods**: score=0.2, time=2020-01-04 11:25:17.814000, change=-43%
* **KoreanFood**: score=0.26, time=2020-01-04 11:25:21.795000, change=-100%
```

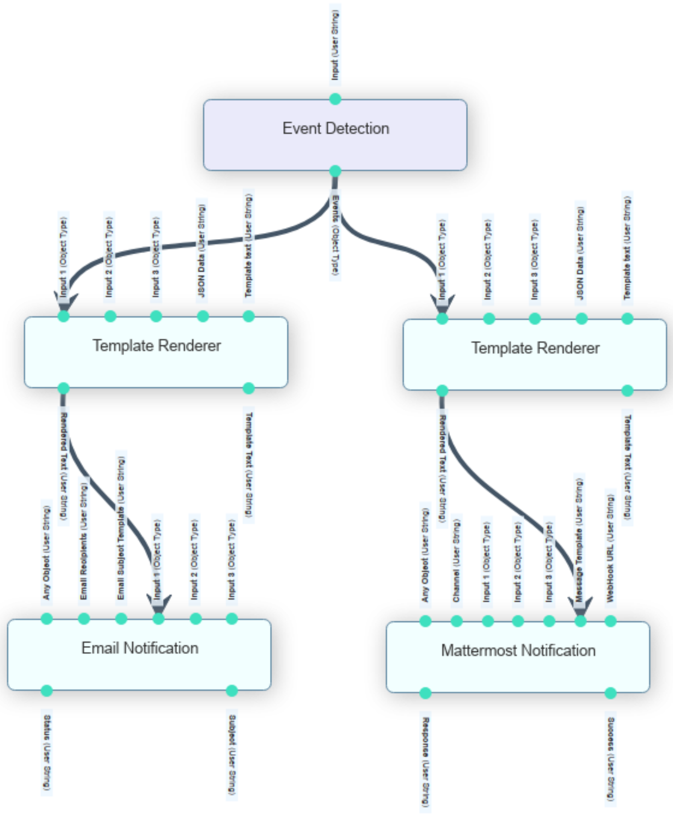


Figure 56 – Event Detection Workflow using the Template Renderer

2.6.3.10 Generic Harvester

The generic *Harvest* process allows downloading files from a remote location to a local folder. The harvester supports the FTP and HTTP protocols. Files may be downloaded recursively and credentials may be provided to authenticate to remote FTP servers should it be necessary.

The input parameters that must be provided to the process are the following:

- **Source URL**: FTP or HTTP URL where the data will be found.
- **Encrypted Credentials File**: Should the FTP server require authentication to give access to the files, the FTP user credentials must be provided in an encrypted form to the process. This parameter receives the path to the file that contains the encrypted FTP user and password.
- **Local Path**: The path to the folder where the downloaded files must be stored.
- **Glob Filter**: Use this parameter to indicate which files must be downloaded by means of a glob string. If all the files must be downloaded, use the asterisk character "`*`".
- **Recurse**: Set to "`True`" if the files must be downloaded recursively.

The process outputs the following information:

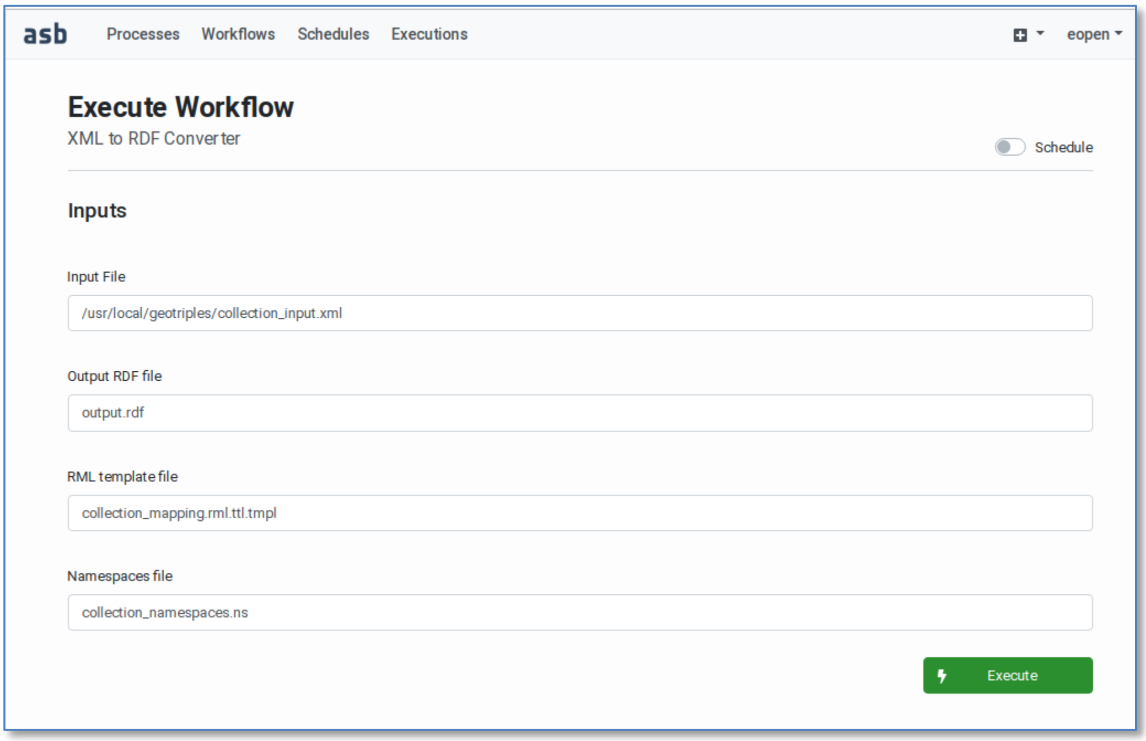
- **New Files**: JSON array containing the full list of downloaded files (with their path).
- **New Files Count**: The amount of downloaded files (must match the size of the JSON array).
- **Status**: "success".

2.6.4 Workflow On-Demand Execution

An immediate on-demand Workflow execution may be requested from both the Workflows Management page (Figure 44) and in a specific Workflow Management page (Figure 46).

Both pages include a Configure Execution button. Clicking on it leads to the Workflow Parameterization page (Figure 57). This shows a form that allows entering or selecting the values to be provided to the workflow. The form content depends on the workflow definition and in particular the processes it includes and their unconnected input parameters.

Click on the Execute button located below the form to submit the order and initiate the execution of the workflow. The Executions page (see section 2.6.6) is then automatically displayed. That page is also reachable using the Executions tab located in the header panel.



Execute Workflow

XML to RDF Converter

Inputs

Input File: /usr/local/geotriples/collection_input.xml

Output RDF file: output.rdf

RML template file: collection_mapping.rml.ttl.tmpl

Namespaces file: collection_namespaces.ns

Figure 57 – Workflow Parameterisation Page

Note: As can be seen on the figure above, a Schedule switch is provided above the parameterisation form. This allows revealing or hiding a second form for scheduling unattended executions (described in the next section). The same page thus allows initiating instant executions and configuring scheduled execution(s).

2.6.5 Workflow Executions Scheduling

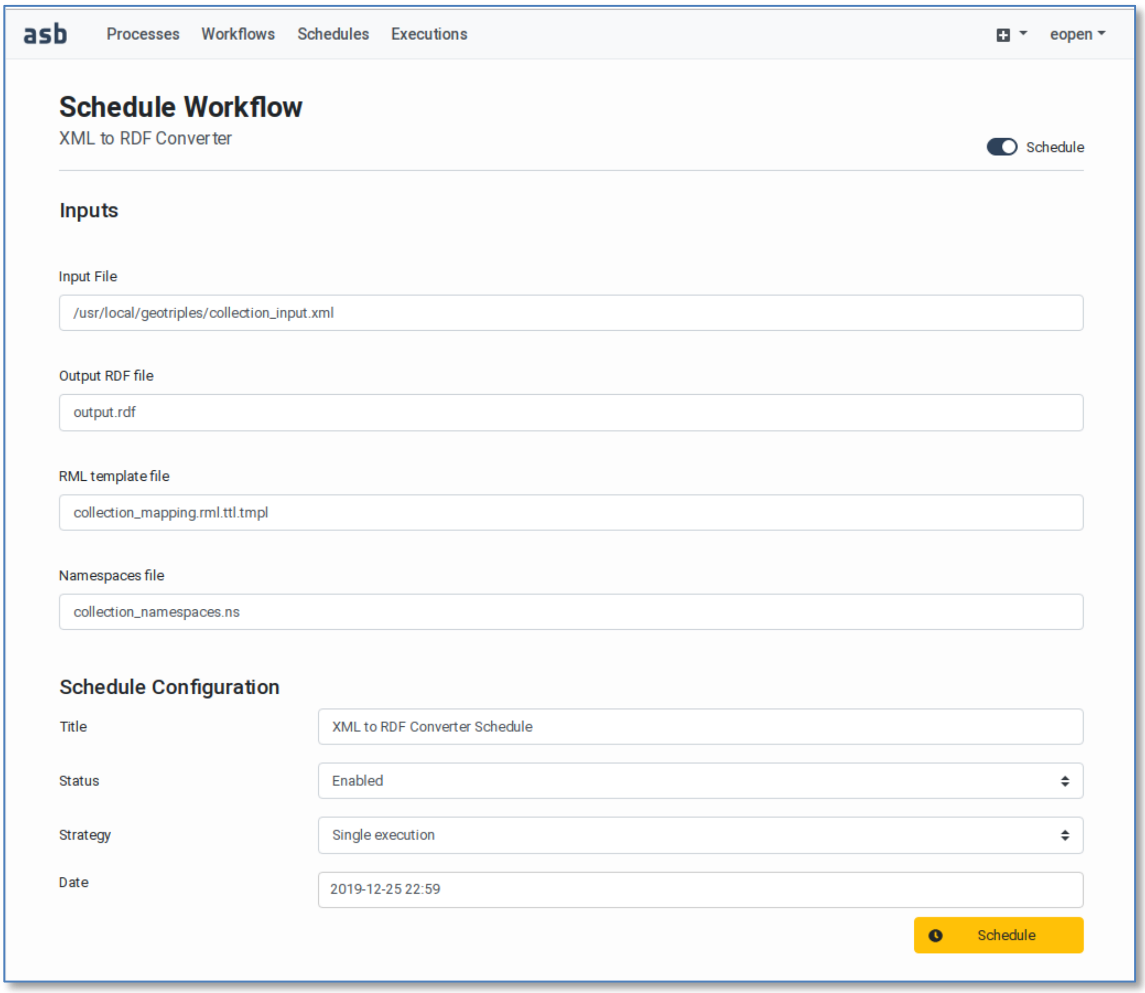
The Workflow Execution Scheduling page is accessed either by clicking on a Schedule Executions button located on the Workflows Management page (see Figure 44) or in a specific Workflow Management page (Figure 46).

Scheduled execution allows to configure the date(s) and time(s) at which a given workflow must be executed. This allows, for example, executing a workflow a few hours after a given product is expected to become available, or each time the content of a database must be updated.

The available options are similar to what "`cron`" jobs allow in Linux/Unix systems:

- Single execution at a given future date and time.
- Repeated executions at a given time and interval (expressed in days), within a date range.
- Repeated executions at a given time on specific month days. This allows, for example, executing a workflow at 1:00 AM every 1st, 11th and 21st day of each month.

In addition to the configuration of the scheduler itself, the Workflow Execution Scheduling page (as depicted on Figure 58) asks for the values to be given to the input parameters at each workflow execution.



Schedule Workflow

XML to RDF Converter

Schedule

Inputs

Input File: /usr/local/geotriples/collection_input.xml

Output RDF file: output.rdf

RML template file: collection_mapping.rml.ttl.tmpl

Namespaces file: collection_namespaces.ns

Schedule Configuration

Title	XML to RDF Converter Schedule
Status	Enabled
Strategy	Single execution
Date	2019-12-25 22:59

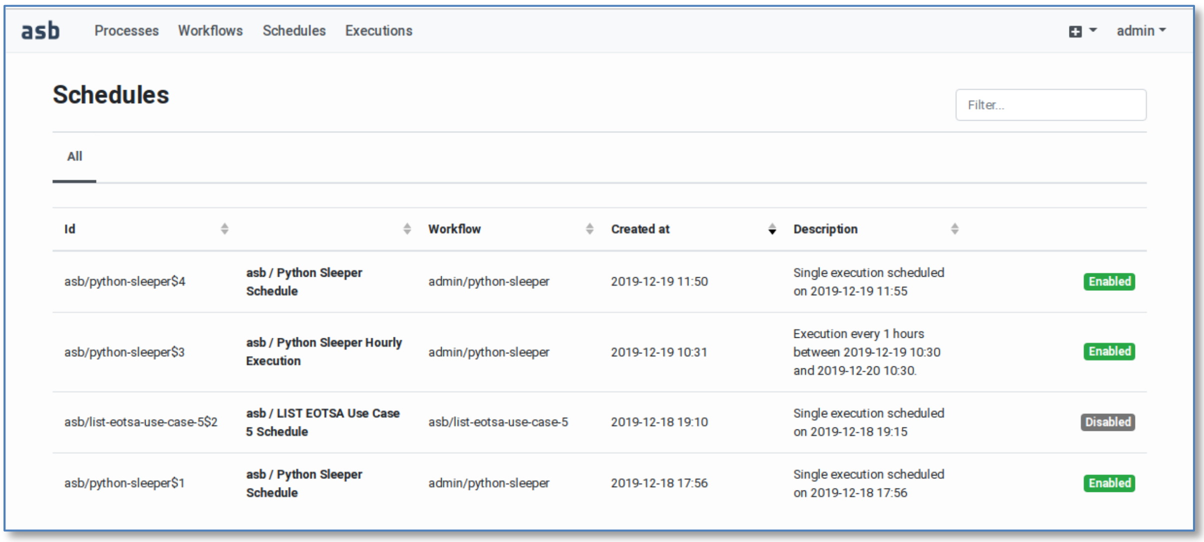
Figure 58 – Workflow Execution Scheduling Page

As for on-demand immediate executions, input parameters of the scheduled workflows must be given static values. Variability is supported by including in the workflow definition tasks that use static inputs to produce context-specific values at run time. This makes it possible, for example, to output a date range that covers the 5 days that precede each execution time. Read more about the Value Producers (Generators) in section 2.6.3.2.

After initial configuration, the schedules are listed in the Schedules page (Figure 59), accessible using the Schedules tab located in the header panel. This page gives an overview of the existing schedules, being enabled or not. The table provides the following information:

- a generated unique identifier,
- the name given to the schedule entry (free text),
- the workflow name and version,
- the date and time the schedule entry has been created,
- a verbalized version of the schedule configuration (schedule description),
- a status flag (Enabled/Disabled)

Click on the schedule identifier to access to its Workflow Execution Scheduling page (Figure 58). This allows enabling/disabling and re-configuring schedules individually.



Schedules

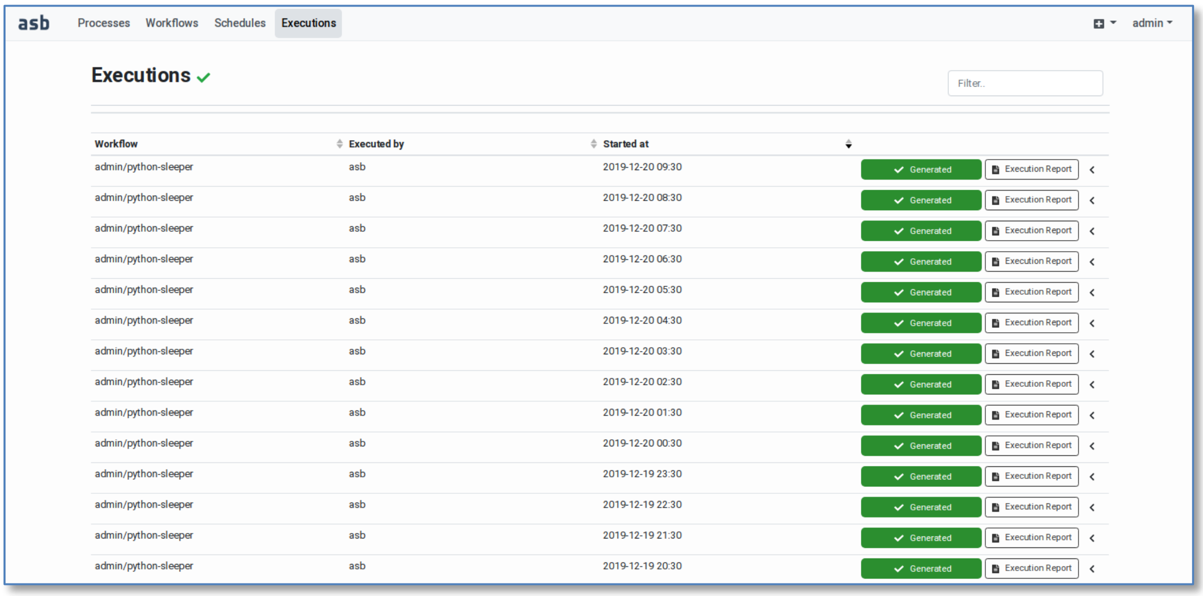
Id		Workflow	Created at	Description	
asb/python-sleeper$4	**asb / Python Sleeper Schedule**	admin/python-sleeper	2019-12-19 11:50	Single execution scheduled on 2019-12-19 11:55	Enabled
asb/python-sleeper$3	**asb / Python Sleeper Hourly Execution**	admin/python-sleeper	2019-12-19 10:31	Execution every 1 hours between 2019-12-19 10:30 and 2019-12-20 10:30.	Enabled
asb/list-eotsa-use-case-5$2	**asb / LIST EOTSA Use Case 5 Schedule**	asb/list-eotsa-use-case-5	2019-12-18 19:10	Single execution scheduled on 2019-12-18 19:15	Disabled
asb/python-sleeper$1	**asb / Python Sleeper Schedule**	admin/python-sleeper	2019-12-18 17:56	Single execution scheduled on 2019-12-18 17:56	Enabled

Figure 59 – Workflow Execution Schedules Page

2.6.6 Workflow Execution Monitoring

Workflow executions may be monitored and inspected in the Workflow Executions page, accessible using the Executions tab located in the header panel.

The page displays all the workflow executions ever started in a workspace accessible by the current user (Figure 60). The executions table is paginated and shows by default the most recent and the on-going executions. Above the table an input field allows filtering the table entries using a string fragment.



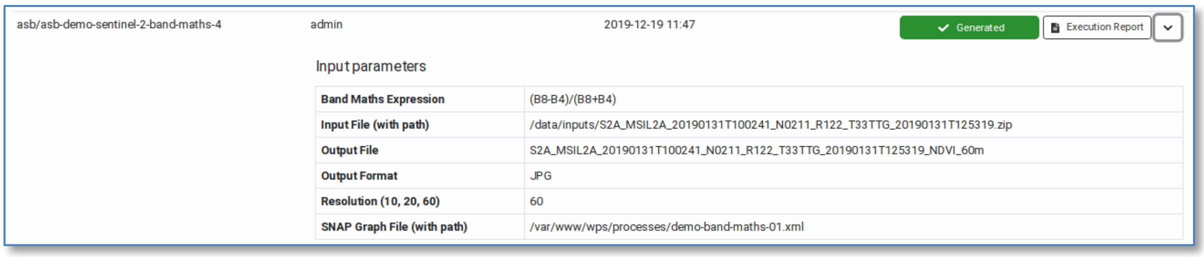
Executions ✓

Workflow	Executed by	Started at		
admin/python-sleeper	asb	2019-12-20 09:30	✓ Generated	Execution Report
admin/python-sleeper	asb	2019-12-20 08:30	✓ Generated	Execution Report
admin/python-sleeper	asb	2019-12-20 07:30	✓ Generated	Execution Report
admin/python-sleeper	asb	2019-12-20 06:30	✓ Generated	Execution Report
admin/python-sleeper	asb	2019-12-20 05:30	✓ Generated	Execution Report
admin/python-sleeper	asb	2019-12-20 04:30	✓ Generated	Execution Report
admin/python-sleeper	asb	2019-12-20 03:30	✓ Generated	Execution Report
admin/python-sleeper	asb	2019-12-20 02:30	✓ Generated	Execution Report
admin/python-sleeper	asb	2019-12-20 01:30	✓ Generated	Execution Report
admin/python-sleeper	asb	2019-12-20 00:30	✓ Generated	Execution Report
admin/python-sleeper	asb	2019-12-19 23:30	✓ Generated	Execution Report
admin/python-sleeper	asb	2019-12-19 22:30	✓ Generated	Execution Report
admin/python-sleeper	asb	2019-12-19 21:30	✓ Generated	Execution Report
admin/python-sleeper	asb	2019-12-19 20:30	✓ Generated	Execution Report

Figure 60 – Workflow Executions Page

Each table row includes the following elements:

- the identification of the executed (or being executed) workflow,
- the user who initiated the (possibly scheduled) execution,
- the date and time the particular execution has started,
- the status of the workflow execution using a colour code: Pending (grey), Running (blue), Success (green), Failed (red). A percentage of completion is shown for on-going executions.
- an Execution Report button that leads to the Workflow Execution Report page (see section 2.6.7),
- a caret < that allows revealing and hiding the workflow execution parameters right within the table (see Figure Figure 61)



asb/asb-demo-sentinel-2-band-maths-4	admin	2019-12-19 11:47	✓ Generated · Execution Report

Input parameters

Band Maths Expression	(B8-B4)/(B8+B4)
Input File (with path)	/data/inputs/S2A_MSIL2A_20190131T100241_N0211_R122_T33TTG_20190131T125319.zip
Output File	S2A_MSIL2A_20190131T100241_N0211_R122_T33TTG_20190131T125319_NDVI_60m
Output Format	JPG
Resolution (10, 20, 60)	60
SNAP Graph File (with path)	/var/www/wps/processes/demo-band-maths-01.xml

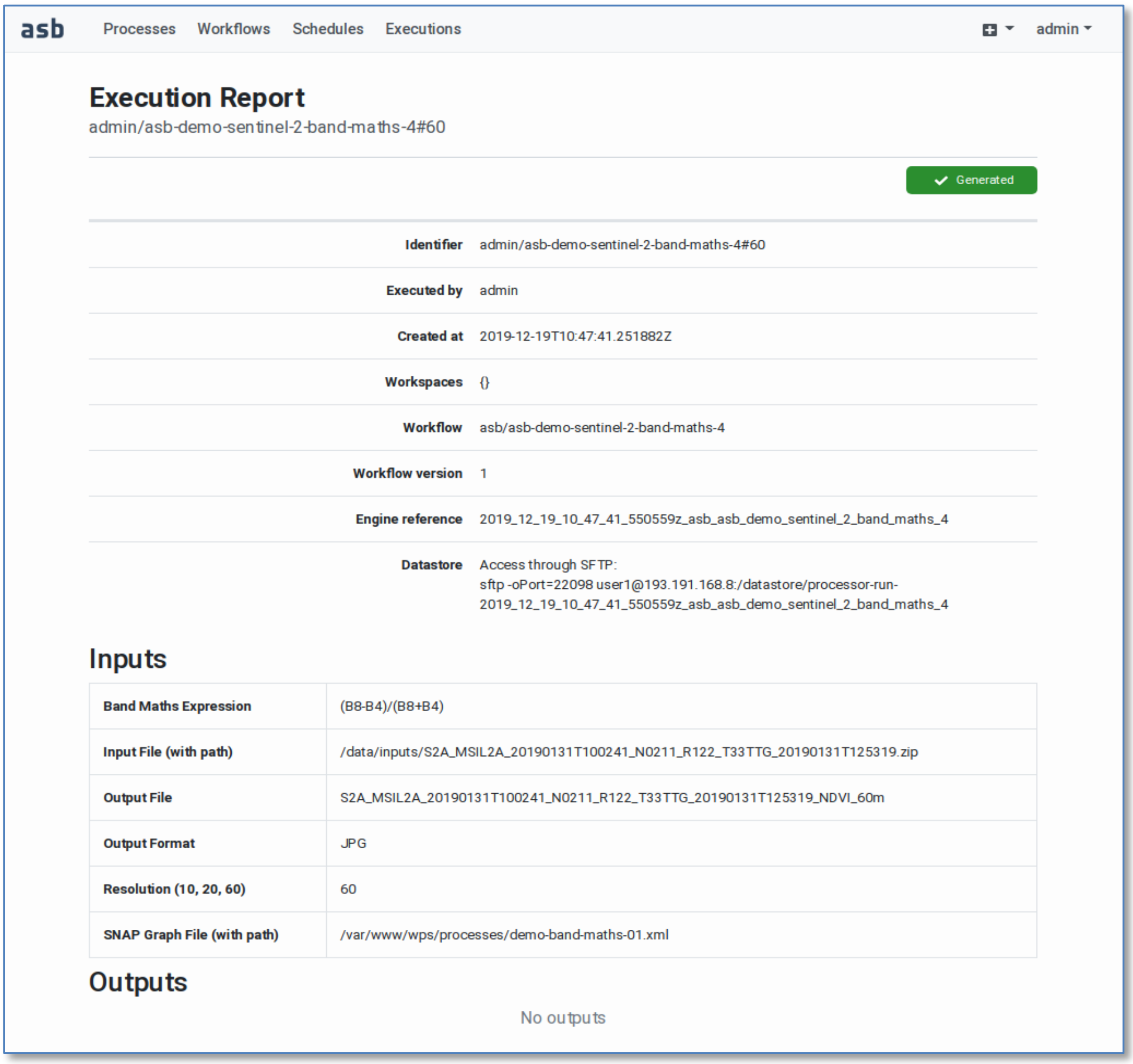
Figure 61 – Workflow Execution Parameters

2.6.7 Workflow Execution Report

Access to the Workflow Execution Report pages is only available via the Workflow Executions page.

A Workflow Execution Report allows to inspect the execution metadata, the user-specified input parameters (bounding box, time range, scene identifiers, and other specific input values), the list of outputs and generated product files, and if available quicklooks of the output products. Figure 62 shows an example Workflow Execution Report.

At the top, the workflow execution metadata contain an EOPEN Datastore link (see the red box on the Figure) that points to the location where the files generated by the workflow have been collected. Clicking on that link opens the location in a new page (or tab depending on the browser configuration), as represented in Figure 63, below.



Execution Report

admin/asb-demo-sentinel-2-band-maths-4#60

✓ Generated

Identifier	admin/asb-demo-sentinel-2-band-maths-4#60
Executed by	admin
Created at	2019-12-19T10:47:41.251882Z
Workspaces	{}
Workflow	asb/asb-demo-sentinel-2-band-maths-4
Workflow version	1
Engine reference	2019_12_19_10_47_41_550559z_asb_asb_demo_sentinel_2_band_maths_4
Datastore	Access through SFTP: sftp -oPort=22098 user1@193.191.168.8:/datastore/processor-run-2019_12_19_10_47_41_550559z_asb_asb_demo_sentinel_2_band_maths_4

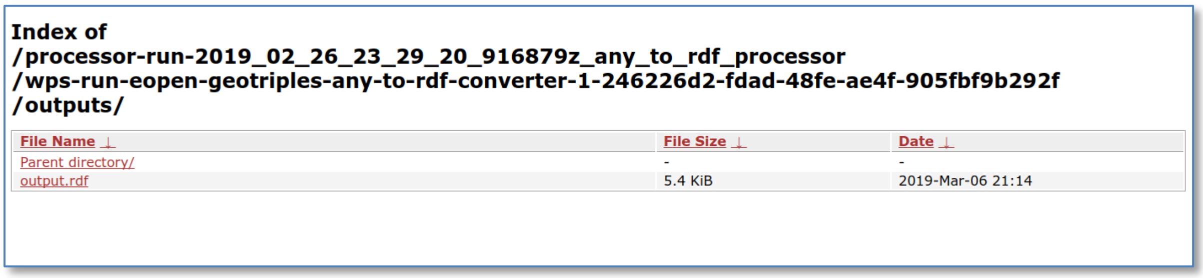
Inputs

Band Maths Expression	(B8-B4)/(B8+B4)
Input File (with path)	/data/inputs/S2A_MSIL2A_20190131T100241_N0211_R122_T33TTG_20190131T125319.zip
Output File	S2A_MSIL2A_20190131T100241_N0211_R122_T33TTG_20190131T125319_NDVI_60m
Output Format	JPG
Resolution (10, 20, 60)	60
SNAP Graph File (with path)	/var/www/wps/processes/demo-band-maths-01.xml

Outputs

No outputs

Figure 62 – Workflow Execution Report



Index of /processor-run-2019_02_26_23_29_20_916879z_any_to_rdf_processor /wps-run-eopen-geotriples-any-to-rdf-converter-1-246226d2-fdad-48fe-ae4f-905fbf9b292f /outputs/

File Name ↓	File Size ↓	Date ↓
Parent directory/	-	-
output.rdf	5.4 KiB	2019-Mar-06 21:14

Figure 63 – Workflow Run Output Folder in the Datastore

2.6.8 Workflow Sharing

By default, a Workflow is only visible and usable by its owner, that is, the user who created it.

In order to share a Workflow with other platform users, this must be added in a workspace accessible by these users (that is, a workspace in which they have a role).

In the following example, user “eopen” wants to share his Workflow “Example EOPEN Workflow” with the users who are given access to workspace “EOPEN”.

As can be seen on Figure 64, the process is not yet assigned to any workspace. To do this, click on the Share this workflow button. A popup dialog box appears. This allows selecting the workspace(s) the workflow must be assigned to. Workspaces must be selected in a drop-down list. Once selected, a workspace may be removed by clicking on its "X" icon. The sequence of operations is depicted in Figure 65.

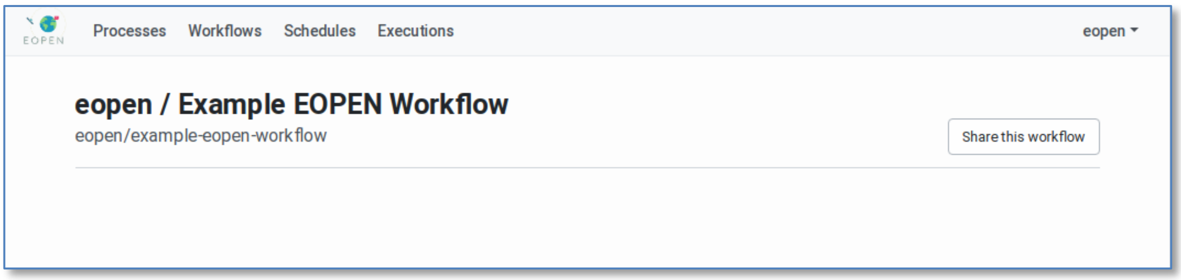


Figure 64 – Workflow Management Page

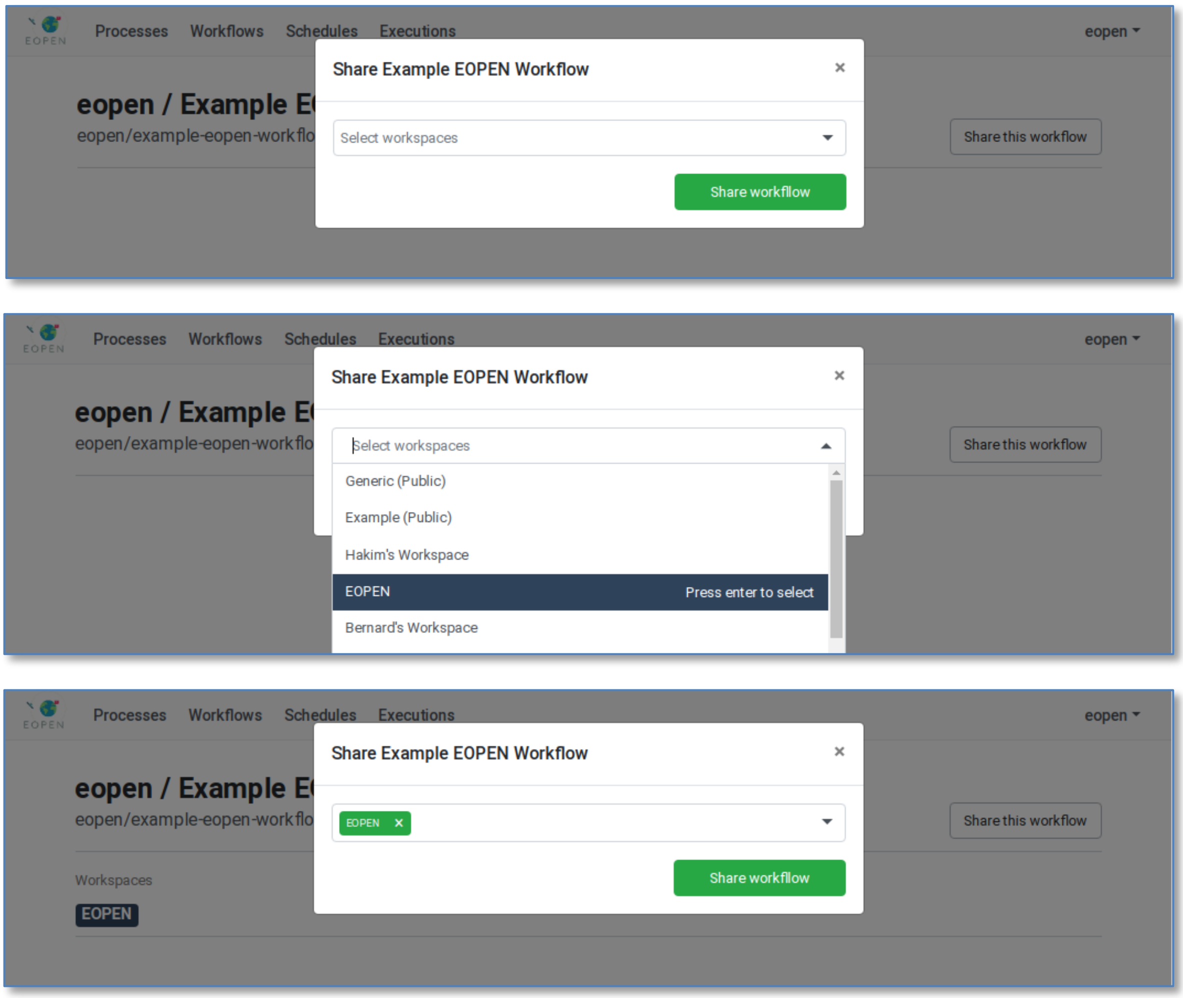


Figure 65 – Workflow Sharing Operations

To cancel the changes, click on the "X" icon in the top-right corner or simply click outside the dialog box. Click on the Share workflow button to apply the changes and close the box.

Appendix A Glossary

In this section you will find the definition of the main concepts and technologies used in the EOPEN Platform.

Algorithm	The code written by the developers and used to process data. In the EOPEN Platform, files implementing the algorithms must be imported as processes as explained in section 2.5.7.
Auxiliary Folder	The Auxiliary folder (which may contain sub-folders to organize the files) is meant to contain files consumed by the processes at execution time. The auxiliary folder is mounted in read-only in the execution environment of each process instance to guarantee its immutability. Currently, the users may not populate the auxiliary folder themselves. Please contact the platform administrators (Space Applications Services) when files must be added or removed from the auxiliary folder.
Controller Node	The system that hosts the core components of the platform. For example, core components provide the following services: • Web-based user interface • Persistence of the configuration • Workflow processes orchestration • Cloud resources management • User management In the context of the First EOPEN Prototype, the Controller Node is hosted at Space Applications Services.
Datastore	This is the storage volume where all the output files generated by the processes are persisted. Each Workflow Execution Report provides a link to the folder in the Datastore that contains the outputs of the executed processes. See section 2.6.7.
Docker/Dockerfile	Docker is the technology used to build the execution environment (Docker image) of each individual process. In this environment, the tools and libraries necessary for running the process are pre-installed. The software dependencies must be specified at import time (see section 2.5.7). At execution time, an instance of the Docker image is created and started as a Docker container. Within the container, the process runs in a sandboxed manner. A Dockerfile contains the instructions for building a particular Docker image.
Owner (Process and Workflow)	Each Process and Workflow existing in the platform is associated to one and only one Owner. By default, the owner is the user who has created a resource. Note: Changing an ownership cannot be done by the developers. It is under the responsibility of the platform administrators.

Process	A Process is a containerized algorithm. A Process definition includes a name, description, and version, as well as (typed) input and output parameters, and software and hardware dependencies. The typed inputs and outputs allow ensuring the compatibility of the parameters inter-connected in the workflow graphs. The EOPEN Developer Portal allows creating and configuring processes, uploading process (version) implementation files, and building and registering new process versions. In the EOPEN Platform, executing a process (as part of a Workflow) is a one-shot operation. It is deployed, executed once, and then it is un-deployed.
Process Version	A Process Version is a variant of a process that is implemented by a specific set of files. Multiple versions may be created for the same process for example to provide slightly different implementations, or to enhance the quality or the capabilities of the process implementation. Once it is released, a Process Version may be selected and integrated in Workflows. More about the Process and Process Version development lifecycle may be found in section 2.5.1.
Process Wrapper	In the EOPEN Platform context, a Process Wrapper is a script written in the Python language that acts as adapter for the imported algorithms. Algorithms require different sets of parameters and may potentially be implemented in various languages, compiled or not (e.g. Python, Java, R, C/C++). This has an impact on the manner an algorithm must be executed. Concretely an "`execute(…)`" function must be implemented in each process wrapper to pass the input parameters to the algorithm and return back the results. The Process Import Tool must be used to generate process wrapper templates (see section 2.5.5).
Public Folder **Public Volume**	The Public Folder (or Volume) is meant to receive the files generated by the workflows and which must be available as input for other workflows (see section 2.5.10.8)
Role	A Role is a permission level that may be given to a platform User in a particular Workspace. A User may play several Roles in the same Workspace and may play different Roles in different Workspaces. Workspace and Roles determine the resources (Process, Workflow, Schedule, Report) a User may access and the actions he may execute on them.
Service	In the EOPEN Platform, a service may be seen as a persistent process. A service is deployed and started once. After that it remains active and is invoked by client processes. Example services are database engines (PostgreSQL/PostGIS, MongoDB), OGC web services (GeoServer) and Product Catalogues. They must be always available for use by client processes (orchestrated in workflows). The EOPEN Platform does not provide a user interface for importing, deploying and managing the orchestration (status, start, restart, stop) the services. These operations are performed manually by the platform administrators. Please contact them if necessary.

WebHook	A WebHook is a configurable HTTP end-point in a running service. In the EOPEN Platform, Mattermost Incoming WebHooks are used to post instant messages. This feature is described in section 2.6.3.7. Supporting WebHooks in other software products is possible by implementing the appropriate client process.
Worker Node	A system that has been prepared for accepting process deployment and execution requests. Multiple processes may be run in parallel in a single worker node but running a variable amount of worker node provides better scalability. Worker nodes are typically created in cloud environments as they allow dynamically starting and stopping them depending on the demand.
Workflow	A Workflow is an Application defined by a graph of inter-connected Processes. The EOPEN Developer Portal includes a graphical Workflow Editor (see section 2.6.2) for creating workflows interactively, e.g. selecting the appropriate processes and connecting parameters with drag-&-drop. Workflows can be executed on-demand, scheduled or externally triggered. The platform automatically generates the parameterisation forms that allow giving values to unconnected input parameters. EOPEN includes interfaces for monitoring and control, reporting and data access. All the Workflows related features are described in section 2.6.
Workspace	A Workspace is a virtual environment which allows sharing resources, including Processes and Workflows, with other users. On one hand individual Users may be given one or more Roles in certain Workspaces. On the other hand, each resource may below to selected Workspaces. The main rule is that a resource is accessible to a user only if he has a role in one of the resource workspaces. The role then determines what the user can do with the resource: View, Edit, Delete, etc. Process and Workflow sharing is described in sections 2.5.9 and 2.6.8, respectively.

Appendix B Inventory of the Integrated EOPEN Modules

This appendix provides an overview of the modules that have been integrated in the First EOPEN Prototype, either as processes or as services.

B.1 Integrated Processes

Process	**Search Hubs 2**
Description	Search Sentinel data hubs for S1, S2 and S3 metadata. Store the metadata in the Sentinel Product Catalogue.
Provider	NOA
Reference	Umbrella Application of Sentinel Hubs, KR10 (NOA, Task 3.1, M1-M32, D3.1)

Process	**Scoring Hubs v1**
Description	Measure Download Speed of Hubs and update the Product Catalogue.
Provider	NOA
Reference	Umbrella Application of Sentinel Hubs, KR10 (NOA, Task 3.1, M1-M32, D3.1)

Process	**Delete Metadata v1**
Description	Delete from the Product Catalogue the products that no longer exist in the Sentinel hubs
Provider	NOA
Reference	Umbrella Application of Sentinel Hubs, KR10 (NOA, Task 3.1, M1-M32, D3.1)

Process	**Discovery Process v1**
Description	Discover Sentinel-1 and Sentinel-2 products using the NOA umbrella API.
Provider	CERTH
Reference	Change Detection in EO Data, KR01 (CERTH, Task 4.1, M1-M33, D4.4)

Process	**Download Product v1**
Description	Download a list of Sentinel-1 and Sentinel-2 products.
Provider	CERTH
Reference	Change Detection in EO Data, KR01 (CERTH, Task 4.1, M1-M33, D4.4)

Process	**Sentinel-1 Waterbodies Generation v5**
Description	Create water bodies and processed images based on selected VV or VH band. Receive as inputs a list with multiple product filenames, an AOI polygon and optionally the desired bands to process (VV is default). Store information about the processed products in MongoDB.
Provider	CERTH
Reference	Change Detection in EO Data, KR01 (CERTH, Task 4.1, M1-M33, D4.1)

Process	**Sentinel-2 Watermask Generation v2**
Description	Receive a list of Sentinel-2 products as input, generate a water mask for each scene, and store the results in MongoDB.
Provider	CERTH
Reference	Change Detection in EO Data, KR01 (CERTH, Task 4.1, M1-M33, D4.1)

Process	**Event Detection v1**
Description	Detect peaks in the daily number of tweets over a month.
Provider	CERTH
Reference	Event Detection Module, KR02 (CERTH, Task 4.2, M3-M32, D4.4)

Process	**GeoTriples Any to RDF Converter v1**
Description	Use GeoTriples to convert structured data into RDF.
Provider	SpaceApps
Reference	Linked open EO data, KR09 (SpaceApps, Task 5.2, M7-M33, D5.3)

Process	**Publish on GeoServer**
Description	Publish a GeoTIFF or a Shapefile product as a GIS layer in GeoServer.
Provider	SpaceApps
Reference	EOPEN System Integration (SpaceApps, Task 6.2, M5-M33, D6.3)

Process	**Mattermost Notification**
Description	Send a notification to a Mattermost channel. See section 2.6.3.7.
Provider	SpaceApps
Reference	EOPEN System Integration (SpaceApps, Task 6.2, M5-M33, D6.3)

Process	**Harvester v2**
Description	Copy files from a (possibly remote) location to a local folder. See section 2.6.3.10.
Provider	SpaceApps
Reference	EOPEN System Integration (SpaceApps, Task 6.2, M5-M33, D6.3)

B.2 Integrated Services

The services listed here are used by the processes introduced above when they are executed within workflows.

Service	**Mattermost**
Description	Mattermost, the messaging and notification service.
Provider	SpaceApps
Reference	EOPEN System Integration (SpaceApps, Task 6.2, M5-M33, D6.3)

Service	**eopen-communities**
Description	Detect communities in Twitter records and return the results in JSON format.
Provider	CERTH
Reference	Community Detection Module, KR07 (CERTH, Task 4.5, M5-M33, D4.4)

Service	**eopen-clustering**
Description	Apply a clustering mechanism to perform topic detection in Twitter records and return the results in JSON format.
Provider	CERTH
Reference	Data Clustering Module, KR05 (CERTH, Task 4.4, M1-M36, D4.2)

Service	**twitter-web**
Description	Convert analysis results formatted in JSON into RDF formatted in Turtle (TTL) and use the GraphDB service to store the result.
Provider	CERTH
Reference	Reasoning for Decision Support, KR08 (CERTH, Task 5.3, M6-M32, D5.1)

Service	**Umbrella Application of Sentinel Hubs**
Description	Implement a Product Catalogue that contains the metadata of the Sentinel missions. The data is stored in PostgreSQL/PostGIS.
Provider	NOA
Reference	Umbrella Application of Sentinel Hubs, KR10 (NOA, Task 3.1, M1-M32, D3.1)

Service	**GraphDB**
Description	Store the Linked Data generated by CERTH's JSON to RDF converter
Provider	CERTH
Reference	Knowledge Management, KR08 (CERTH, Task 5.3, M6-M32, D5.1)

Service	**MongoDB**
Description	Store data about the collected tweets and the analysed EO products
Provider	CERTH
Reference	Social Media Crawlers, KR12 (CERTH, Task 3.2, M1-31, D3.3)

Service	**PostgreSQL / PostGIS**
Description	Stores the Product Catalogue (Umbrella Application of Sentinel Hubs) data.
Provider	SpaceApps
Reference	n/a

Service	**GeoServer**
Description	Organize and serve the geo-temporal data stored or generated by EOPEN using OGC standards (incl. WMS, WFS).
Provider	SpaceApps
Reference	Interactive real-time visualisations (SpaceApps, Task 6.4, M7-M33, D6.5)

Appendix C SNAP Graph Parameterisation

SNAP graphs edited and exported using the SNAP Graph Builder, built in the SNAP Desktop application only contain hard-coded parameters. In order to execute such a graph using SNAP Graph Processing Tool (GPT) and giving the possibility to specify parameter values at execution time, it is necessary to adapt the graph by replacing hard-coded values with named placeholders.

Some SNAP operators also omit to specify input parameters because they are expected to be provided by the user when the graph is executed using the SNAP Desktop application. In such a case, the missing parameters must be added with named placeholders.

The graph fragment shown in Figure 66 includes example operators with omitted (in the "`Read`" operator) and hard-coded parameters (in the "`Write`" operator).

```xml
<graph id="Graph">
  <version>1.0</version>
  <node id="Read">
    <operator>Read</operator>
    <sources/>
    <parameters class="com.bc.ceres.binding.dom.XppDomElement"/>
  </node>
  <!-- elements removed here -->
  <node id="Write">
    <operator>Write</operator>
    <sources>
      <sourceProduct refid="Convert-Datatype"/>
    </sources>
    <parameters class="com.bc.ceres.binding.dom.XppDomElement">
      <file>L:\S1_SMCampaign\Output\target.tif</file>
      <formatName>GeoTIFF-BigTIFF</formatName>
    </parameters>
  </node>
  <applicationData id="Presentation">
  </applicationData>
</graph>
```

Missing "file" parameter

Hard-coded file name

Figure 66 – SNAP Graph (Fragment) Exported by the Graph Builder

The next figure shows the same SNAP graph fragment in which the omitted and the hard-coded parameters have been replaced with named placeholders:

```xml
<graph id="Graph">
  <version>1.0</version>
  <node id="Read">
    <operator>Read</operator>
    <sources/>
    <parameters class="com.bc.ceres.binding.dom.XppDomElement">
      <file>${scene1}</file>
    </parameters>
  </node>
  <!-- elements removed here -->
  <node id="Write">
    <operator>Write</operator>
    <sources>
      <sourceProduct refid="Convert-Datatype"/>
    </sources>
    <parameters class="com.bc.ceres.binding.dom.XppDomElement">
      <file>${outputTiff}</file>
      <formatName>GeoTIFF-BigTIFF</formatName>
    </parameters>
  </node>
  <applicationData id="Presentation">
  </applicationData>
</graph>
```

`${scene1}`

`${outputTiff}`

Figure 67 – SNAP Graph (Fragment) Edited With Placeholders

To execute the parameterized SNAP graph using GPT, a value must be provided to fill-in each placeholder using the syntax "`-P{name}={value}`". To be on the safe side, it is advised to enclose the value within double quotes.

Example GPT call:

```
/snap/bin/gpt "snap_gaph.xml" \
   -PoutputTiff="target.tif" \
   -Pscene1="S1B_S3_SLC__1SDV_20180201T173939_20180201T174013_009433_010F43_29FE.zip"
```

Appendix D Example process_wrapper.py Scripts

D.1 Execution of a SNAP Graph using GPT

The following code gives an example of process wrapper function that executes the command-line SNAP GPT (Graph Processing Tool) on a parameterized SNAP Graph whose name is provided in parameter.

The code on white background is automatically produced by the Process Wrapper Template Generator (see section 2.5.5 on page 46). The custom instructions added into the template are highlighted in the pink areas. The `execute` function generates the "`gpt`" execution string using the values received in the input parameters then executes it in a sub-process using the Python `subprocess` library. The function returns the path to the output file.

```
import datetime, os, subprocess
```

```
# -----------------------------------------------------------------------------------------
# Save this code in file "process_wrapper.py" and adapt as indicated in inline comments.
#
# Notes:
#  - This is a Python 2 script. It is incompatible with Python 3.
#  - The inputs will be given values by name, thus their order has no importance ...
#  - ... except that the inputs with a default value must be listed last.
#  - Parameter names are automatically converted into valid Python variable names.
#  - Any empty line or line starting with a '#' character will be ignored.
# -----------------------------------------------------------------------------------------
SNAP_HOME='/home/worker/snap/'
JAVA_HOME='/usr/local/jre'
JRE_HOME='/usr/local/jre'
def log_info(out_dir, message):
    with open(os.path.join(out_dir, 'stdout.txt'), 'a') as out_file:
        out_file.write('[%s]\n%s\n' % (datetime.datetime.today(), message))

def log_error(out_dir, message):
    with open(os.path.join(out_dir, 'stderr.txt'), 'a') as out_file:
        out_file.write('[%s]\n%s\n' % (datetime.datetime.today(), message))

def execute(out_dir, snap_graph_file, input_file, resolution, band_maths_expression, \
            output_file, output_format):
    """
    Identification:
    Name -- ASB Demo Sentinel-2 Band Maths
    Description --
    Version -- 1
    Author --
    Mission -- sentinel_2

    Inputs:
    snap_graph_file -- SNAP Graph File (with path) -- 45/User String
    input_file -- Input File (with path) -- 45/User String
    resolution -- Resolution (10, 20, 60) -- 45/User String
    band_maths_expression -- Band Maths Expression -- 45/User String
    output_file -- Output File -- 45/User String
    output_format -- Output Format -- 45/User String

    Outputs:
    output_path -- Output Path -- 45/User String

    Main Dependency:
    snap_sen_tbx-7.0
```

```
Software Dependencies:
python-2

Processing Resources:
ram -- 8
disk -- 100
cpu -- 4
"""

output_path = None

# ----------------------------------------------------------------------------------
# Insert your own code below.
# Store the generated files in the "out_dir" folder. Anything else is dropped after
# each process execution.
# Give appropriate values to the ouput parameters. These will be passed to the next
# process(es) following the worklow connections.
# ----------------------------------------------------------------------------------

proc = None
output_file = os.path.join(out_dir, os.path.split(output_file_name)[1])
# Add '-e' parameter to get more stack traces in case of error
cmd = ('gpt "%s" -c 16G -q 8 -e -Pinput_file="%s" -Pband_maths_expression="%s" ' \
       '-Pname="%s" -Ptype="%s" -Poutput_file="%s" -Poutput_format="%s"') % \
      (snap_graph_file, input_file, band_maths_expression, name, type, \
       output_file_name, output_format)

log_info(out_dir, 'Command: \n%s\n' % cmd)

try:
    proc = subprocess.Popen([cmd], stderr=subprocess.PIPE, shell=True)
    (out, err) = proc.communicate()

    log_info(out_dir, out)
    log_error(out_dir, err)

except Exception as e:
    if not proc:
        raise Exception('Exception while preparing gpt execution: %s' % e)
    log_info(out_dir, 'Process return code: %s' % proc.returncode)
    raise Exception('Exception during gpt execution: %s' % e)
# ----------------------------------------------------------------------------------
# The wrapper must return a dictionary that contains the output parameter values.
# ----------------------------------------------------------------------------------

return {
    'output_path': output_file
}
```

Figure 68 – Example `process_wrapper.py` executing a SNAP graph

D.2 Execution of GeoTriples using JRE

The following code gives an example of process wrapper function that executes the GeoTriples application in headless mode. GeoTriples is used to convert structured data (including JSON, XML, and Shapefile) into RDF. It receives as inputs the name of the input and output files, as well as the name of the files that contain the mapping rules and the applicable RDF namespaces.

```
import datetime, os, subprocess

# ---------------------------------------------------------------------------------------
# Save this code in file "process_wrapper.py" and adapt as indicated in inline comments.
#
# Notes:
#  - This is a Python 2 script. It is incompatible with Python 3.
#  - The inputs will be given values by name, thus their order has no importance ...
#  - ... except that the inputs with a default value must be listed last.
#  - Parameter names are automatically converted into valid Python variable names.
#  - Any empty line or line starting with a '#' character will be ignored.
# ---------------------------------------------------------------------------------------
JRE_BIN='/usr/local/jre/bin/java'
JAVA_HOME='/usr/local/jre'
JRE_HOME='/usr/local/jre'
JRE_BIN='/usr/local/jre/bin/java'
GEOTRIPLES_HOME='/usr/local/geotriples'

def execute(out_dir, input_file='', rml_template_file='mapping.rml.ttl.tmpl', \
            output_rdf_file='output.rdf', namespaces_file='namespaces.ns'):
    """
    Identification:
    Name -- GeoTriples Any to RDF Converter
    Description -- Use GeoTriples to convert structured data into RDF
    Version -- 1
    Author --
    Mission -- eopen

    Inputs:
    input_file -- Input file -- 45/User String
    rml_template_file -- RML template file -- 45/User String -- mapping.rml.ttl.tmpl
    namespaces_file -- Namespaces definition file -- 45/User String -- namespaces.ns
    output_rdf_file -- Output RDF file -- 45/User String -- output.rdf

    Outputs:
    status -- Status -- 45/User String
    output_file -- Output file -- 45/User String

    Main Dependency:
    python-2

    Software Dependencies:
    python-2
    oracle_jre-8u171
    geotriples-1.1.6
```

```
Processing Resources:
ram -- 2
disk -- 10
cpu -- 1
"""

output_path = None

# ----------------------------------------------------------------------------------
# Insert your own code below.
# Store the generated files in the "out_dir" folder. Anything else is dropped after
# each process execution.
# Give appropriate values to the ouput parameters. These will be passed to the next
# process(es) following the worklow connections.
# ----------------------------------------------------------------------------------

jre = JRE_BIN
jar = os.path.join(GEOTRIPLES_HOME, 'geotriples-1.1.6-SNAPSHOT-cmd.jar')
cmd = 'dump_rdf'
output_file = os.path.join(out_dir, output_rdf_file)

# Render the RML template file into an RML mapping file
# That is, replace the placeholders ${input_file} with the value of intput_file
rml_mapping_file = '/tmp/mapping.rml.ttl'
rml_template_file_in = open(rml_template_file, 'r')
rml_mapping_file_out = open(rml_mapping_file, 'w')
for line in rml_template_file_in:
    rml_mapping_file_out.write(line.replace('${input_file}', input_file))
rml_template_file_in.close()
rml_mapping_file_out.close()

log4j = '-Dlog4j.configuration=file://'+GEOTRIPLES_HOME+'/log4j.properties'

try:
    # java -jar ../../target/geotriples-1.0.5-SNAPSHOT-cmd.jar dump_rdf
    #       -ns namespaces.ns -s 31370 -rml -o output.rdf  mapping.rml.ttl
    cmd_str = "%s %s -jar '%s' %s -ns '%s' -s 31370 -rml -o '%s' '%s'" % \
              (jre, log4j, jar, cmd, namespaces_file, output_file, rml_mapping_file)
    print(cmd_str)
    status = subprocess.Popen(cmd_str, shell=True, \
                              stdout=subprocess.PIPE).stdout.read()
except Exception as e:
    status = 'Failed with exception: %s' % str(e)

# ----------------------------------------------------------------------------------
# The wrapper must return a dictionary that contains the output parameter values.
# ----------------------------------------------------------------------------------

return {
    'status': status,
    'output_file': output_file
}
```

Figure 69 – Example `process_wrapper.py` executing a SNAP graph

D.3 Execution of local shell scripts

The following code gives an example of process wrapper function that executes a local shell script whose name is provided in the "`script`" input parameter. Other input values are passed to the Bash script as well.

This particular example is used to execute a process pre-deployed at HLRS, get back the output of the process (`showresult`), as well as retrieve the input text (`showinput`). This last step is included for testing purpose.

```
# ------------------------------------------------------------------------------------
# Save this code in file "process_wrapper.py" and adapt as indicated in inline comments.
#
# Notes:
#  - This is a Python 2 script. It is incompatible with Python 3.
#  - The inputs will be given values by name, thus their order has no importance ...
#  - ... except that the inputs with a default value must be listed last.
#  - Parameter names are automatically converted into valid Python variable names.
#  - Any empty line or line starting with a '#' character will be ignored.
# ------------------------------------------------------------------------------------

def execute(out_dir, script, username, key, input_file, output_file):
    """
    Identification:
    Name -- EOPEN HLRS SSH Integration
    Description -- Proof-of-concept for EOPEN HLRS Integration. Running a SPARK example
through ssh. Implemented for 16/11/2018 review.
    Version -- 1
    Author -- Space Applications Services
    Mission -- eopen

    Inputs:
    script -- Script -- 45/User String
    username -- Username -- 45/User String
    key -- Key -- 45/User String
    input_file -- Input File -- 45/User String
    output_file -- Output File -- 45/User String

    Outputs:
    input_content -- Input content -- 45/User String
    result -- Result -- 45/User String
    logs -- Logs -- 45/User String

    Main Dependency:
    python-2

    Processing Resources:
    ram -- 1
    disk -- 1
    cpu -- 1

    """
    input_content = None
    result = None
    logs = None

    # --------------------------------------------------------------------------------
    # Insert your own code below.
    # Store the generated files in the "out_dir" folder. Anything else is dropped after
    # each process execution.
    # Give appropriate values to the ouput parameters. These will be passed to the next
    # process(es) following the worklow connections.
    # --------------------------------------------------------------------------------
    import subprocess
    proc = subprocess.Popen(
               ['bash', script, 'execute', username, key, input_file, output_file],
               stdout=subprocess.PIPE, stderr=subprocess.STDOUT)
    logs = proc.stdout.read()
    proc = subprocess.Popen(
               ['bash', script, 'showresult', username, key, input_file, output_file],
               stdout=subprocess.PIPE, stderr=subprocess.STDOUT)
    result = proc.stdout.read()
    proc = subprocess.Popen(
               ['bash', script, 'showinput', username, key, input_file, output_file],
               stdout=subprocess.PIPE, stderr=subprocess.STDOUT)
    input_content = proc.stdout.read()
    # ----------------------------------------------------------------------------------
    # The wrapper must return a dictionary that contains the output parameter values.
    # ----------------------------------------------------------------------------------

    return {
        'input_content': input_content,
        'result': result,
        'logs': '<![CDATA[' + logs + ']]>',
    }
```

Figure 70 – Example `process_wrapper.py` executing Bash scripts