ZONE OVERPASS TOOL – FILE TRANSFER DOCUMENT

1. INTRODUCTION

This is the File Transfer Document for the ZoneOverPass executable program that calculates the entry and exit time when a given instrument swath passes over a zone or set of zones.

1.1 Change History

Issue	Change Description
1.3	First Issue
1.3.1	Update *mission_configuration_files* folder to v1.2
1.4	Update *mission_configuration_files* folder to v1.3 ZoneOverPass generates HTML output files Corrected path to ORBIT SDF for Aeolus
1.4.1	Update *mission_configuration_files* folder to v1.4
2.0	Distinguish between Ground Site (zone with num_points=1) and Zone in output files For Ground Site, calculate distance to ground track Swath filename in configuration file User-defined Swath identifier in configuration file Update *mission_configuration_files* folder to v1.5
2.0.1	Update *mission_configuration_files* folder to v1.6
2.1	Add support for TLE files Add support for non pre-defined missions (using satellite configuration file)
2.1.1	Update *mission_configuration_files* folder to v1.10
2.2	Draw circle of given radius around ground sites in KML output Add balloon in KML for point-zone Add relative orbit number if orbit file input is Orbit Scenario File (ORBSCT type) Update *mission_configuration_files* folder to v1.12
2.3	Add cycle number to output when ORBSCT file type Add GENERIC_MEO Add parameter to input configuration file to set the duration when using TLE file (before 15 days was used as default) Update *mission_configuration_files* folder to v1.17
2.3.1	Disable verbose command to log warning messages in zone calculation function Calculate distance to mid-swath instead of distance to ground-track Enlarge width of HTML report in CSS stylesheet
2.3.2	Correct 0.5 seconds offset in distance to mid-swath output (for point or circle zones) Calculate distance from ground site to satellite and pointing angles from ground site to satellite (for point or circle zones) Add support for SENTINEL1/2/3-C Remove *mission_configuration_files* from package
2.4	Correct issue with KML: coordinates of swath points after step not updated
2.4.1 (internal)	Linked against EO CFI v4.24, before v4.15 Added Target2Satellite azimuth at entry/exit point

	UTC times in CCSDSA with Microseconds (output)
2.5	Added support for CHIME, CIMR, CO2M, CRISTAL, FORUM, LSTM, ROSEL, TRUTHS Added as output site2sun azimuth/elevation topocentric angles, sat2site azimuth/elevation angles in satellite attitude (for ground sites only)

1.2 Reference Documents

[RD 01] Earth Observation Mission Software File Format Specification
Ref. PE-ID-ESA-GS-584 - Issue 1.8- Date: 2022-06-27

[RD 02] OGC® KML Standard
Ref. OGC 12-007r2 - Version: 2.3.0 - Date: 2015-08-04

2. ARCHIVE CONTENT

Separate archive files are available, to support execution in Linux, Mac OS X and Windows platforms.

2.1 Linux 64-bit

The following archive file has been delivered (compressed with the zip utility):
ZoneOverPass_LINUX64_v2_5_date_15_JUN_2023.zip

The archive has the following MD5 checksum:
a0cf51fb311ce80de50f33a5dca22a96

The archive contains the following files:
```
input_config_file_S2A_MSI.txt
input_config_file_S2A_ORBIT.txt
input_config_file_S3A_OLCI.txt
example_input_files/…
overpass_table.css
Readme.txt
ZoneOverPass
```

2.2 macOS Intel 64-bit

The following archive file has been delivered (compressed with the zip utility):
ZoneOverPass_MACIN64_v2_5_date_15_JUN_2023.zip

The archive has the following MD5 checksum:
dca0357ad4c91b15c69fedc63889af

The archive contains the following files:
```
input_config_file_S2A_MSI.txt
input_config_file_S2A_ORBIT.txt
input_config_file_S3A_OLCI
example_input_files/…
overpass_table.css
Readme.txt
ZoneOverPass
```

2.3 Windows 64-bit

The following archive file has been delivered (compressed with the zip utility):
ZoneOverPass_WINDOWS64_v2_5_date_15_JUN_2023.zip

The archive has the following MD5 checksum:
aa3494f14a8b3e4c48daceb6cdee72

The archive contains the following files:
input_config_file_S2A_MSI.txt
input_config_file_S2A_ORBIT.txt
input_config_file_S3A_OLCI
overpass_table.css
pthreadVC2.dll
example_input_files\…
Readme.txt
ZoneOverPass.exe

3. ARCHIVE CONTENT DESCRIPTION

The files contained in the archives are described in table below:

File		Description
EXAMPLE_ZONEDBFILE.EOF		Example Zone Database File
input_config_file_S2A_MSI.txt		Example configuration file of SENTINEL2A with MSI swath, with example zone database file
input_config_file_S3A_ORBIT.txt		Example configuration file of SENTINEL3A with ORBIT ground-track, with example zone database file
input_config_file_S3A_OLCI.txt		Example configuration file of SENTINEL3A with OLCI swath, with example zone database file
example_input_files/…		Example input orbit files and swath files Note: Package with mission files for all supported missions can be found under the link: http://eop-cfi.esa.int/Repo/PUBLIC/DOCUMENTATION/MISSION_DATA/ORBIT_SWATH_DATA/ See Readme_mission_config.txt for further details
Readme.txt		Readme file with example commands and input/output file description
overpass_table.css		CSS stylesheet file for HTML output
For LINUX 64-bit	ZoneOverPass	Executable file for Linux
For macOS Intel 64-bit	ZoneOverPass	Executable file for macOS Intel
For WINDOWS 64-bit	ZoneOverPass.exe	Executable file for Windows
	pthreadVC2.dll	Auxiliary pthread library for Windows

4. INSTALLATION

The archive can be expanded with Winzip / 7-zip (in MS Windows) or with the command unzip (in Linux/Mac OS).

5. USAGE

5.1 Executable program *ZoneOverPass*

For a requested UTC time interval, the executable program *ZoneOverPass* calculates the entry and exit times when a given instrument swath passes over a zone or set of zones. The program expects as input a configuration file setting the various input parameters, among them the mission name, orbit file, zone database file and instrument swath name.

The default orbit and swath characteristics are defined in the mission configuration files folder. It is possible to provide as orbit file other types of EOCFI-compatible OSV-based orbit files see ([RD 01]), e.g. Predicted Orbit File (ORBPRE file type), Restituted Orbit Files (ORBRES file type), OEM files, etc.

The program generates a set of output files with the overpass tables per zone (in .CSV, .KML format and .HTML format).

5.1.1 Command line input parameters description

The command line parameters of the executable routine are the following (provided in the order in which they have to be supplied):

INPUT PARAMETERS	Definition	Value
Input Configuration File	Filename (it may include the path to the file)	Given by the user
UTC Start Time	UTC start time of the time interval CCSDS-A ASCII format with seconds (YYYY-MM-DDTHH:mm:ss)	Given by the user
UTC Stop Time	UTC stop time of the time interval CCSDS-A ASCII format with seconds (YYYY-MM-DDTHH:mm:ss)	Given by the user

5.1.2 Input configuration file format description

The contents of the input configuration file are detailed below:

INPUT PARAMETERS	Definition	Value
Satellite	Satellite identifier	AEOLUS CHIME CIMR CO2M CRISTAL CRYOSAT2 EARTHCARE FLEX FORUM LSTM METOPSG ROSEL SEOSAT SENTINEL1A SENTINEL1B SENTINEL1C SENTINEL2A SENTINEL2B SENTINEL2C SENTINEL3A SENTINEL3B SENTINEL3C SENTINEL5P SENTINEL6 SMOS TRUTHS GENERIC (see Section 5.2) Mission Name String (see Section 5.2) GENERIC_MEO
Orbit Filename	Orbit Filename	Given by the user

	Default: Orbit Scenario Filename in mission_configuration_files folder	
Instrument Swath	Instrument Swath Filename Default: Swath Definition Files in mission_configuration_files folder	Given by the user
Zone Database Filename	File with list of zones, in EO CFI / Esov NG Zone Database format	Given by the user
Swath Colour	Swath Color (aabbggrr, aa=alpha, bb=blue, gg=green rr=red, with ranges 00 to ff)	Given by the user
TLE number of days	Number of days to propagate after TLE record time (e.g to propagate for one month into the future, set to 30.0). If orbit file type other than TLE, this parameters is not used	Given by the user

5.1.3 Output file format description

The executable program *ZoneOverPass* produces two output files per zone in Zone Database file:

- Comma Separated Value (.CSV)
- Google Earth KML file (.KML)
- Web browser HTML file (.HTML)

The output file names are automatically generated using the satellite identifier, the zone name, the swath name and the start and stop UTC times.

5.1.3.1 CSV Files

5.1.3.1.1 <u>If ORBSCT is given as input orbit file</u>

The CSV output file contains one row per each entry/exit visibility time segment, format of the CSV output file:

- Row 1-7: Header containing execution input information
- From Row 8:
  - Column 1: UTC Time Start in calendar format (CCSDS format “yyyy-mm-ddThh:mm:ss”)
  - Column 2: Absolute Orbit Start
  - Column 3: Relative Orbit Start
  - Column 4: Cycle Start
  - Column 5: Start Seconds since Ascending Node Crossing (ANX)
  - Column 6: Topocentric Azimuth (Heading) from satellite to site at entry point [deg]
  - Column 7: UTC Time Stop in calendar format (CCSDS format “yyyy-mm-ddThh:mm:ss”)
  - Column 8: Absolute Orbit Stop
  - Column 9: Relative Orbit Stop
  - Column 10: Cycle Stop
  - Column 11: Stop Seconds since Ascending Node Crossing (ANX)
  - Column 12: Topocentric Azimuth (Heading) from satellite to site at exit point [deg]
  - Column 13: Pass Duration (seconds)
  - Column 14 (optional, if Ground Site): Distance from site to mid-swath [km] is the geodetic distance between the two points. The mid-swath point corresponds to the mid-point of the swath file at the time half-way between entry and exit times of the ground site circle
  - Column 15 (optional, if Ground Site): Topocentric Azimuth from site to satellite [deg]
  - Column 16 (optional, if Ground Site): Topocentric Elevation from site to satellite [deg]
  - Column 17 (optional, if Ground Site): Range from site to satellite [km]
  - Column 18 (optional, if Ground Site): Topocentric Azimuth from site to Sun [deg]
  - Column 19 (optional, if Ground Site): Topocentric Elevation from site to Sun [deg]
  - Column 20 (optional, if Ground Site): Satellite Attitude Azimuth from satellite to site [deg]
  - Column 21 (optional, if Ground Site): Satellite Attitude Elevation from satellite to site [deg]
  - Column 22 (14): Ascending or Descending Pass (ASC/DESC)

- Column 23 (15): Zone/Ground Site Name
- Column 24 (16): Instrument Swath Name

- Last Row: End of file (EOF)

5.1.3.1.2 If input orbit file other than ORBSCT

The CSV output file contains one row per each entry/exit visibility time segment, format of the CSV output file:

- Row 1-7: Header containing execution input information
- From Row 8:
  - Column 1: UTC Time Start in calendar format (CCSDS format “yyyy-mm-ddThh:mm:ss”)
  - Column 2: Absolute Orbit Start
  - Column 3: Start Seconds since Ascending Node Crossing (ANX)
  - Column 4: Topocentric Azimuth (Heading) from satellite to site at entry point [deg]
  - Column 5: UTC Time Stop in calendar format (CCSDS format “yyyy-mm-ddThh:mm:ss”)
  - Column 6: Absolute Orbit Stop
  - Column 7: Stop Seconds since Ascending Node Crossing (ANX)
  - Column 8: Topocentric Azimuth (Heading) from satellite to site at exit point [deg]
  - Column 9: Pass Duration (seconds)
  - Column 10 (optional, if Ground Site): Distance from site to mid-swath [km] is the geodetic distance between the two points. The mid-swath point corresponds to the mid-point of the swath file at the time half-way between entry and exit times of the ground site circle
  - Column 11 (optional, if Ground Site): Topocentric Azimuth from site to satellite [deg]
  - Column 12 (optional, if Ground Site): Topocentric Elevation from site to satellite [deg]
  - Column 13 (optional, if Ground Site): Range from site to satellite [km]
  - Column 14 (optional, if Ground Site): Topocentric Azimuth from site to Sun [deg]
  - Column 15 (optional, if Ground Site): Topocentric Elevation from site to Sun [deg]
  - Column 16 (optional, if Ground Site): Satellite Attitude Azimuth from satellite to site [deg]
  - Column 17 (optional, if Ground Site): Satellite Attitude Elevation from satellite to site [deg]
  - Column 18 (10): Ascending or Descending Pass (ASC/DESC)
  - Column 19 (11): Zone/Ground Site Name
  - Column 20 (12): Instrument Swath Name
- Last Row: End of file (EOF)

The CSV files can be opened with dedicated spreadsheet software (e.g. Excel, LibreOffice) or any text editor.

5.1.3.2 KML Files

The KML output file contains the same information as the CSV but presented graphically.
The format of the provided KML files is defined in KML Version 2.3 standard (see [RD 02]).

The KML files can be opened with Google Earth v7 or higher.

5.1.3.3 HTML Files

The HTML output file contains the same information as the CSV but presented in a tabular format, ready to be displayed in a web browser. A CSS stylesheet (*overpass_table.css*) is provided as part of the package to apply a given style to the HMTL elements. The HTML output file requires the CSS stylesheet to be located in the same folder.

The HTML files can be opened with any web browser (e.g. Firefox). Once opened in a web browser, it is possible to export the HTML report to PDF (Print as PDF).

5.1.4 Example

5.1.4.1 Running the executable

The executable program can be called in the following way:

- From Mac OSX / Linux Terminal window

```
./ZoneOverPass input_config_file_S2A_MSI.txt 2023-06-21T00:00:00 2023-06-24T00:00:00
```

- From Windows command prompt window

```
ZoneOverPass.exe input_config_file_S2A_MSI.txt 2023-06-21T00:00:00 2023-06-24T00:00:00
```

The executable program shows the following messages:

```
Execution of program ZoneOverPass v2.5

Input data set by the user:
Satellite: SENTINEL2A
Orbit File:
./example_input_files/SENTINEL2A/OSF/S2A_OPER_MPL_ORBSCT_20150625T073255_99999999T999999_0009.EOF
Swath File: ./example_input_files/SENTINEL2A/SDF/SDF_MSI.S2
Swath ID: MSI
Zone File: ./example_input_files/EXAMPLE_ZONEDBFILE.EOF
Start Time: 2023-06-21T00:00:00
Stop  Time: 2023-06-24T00:00:00
Start Time: 8572.000000000000
Stop Time: 8575.000000000000
Start Orbit: 41754
Stop  Orbit: 41797

Output Filename KML:
S2A_EXAMPLE_CIRCLE_MSI_VISIBILITY_SEGMENTS_20230621_000000_20230624_000000_0001.KML
Output Filename CSV:
S2A_EXAMPLE_CIRCLE_MSI_VISIBILITY_SEGMENTS_20230621_000000_20230624_000000_0001.CSV
Output Filename HTML:
S2A_EXAMPLE_CIRCLE_MSI_VISIBILITY_SEGMENTS_20230621_000000_20230624_000000_0001.HTML
Output Filename KML:
S2A_EXAMPLE_POINT_MSI_VISIBILITY_SEGMENTS_20230621_000000_20230624_000000_0001.KML
Output Filename CSV:
S2A_EXAMPLE_POINT_MSI_VISIBILITY_SEGMENTS_20230621_000000_20230624_000000_0001.CSV
Output Filename HTML:
S2A_EXAMPLE_POINT_MSI_VISIBILITY_SEGMENTS_20230621_000000_20230624_000000_0001.HTML
Output Filename KML: S2A_AFRICA_MSI_VISIBILITY_SEGMENTS_20230621_000000_20230624_000000_0001.KML
Output Filename CSV: S2A_AFRICA_MSI_VISIBILITY_SEGMENTS_20230621_000000_20230624_000000_0001.CSV
Output Filename HTML: S2A_AFRICA_MSI_VISIBILITY_SEGMENTS_20230621_000000_20230624_000000_0001.HTML
Output Filename KML: S2A_PACIFIC_AREA_MSI_VISIBILITY_SEGMENTS_20230621_000000_20230624_000000_0001.KML
Output Filename CSV: S2A_PACIFIC_AREA_MSI_VISIBILITY_SEGMENTS_20230621_000000_20230624_000000_0001.CSV
Output Filename HTML:
S2A_PACIFIC_AREA_MSI_VISIBILITY_SEGMENTS_20230621_000000_20230624_000000_0001.HTML

Output files created successfully
```

5.1.4.2 Input File

Contents of the input configuration file used as example (`input_config_file_S2A_MSI.txt`):

```
SENTINEL2A
./example_input_files/SENTINEL2A/OSF/S2A_OPER_MPL_ORBSCT_20150625T073255_99999999T999999_0009.EOF
./example_input_files/SENTINEL2A/SDF/SDF_MSI.S2
./example_input_files/EXAMPLE_ZONEDBFILE.EOF
MSI
500000ff
15.0
```

5.1.4.3 Output Files

5.1.4.3.1 CSV Files

Several CSV output files are created (on per zone in zone database file):

S2A_AFRICA_MSI_VISIBILITY_SEGMENTS_20230621_000000_20230624_000000_0001.CS
S2A_EXAMPLE_CIRCLE_MSI_VISIBILITY_SEGMENTS_20230621_000000_20230624_000000_0001.CSV
S2A_EXAMPLE_POINT_MSI_VISIBILITY_SEGMENTS_20230621_000000_20230624_000000_0001.CSV
S2A_PACIFIC_AREA_MSI_VISIBILITY_SEGMENTS_20230621_000000_20230624_000000_0001.CSV

Example ZONE output file
S2A_AFRICA_MSI_VISIBILITY_SEGMENTS_20230621_000000_20230624_000000_0001.CSV:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	FILENAME	S2A_AFRICA_MSI_VISIBILITY_SEGMENTS_20230621_000000_20230624_000000_0001.CSV															
2	CREATION_DATE	2023-06-15T13:24:56															
3	EXECUTABLE_NAME_VERSION	ZoneOverPass_v2.5															
4	MISSION	SENTINEL2A															
5	ORBIT_FILE	/example_input_files/SENTINEL2A/OSF/S2A_OPER_MPL_ORBSCT_20150625T073255_99999999T999999_0009.EOF															
6	ZONE	AFRICA															
7	VALIDITY_START	2023-06-21T00:00:00															
8	VALIDITY_STOP	2023-06-24T00:00:00															
9	PASS	UTC_TIME_START	ABS_ORBIT_START	REL_ORBIT_START	CYCLE_START	ANX_TIME_START[s]	SATELLITE_TO_SITE_TOP_AZIMUTH_START [deg]	UTC_TIME_STOP	ABS_ORBIT_STOP	REL_ORBIT_STOP	CYCLE_STOP	ANX_TIME_STOP[s]	SATELLITE_TO_SITE_TOP_AZIMUTH_STOP [deg]	DURATION[s]	ASCENDING/DESCENDING PASS	ZONE	SWATH
10	1	2023-06-21T07:36:55.682386	41759	6	297	2836,619778	178,535605	2023-06-21T07:40:24.098139	41759	6	297	3045,035531	169,233293	208,415753	DESC	AFRICA	MSI
11	2	2023-06-21T07:42:37.880179	41759	6	297	3178,817571	153,158846	2023-06-21T07:44:54.353358	41759	6	297	3315,29075	106,029667	136,473179	DESC	AFRICA	MSI
12	3	2023-06-21T09:11:45.296806	41760	7	297	2484,276156	155,631381	2023-06-21T09:26:33.818209	41760	7	297	3372,797559	93,06239	888,521403	DESC	AFRICA	MSI
13	4	2023-06-21T10:50:58.324784	41761	8	297	2395,346092	135,182541	2023-06-21T11:00:05.819669	41761	8	297	2942,840977	116,548408	547,494885	DESC	AFRICA	MSI
14	5	2023-06-21T20:10:14.813957	41766	13	297	5742,045055	104,152399	2023-06-21T20:24:11.301115	41767	14	297	536,574171	157,11151	836,487158	ASC	AFRICA	MSI
15	6	2023-06-21T21:47:25.600488	41767	14	297	5530,873544	75,572206	2023-06-21T21:51:46.060325	41767	14	297	5791,333381	103,039455	260,459837	ASC	AFRICA	MSI
16	7	2023-06-21T21:55:24.908913	41767	14	297	6010,181969	118,55288	2023-06-21T21:56:05.566804	41768	15	297	8,881818	120,663127	40,657891	ASC	AFRICA	MSI
17	8	2023-06-21T21:57:13.198700	41768	15	297	76,513714	123,721442	2023-06-21T22:05:59.637671	41768	15	297	602,952685	133,829541	526,438971	ASC	AFRICA	MSI
18	9	2023-06-22T08:41:38.500738	41774	21	297	2490,0675	163,898473	2023-06-22T08:59:48.858426	41774	21	297	3580,425188	69,054351	1090,357688	DESC	AFRICA	MSI
19	10	2023-06-22T10:20:45.672370	41775	22	297	2395,28109	141,545747	2023-06-22T10:29:34.948781	41775	22	297	2924,557501	120,644915	529,276411	DESC	AFRICA	MSI
20	11	2023-06-22T19:44:34.399871	41780	27	297	6014,218382	167,648613	2023-06-22T19:52:48.539068	41781	28	297	466,399537	166,145464	494,139197	ASC	AFRICA	MSI
21	12	2023-06-22T21:16:11.613823	41781	28	297	5469,474292	58,676643	2023-06-22T21:36:06.548955	41782	29	297	622,451382	140,086042	1194,935132	ASC	AFRICA	MSI
22	13	2023-06-22T23:07:56.696729	41783	30	297	90,641114	115,87882	2023-06-22T23:13:38.542427	41783	30	297	432,486812	121,099244	341,845698	ASC	AFRICA	MSI
23	14	2023-06-23T08:14:06.682362	41788	35	297	2650,836537	168,214009	2023-06-23T08:29:46.245144	41788	35	297	3590,399319	58,427358	939,562782	DESC	AFRICA	MSI
24	15	2023-06-23T09:51:58.626717	41789	36	297	2480,82285	145,545553	2023-06-23T09:59:41.337593	41789	36	297	2943,533726	124,010289	462,710876	DESC	AFRICA	MSI
25	16	2023-06-23T11:32:18.730158	41790	37	297	2458,968249	125,95799	2023-06-23T11:38:36.345431	41790	37	297	2836,583522	116,326415	377,615273	DESC	AFRICA	MSI
26	17	2023-06-23T19:16:08.420295	41795	42	297	78,868176	184,857012	2023-06-23T19:17:46.017812	41795	42	297	176,465693	181,540958	97,597517	ASC	AFRICA	MSI
27	18	2023-06-23T20:46:51.516521	41795	42	297	5521,964402	53,471473	2023-06-23T21:04:30.217351	41796	43	297	538,70719	146,760582	1058,70083	ASC	AFRICA	MSI
28	19	2023-06-23T22:37:40.546313	41797	44	297	87,07811	118,720438	2023-06-23T22:45:27.519243	41797	44	297	554,05104	126,315029	466,97293	ASC	AFRICA	MSI
29	EOF																

Example of GROUND_SITE output file
S2A_EXAMPLE_CIRCLE_MSI_VISIBILITY_SEGMENTS_20230621_000000_20230624_000000_0001.CSV:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y
1	FILENAME	S2A_EXAMPLE_CIRCLE_MSI_VISIBILITY_SEGMENTS_20230621_000000_20230624_000000_0001.CSV																							
2	CREATION	2023-06-15T13:24:56																							
3	EXECUTAB	ZoneOverPass_v2.5																							
4	MISSION	SENTINEL2A																							
5	ORBIT_FIL	/example_input_files/SENTINEL2A/OSF/S2A_OPER_MPL_ORBSCT_20150625T073255_99999999T999999_0009.EOF																							
6	GROUND_	EXAMPLE_CIRCLE																							
7	GROUND_	5																							
8	VALIDITY_	2023-06-21T00:00:00																							
9	VALIDITY_	2023-06-24T00:00:00																							
10	PASS	UTC_TIME_START	ABS_ORBIT_START	REL_ORBIT_START	CYCLE_START	ANX_TIME_START[s]	SATELLITE_TO_SITE_TOP_AZIMUTH_START[deg]	UTC_TIME_STOP	ABS_ORBIT_STOP	REL_ORBIT_STOP	CYCLE_STOP	ANX_TIME_STOP[s]	SATELLITE_TO_SITE_TOP_AZIMUTH_STOP[deg]	DURATION[s]	DISTANCE_TO_MID_SWATH[km]	SITE_TO_SATELLITE_TOP_AZIMUTH[deg]	SITE_TO_SATELLITE_TOP_ELEVATION[deg]	SITE_TO_SATELLITE_RANGE[km]	SITE_TO_SUN_TOP_AZIMUTH[deg]	SITE_TO_SUN_TOP_ELEVATION[deg]	SATELLITE_TO_SITE_AZIMUTH_ATT[deg]	SATELLITE_TO_SITE_ELEVATION_ATT[deg]	ASCENDING/DESCENDING PASS	GROUND_SITE	SWATH
11	1	2023-06-21T23:47:14.846325	41769	16	297	636,203297	65,54716	2023-06-21T23:47:16.336601	41769	16	297	637,693573	80,690019	1,490276	36,930015	253,307897	86,955906	794,660884	330,944441	-22,951846	83,888307	87,292776	ASC	EXAMPLE_CIRCLE	MSI
12	EOF																								

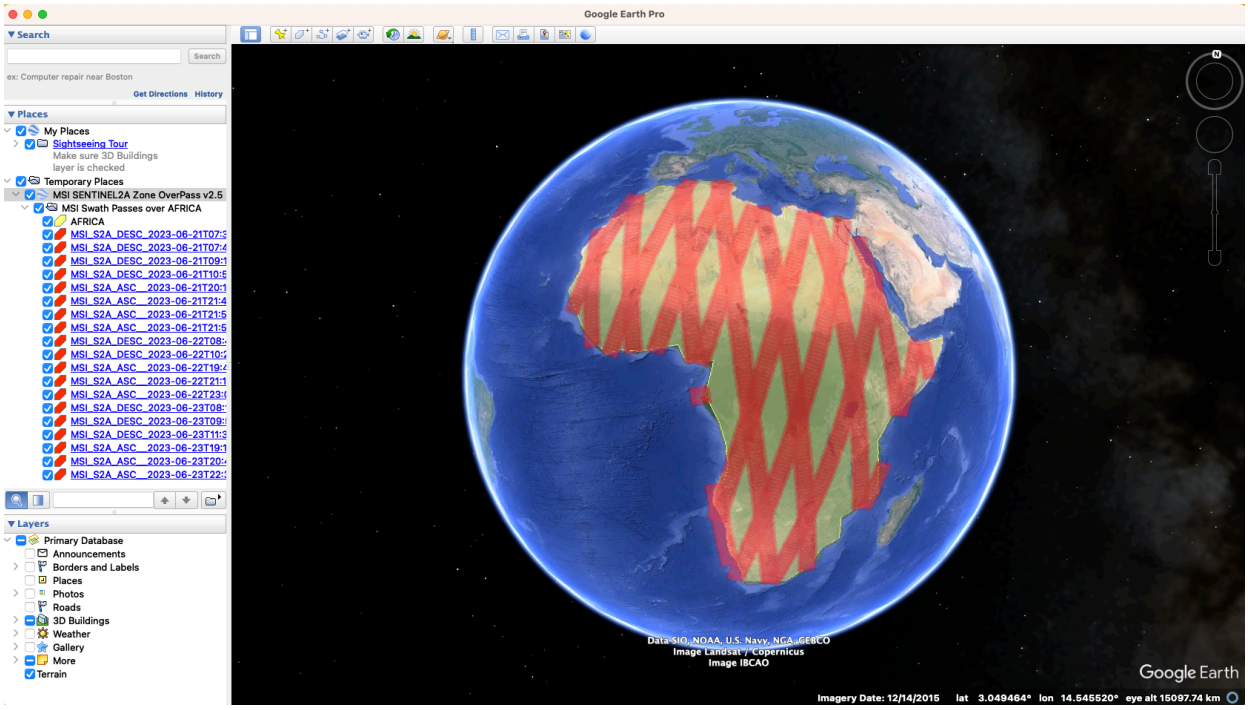
5.1.4.3.2 KML Files

Several KML output files are created (on per zone in zone database file):

S2A_EXAMPLE_CIRCLE_MSI_VISIBILITY_SEGMENTS_20230621_000000_20230624_000000_0001.KML
S2A_EXAMPLE_POINT_MSI_VISIBILITY_SEGMENTS_20230621_000000_20230624_000000_0001.KML
S2A_AFRICA_MSI_VISIBILITY_SEGMENTS_20230621_000000_20230624_000000_0001.KML
S2A_PACIFIC_AREA_MSI_VISIBILITY_SEGMENTS_20230621_000000_20230624_000000_0001.KML

After loading the files with Google Earth, the overpass data can be found in the “Places” window, under “Temporary Places”.

Example of ZONE output file
S2A_AFRICA_MSI_VISIBILITY_SEGMENTS_20230621_000000_20230624_000000_0001.KML:



When moving the mouse over the swaths, the lines are highlighted (increase in thickness and lighter in colour). Then by clicking on top of the track, a balloon showing additional information is displayed, namely the absolute and relative orbit number sand the longitude and UTC time of the ascending node crossing of the selected orbit.

5.1.4.3.3 HTML Files

Several HTML output files are created (on per zone in zone database file):

S2A_EXAMPLE_CIRCLE_MSI_VISIBILITY_SEGMENTS_20230621_000000_20230624_000000_0001.HTML
S2A_EXAMPLE_POINT_MSI_VISIBILITY_SEGMENTS_20230621_000000_20230624_000000_0001.HTML
S2A_AFRICA_MSI_VISIBILITY_SEGMENTS_20230621_000000_20230624_000000_0001.HTML
S2A_PACIFIC_AREA_MSI_VISIBILITY_SEGMENTS_20230621_000000_20230624_000000_0001.HTML

By double-clicking on the HTML file, it opens with the default browser, applying the style from CSS stylesheet.
Example of ZONE output file *S2A_AFRICA_MSI_VISIBILITY_SEGMENTS_20230621_000000_20230624_000000_0001.HTML*:

ZONE OVERPASS TABLE HTML REPORT

Creation Date: 2023-06-15T13:24:56

Filename	S2A_AFRICA_MSI_VISIBILITY_SEGMENTS_20230621_000000_20230624_000000_0001.HTML
Executable Name and Version	ZoneOverPass_v2.5
Mission	SENTINEL2A
Orbit File	./example_input_files/SENTINEL2A/OSF/S2A_OPER_MPL_ORBSCT_20150625T073255_99999999T999999_0009.EOF
Zone	AFRICA
Validity Start	2023-06-21T00:00:00
Validity Stop	2023-06-24T00:00:00

Zone Overpass Table

Pass	UTC Time Start	Abs Orbit Start	Rel Orbit Start	Cycle Start	ANX Time Start[s]	Satellite to Site Topocentric Azimuth Start[deg]	UTC Time Stop	Abs Orbit Stop	Rel Orbit Stop	Cycle Stop	ANX Time Stop[s]	Satellite to Site Topocentric Azimuth Stop[deg]	Duration[s]	Ascending / Descending	Zone	Swath
1	2023-06-21T07:36:55.682386	41759	6	297	2836.619778	178.535605	2023-06-21T07:40:24.098139	41759	6	297	3045.035531	169.233293	208.415753	DESC	AFRICA	MSI
2	2023-06-21T07:42:37.880179	41759	6	297	3178.817571	153.158846	2023-06-21T07:44:54.353358	41759	6	297	3315.290750	106.029667	136.473179	DESC	AFRICA	MSI
3	2023-06-21T09:11:45.296806	41760	7	297	2484.276156	155.631381	2023-06-21T09:26:33.818209	41760	7	297	3372.797559	93.062390	888.521403	DESC	AFRICA	MSI
4	2023-06-21T10:50:58.324784	41761	8	297	2395.346092	135.182541	2023-06-21T11:00:05.819669	41761	8	297	2942.840977	116.548408	547.494885	DESC	AFRICA	MSI
5	2023-06-21T20:10:14.813957	41766	13	297	5742.045055	104.152399	2023-06-21T20:24:11.301115	41767	14	297	536.574171	157.111510	836.487158	ASC	AFRICA	MSI
6	2023-06-21T21:47:25.600488	41767	14	297	5530.873544	75.572206	2023-06-21T21:51:46.060325	41767	14	297	5791.333381	103.039455	260.459837	ASC	AFRICA	MSI
7	2023-06-21T21:55:24.908913	41767	14	297	6010.181969	118.552880	2023-06-21T21:56:05.566804	41768	15	297	8.881818	120.663127	40.657891	ASC	AFRICA	MSI
8	2023-06-21T21:57:13.198700	41768	15	297	76.513714	123.721442	2023-06-21T22:05:59.637671	41768	15	297	602.952685	133.829541	526.438971	ASC	AFRICA	MSI

Example of GROUND_SITE output file *S2A_EXAMPLE_CIRCLE_MSI_VISIBILITY_SEGMENTS_20230621_000000_20230624_000000_0001.HTML*:

GROUND SITE OVERPASS TABLE HTML REPORT

Creation Date: 2023-06-15T13:24:56

Filename	S2A_EXAMPLE_CIRCLE_MSI_VISIBILITY_SEGMENTS_20230621_000000_20230624_000000_0001.HTML
Executable Name and Version	ZoneOverPass_v2.5
Mission	SENTINEL2A
Orbit File	./example_input_files/SENTINEL2A/OSF/S2A_OPER_MPL_ORBSCT_20150625T073255_99999999T999999_0009.EOF
Ground Site	EXAMPLE_CIRCLE
Ground Site Radius	5.000000 km
Validity Start	2023-06-21T00:00:00
Validity Stop	2023-06-24T00:00:00

Ground Site Overpass Table

Pass	UTC Time Start	Abs Orbit Start	Rel Orbit Start	Cycle Start	ANX Time Start[s]	Satellite to Site Topocentric Azimuth Start[deg]	UTC Time Stop	Abs Orbit Stop	Rel Orbit Stop	Cycle Stop	ANX Time Stop[s]	Satellite to Site Topocentric Azimuth Stop[deg]	Duration[s]	Distance from Site to Mid-Swath[km]	Site to Satellite Topocentric Azimuth[deg]	Site to Satellite Topocentric Elevation[deg]	Site to Satellite Range[km]	Site to Sun Topocentric Azimuth[deg]	Site to Sun Topocentric Elevation[deg]	Satellite to Site Azimuth Attitude[deg]	Satellite to Site Elevation Attitude[deg]	Ascending / Descending	Ground Site	Swath
1	2023-06-21T23:47:14.846325	41769	16	297	636.203297	65.547160	2023-06-21T23:47:16.336601	41769	16	297	637.693573	80.690019	1.490276	36.930015	253.307897	86.955906	794.660884	330.944441	-22.951846	83.888307	87.292776	ASC	EXAMPLE_CIRCLE	MSI

5.2 User-defined Mission Configuration

It is possible to use the ZoneOverPass tool with user-defined missions.

5.2.1 Input Configuration Files

A dedicated input configuration file (see Section 5.1.2) needs to be created to set the satellite identifier, the path of the orbit file and the path to the instrument swath file, among other inputs.

5.2.2 Satellite Identifier

The satellite identifier GENERIC can be used for a user-defined satellite. This identifier assumes certain values for the internal orbit parameters, among them the mean frozen eccentricity which is set to a default value (0.001165). This assumption introduces about 100 meters of error in altitude respect to the orbit that it would be obtained by applying the frozen eccentricity value that would be applicable to the user-defined orbit. For certain applications this approximation is good enough.

For more accurate orbit settings, it is possible to set the internal orbit parameters through a Satellite Configuration File (see [RD 01]). The expected file name of the Satellite Configuration File is *sat_default_conf_file.xml*. In this case, it is possible to set the satellite identifier to a string, which needs to match the mission name given to the user-defined mission folder.

5.2.3 User-defined Mission File Folder Organisation

The user-defined folder must be located at the same level of the *ZoneOverPass* executable tool. As mentioned in Section 5.2.1, the name of the folder should match the string GENERIC or the string set in the input configuration file, depending on the option selected.

5.2.4 Orbit Files

The path to the orbit file is specified in the input configuration file (see Section 5.1.2).
The supported Orbit File types are ORBSCT, ORBPRE, ORBRES and ORBTLE (see [RD 01]) for file format specification.

In the particular case of a TLE file, the format of the TLE should be as follows (example for SENTINEL-1A):

```
SENTINEL-1A
1 39634U 14016A   18203.57882331 -.00000001  00000-0  94119-5 0  9999
2 39634  98.1824 210.5045 0001348  77.6271 282.5085 14.59197755229086
```

For user-defined missions, the TLE parameters need to be set through the Satellite Configuration File [RD 01]. This means that user-defined missions having TLE as orbit file source cannot use the GENERIC identifier (so a Satellite Configuration File needs to be provided).

An intermediate ORBPRE file is created when using TLE files. This is done to improve the performance for TLE propagation beyond 1 day time span.

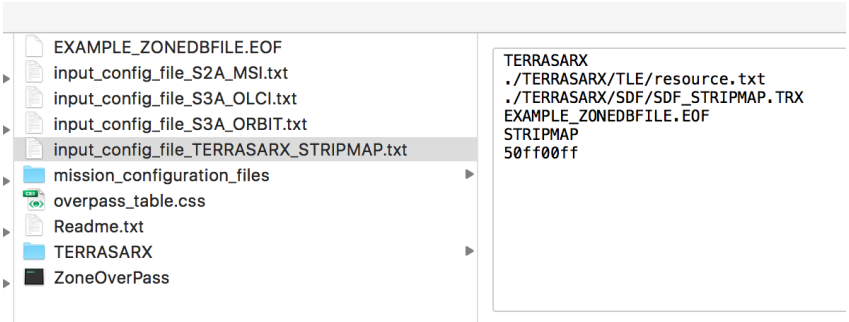
5.2.5 Instrument Swath Definition Files

The path to the instrument swath file is specified in the input configuration file (see Section 5.1.2).
See [RD 01] for file format specification.

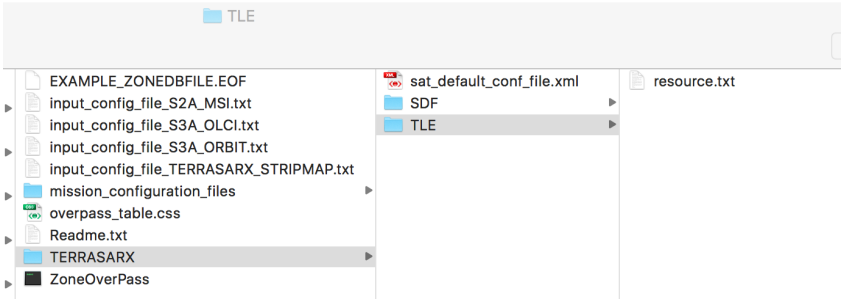
5.2.6 Example

For example, user-defined Mission File Folder TERRASARX in combination with TLE orbit files.

Folder name: TERRASARX
Input Configuration file example: input_config_file_TERRASARX_STRIPMAP.txt



with mission folder contents:



and satellite configuration file *sat_default_config.xml*:

```xml
<?xml version="1.0" encoding="UTF-8"?>
<Earth_Explorer_File
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="http://eop-cfi.esa.int/CFI http://eop-cfi.esa.int/CFI/EE_CFI_SCHEMAS/EO_OPER_INT_SATCFG_0201.XSD"
  schemaVersion="2.1" xmlns="http://eop-cfi.esa.int/CFI">
  <Earth_Explorer_Header>
    <Fixed_Header>
      <File_Name>TRX_TEST_INT_SATCFG_00000000T000000_99999999T999999_0001</File_Name>
      <File_Description>Satellite Configuration</File_Description>
      <Notes></Notes>
      <Mission>TERRASAR-X</Mission>
      <File_Class>TEST</File_Class>
      <File_Type>INT_SATCFG</File_Type>
      <Validity_Period>
        <Validity_Start>UTC=0000-00-00T00:00:00</Validity_Start>
        <Validity_Stop>UTC=9999-99-99T99:99:99</Validity_Stop>
      </Validity_Period>
      <File_Version>0001</File_Version>
      <Source>
        <System>EOCFI</System>
        <Creator>ESTEC</Creator>
        <Creator_Version>1</Creator_Version>
        <Creation_Date>UTC=2017-06-01T12:00:00</Creation_Date>
      </Source>
    </Fixed_Header>
    <Variable_Header></Variable_Header>
  </Earth_Explorer_Header>
   <Data_Block type="xml">
  <Satellite_Name>TERRASAR-X</Satellite_Name>
    <NORAD_Data>
      <Satellite_Number>31698</Satellite_Number>
      <NORAD_Sat_Name>TERRASAR-X</NORAD_Sat_Name>
      <Int_Designator>07026A</Int_Designator>
    </NORAD_Data>
  <Lib_Init>
    <Low_Tolerances>
      <Min_Semi_Major_Axis>6845000.0</Min_Semi_Major_Axis>
      <Max_Semi_Major_Axis>6920000.0</Max_Semi_Major_Axis>
      <Min_Inclination>96.7</Min_Inclination>
      <Max_Inclination>98.4</Max_Inclination>
      <Min_Eccentricity>0.0</Min_Eccentricity>
      <Max_Eccentricity>0.5</Max_Eccentricity>
    </Low_Tolerances>
    <Tight_Tolerances>
      <Min_Semi_Major_Axis>6870000.0</Min_Semi_Major_Axis>
      <Max_Semi_Major_Axis>6895000.0</Max_Semi_Major_Axis>
      <Min_Inclination>97.1</Min_Inclination>
      <Max_Inclination>98.1</Max_Inclination>
      <Min_Eccentricity>0.0</Min_Eccentricity>
      <Max_Eccentricity>0.007</Max_Eccentricity>
    </Tight_Tolerances>
  </Lib_Init>
  <Orbit_Init>
    <Min_Semi_Major_Axis>6882000.0</Min_Semi_Major_Axis>
    <Nom_Semi_Major_Axis>6883513.069846</Nom_Semi_Major_Axis>
    <Max_Semi_Major_Axis>6885000.0</Max_Semi_Major_Axis>
    <Min_Inclination>97.4</Min_Inclination>
    <Nom_Inclination>97.445997</Nom_Inclination>
    <Max_Inclination>97.8</Max_Inclination>
    <Nom_Eccentricity>0.001245</Nom_Eccentricity>
    <Nom_Arg_Perigee>90.0</Nom_Arg_Perigee>
  </Orbit_Init>
   </Data_Block>
</Earth_Explorer_File>
```

6. TECHNICAL DETAILS AND ASSUMPTIONS

6.1 Earth Observation CFI Software Version

The executable has been created using EO CFI SW libraries v4.24.