NWP SAF

MWIPP Version 1 Top Level Design

Version 1.0

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This documentation was developed within the context of the EUMETSAT Satellite Application Facility on Numerical Weather Prediction (NWP SAF), under the Cooperation Agreement dated 7th December 2016, between EUMETSAT and the Met Office, UK, by one or more partners within the NWP SAF. The partners in the NWP SAF are the Met Office, ECMWF, DWD and Météo France.

Change record				
Version	**Date**	**Author**	**Approved**	**Remarks**
0.1	05.04.18	N Atkinson		Initial draft
1.0	13.09.18	N Atkinson	S Pullen	Initial approved version

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1. INTRODUCTION

This document defines the Top Level Design for Version 1 of the Microwave Imager Processing Package (MWIPP), in accordance with the requirements of the NWP SAF. The Top Level Design should be read in conjunction with the Product Specification (RD-1).

1.1 Reference documents

[RD-1] NWPSAF-MO-DS-035, MWIPP Product Specification, v1.0, Feb 2018

1.2 Requirements summary

Version 1 of the MWIPP needs to meet the following high-level requirements:

- Support for SSMIS and AMSR-2. Other instruments will be added later.
- Support for BUFR and hdf5 formats
- Spatial averaging capability
- Re-mapping capability, specifically re-mapping to a user-defined grid
- The design should support future extension to the microwave imagers on Metop-SG (i.e. MWI and ICI)

Specific requirements include:

- Support for the current functionality of the SSMIS_PP Averaging Module, which will allow that deliverable to be withdrawn. Input and output in SSMIS UPP BUFR format (sequence 3-10-025).
- Allows conversion of AMSR-2 native format (hdf5) files to BUFR (local sequence 3-50-254), replicating the AMSR-2 product disseminated operationally by EUMETSAT. This is for the benefit of centres that do not have access to the EUMETSAT product but do have access to native data.

The specification does not mandate support for the GMI and MWRI sensors, but the design naturally accommodates them (section 2).

2. DESIGN

2.1 High-level block diagram

A high-level block diagram is shown in Figure 1. Note that the concept can readily be extended to support other sensors, including MWRI and ICI.

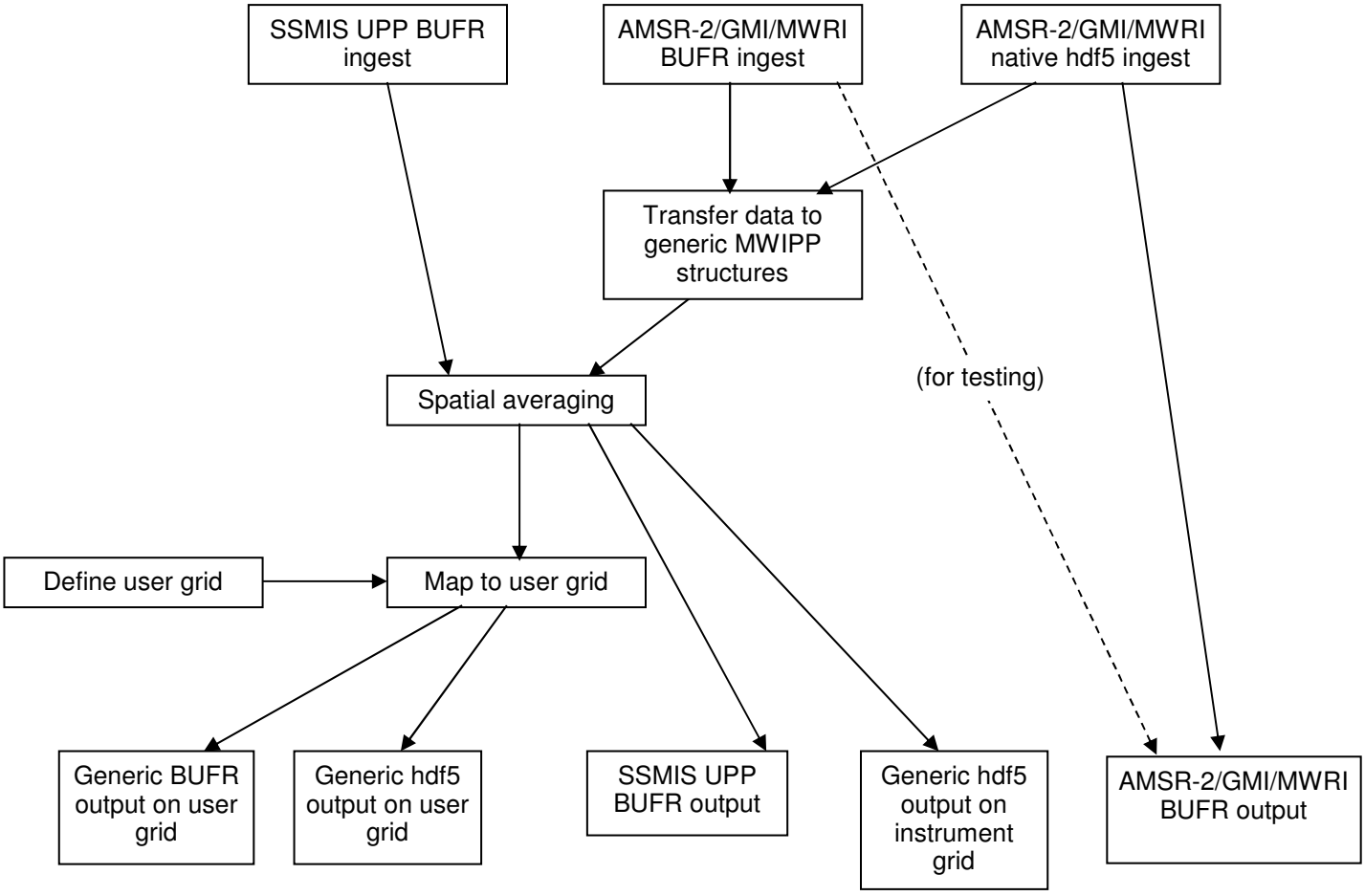

Figure 1: MWIPP block diagram

2.2 External libraries

The software will make use of the following open source libraries:

- ecCodes for BUFR encode/decode (Fortran interfaces): https://software.ecmwf.int/wiki/display/ECC/ecCodes+Home
- hdf5 (Fortran interfaces): https://support.hdfgroup.org/HDF5/index.html

2.3 Source code organisation

The following directory structure is envisaged:

bin (contains executables)
build (contains generated modules and libraries)

src
    bin (main programs)
    libcommon
    libssmis
    libamsr2
    libgmi
    … other instrument-specific libraries

Each instrument will have a separate main program. Command line arguments will specify:

- Input file
- Output file(s)
- Top level namelist

While the top level namelist will specify

- Logical variables indicating which steps are required (e.g. whether averaging is required and whether a user grid is required)
- Names of lower-level namelists, to control the details of the processing (e.g. centre and sub-centre for the BUFR encoding)

Additionally, separate executables may be provided that perform specific functions, such as the conversion of hdf5 to BUFR for AMSR-2 and GMI.

Further details will be provided in the user documentation.

2.4 Build process

External libraries will need to be downloaded and built according to the instructions given by the software provider. Guidelines will be provided in the MWIPP user documentation.

A simple “configure”, “make” system will be used for MWIPP.

2.5 Spatial averaging

Spatial averaging will closely mirror the approach used in SSMIS-PP. For each sample across the scan, nearby samples will be averaged using a set of pre-computed weights. In SSMIS_PP the number of nearby samples was set to 200; in MWIPP this number is configurable (by namelist).

A major difference is that in SSMIS_PP the weights were provided in one-off data files – the code to generate these data files was not provided to users. In MWIPP the weights are computed on-the-fly, using a central portion of the input file to provide the scan geometry. This greatly improves flexibility, and reduces the overall size of the package. There is no significant impact on run time.

Other values specified in the namelist include:

- The averaging domain size, σ (in km), where the weights are given by

$$w_i = \exp\left(-\frac{r_i^2}{2\sigma^2}\right)$$

- A list of channels that are to be averaged
- A rain threshold: if more than this fraction of nearby pixels are rain-flagged in the input file then this pixel is also considered rain-flagged.

2.6 Mapping to a user grid

This is done after spatial averaging. Only nearest neighbour methods are considered. Two distinct approaches are implemented:

1. If it is possible to compute grid position from swath lat/lon (i.e. if a mathematical formula exists), then project each swath point onto the user grid, recording the scan position and scan number as a function of user grid position. If 2 or more swath points map onto the same grid point, choose the best match. Applicable to a regular lat/lon grid.
2. If it is *not* possible to compute grid position from swath position (e.g. if the user grid is arbitrary) then it is proposed to make use of a facility in ecCodes in which the grid is defined in a GRIB file; there is an ecCodes tool to identify the nearest grid point for each swath position. As before, if 2 or more swath points map onto the same grid point, the best match will be chosen. Some sample GRIB files will be provided in the MWIPP test cases.

An approach was considered using AAPP's "invloc", which uses a satpos file generated from orbital elements. However, this is complicated for the user, especially bearing in mind that 2-line elements files for DMSP satellites are not that easy to source. So this method is not implemented.

2.7 BUFR output

BUFR output files can either follow an existing convention, or a generic BUFR sequence can be used.

- SSMIS UPP BUFR output files follow the same format as the input file, but the message subcategory in Section 1 is set to 7 for averaged data. The output file is generated by cloning the input file, and altering only certain values (e.g. brightness temperatures)
- AMSR-2 and GMI BUFR files mirror the corresponding EUMETSAT products (BUFR sequence 350254 and 340012 respectively) and there is currently *no provision for averaged data*.
- For output on the user grid, a generic sequence is envisaged, with the number of channels set by delayed replication. Details of the sequence will be provided in the user documentation.

2.8 hdf5 output

A simple, generic hdf5 output is proposed that will work on both the swath grid and the user grid. It is a direct translation of the various items held in memory in the MWIPP data module.