

JRC TECHNICAL REPORTS

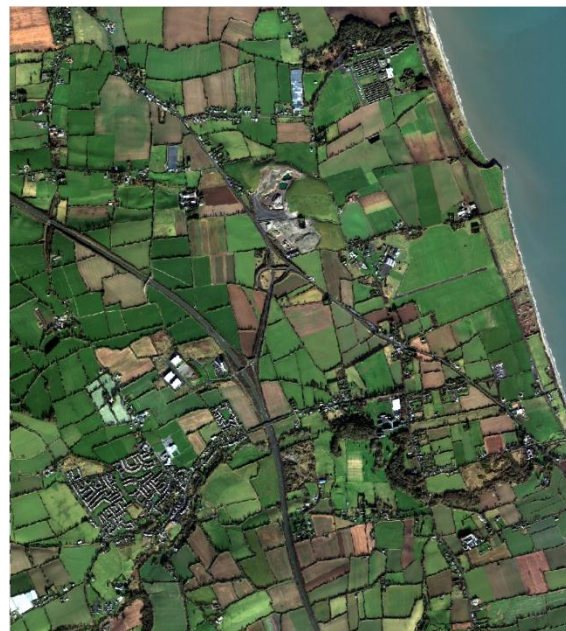
TECHNICAL GUIDANCE

FOR **CWRS** ACCORDING TO THE COUNCIL REGULATION (EC) 1306/2013 (ARTICLES 6(B)21) AND ITS IMPLEMENTING REGULATIONS NO 908/2014 (ARTICLE 26), NO 809/2014 (ARTICLES 24, 38, 39 AND 40), NO 2333/2015, AND FOR THE **LPIS QA** THE DELEGATED REGULATION (EU) NO 640/2014 (ARTICLE 6).

VHR IMAGE ACQUISITION SPECIFICATIONS

CAMPAIGN 2018

Text highlighted in YELLOW contains changes from 2017



<p>Author: Pär Johan ÅSTRAND</p> <p>Co-authors: Blanka VAJSOVA, Csaba WIRNHARDT, Giovanni DI MATTEO, Juergen BREUNIG, Slavko LEMAJIC</p> <p>Agnieszka WALCZYNSKA, Susanne HAIN, Ansgar KORNHOFF, Melanie RANKL, Tine FLINGELLI</p> <p>Approved: Pär Johan ÅSTRAND</p>	<p>Status: V.10</p> <p>Circulation: Internal/Commission, MS administrations and their contractors, FW contractors</p>
<p>Date: 22/03/2018</p>	<p>Int. ref: http://ies-intranet/h04/apps/Chrono/22345.docx earlier years http://ies-intranet/h04/apps/Chrono/21955.docx profiles: http://ies-intranet/h04/apps/Chrono/21615.xls</p>

This publication is a Technical report by the Joint Research Centre (JRC), the European Commission’s science and knowledge service. It aims to provide evidence-based scientific support to the European policy-making process. The scientific output expressed does not imply a policy position of the European Commission. Neither the European Commission nor any person acting on behalf of the Commission is responsible for the use which might be made of this publication.

Contact information

Name: Pär-Johan Åstrand
 Address: Via Fermi 2749, TP272, 27b/033 I-21027 Ispra (VA), Italy
 E-mail: par-johan.astrand@ec.europa.eu
 Tel.: +39.0332.78.6215

JRC Science Hub

<https://ec.europa.eu/jrc>

JRCxxxxx

EUR xxxxx xx

PDF	ISBN xxx-xx-xx-xxxxx-x	ISSN xxxx-xxxx	doi:xx.xxxx/xxxxxx
Print	ISBN xxx-xx-xx-xxxxx-x	ISSN xxxx-xxxx	doi:xx.xxxx/xxxxxx

Ispra, Italy: European Commission, 2017

© European Union, 2017

Reproduction is authorised provided the source is acknowledged.

How to cite: Author(s); title; EUR; doi

All images © European Union 2017,

Table of Contents:

Document history	5
Authors' initials	7
Abbreviations, acronyms and terms	8
1. Introduction	10
2. Pre-image request	13
3. Data requests	14
4. Feasibility assessment	20
5. Acquisition requests	23
6. Quick-look image upload	23
7. Acquisition acceptance – validation	25
8. Ordering.....	27
9. Delivery.....	28
10. Input data quality assessment	28
11. Pricing and invoicing.....	30
12. Image data provision to the JRC (image return) and image access	31
13. VHR image profiles	33
14. Quality assurance/quality control	37
15. Risk of satellite failure	39
16. LPIS QA image acquisition	39
17. JRC responsible staff and e-mail addresses.....	44
18. References	45
19. Annexes	47

List of Figures

Figure 1 - The structure of this document and the SRS image acquisition process	12
Figure 2 - GSD versus elevation angle for the VHR profiles	35
Figure 3 - General recommendations for a buffer creation around CwRS zones	52
Figure 4 - Relation elevation angle versus off-nadir angle and some satellite angles of importance	53

List of Tables

Table 1 - VHR profiles adopted within the CAP OTSCs, and the LPIS QA	34
Table 2 - Main structure nodes	50
Table 3 - XML metadata file, values	50
Table 4 - Possible values for the sensor tag, their allowed abbreviations and their combination with profiles	50
Table 5 - Possible values for MeteoFlag and their description	51
Table 6 - Possible values for ImageMode node and their description	51

Document history

Version	Date	Comment	Author
1.0	01/05/2008	First release includes updates of 2007 specifications (FMP 7528) incorporating exclusion of OrbView3, changes to EROSB, changes to Formosat2, inclusion of WorldView1, backup procedure changes, image return, etc.	PA, ME, image providers
1.1	30/05/2008	Final version after draft revision deadline 30/05/08	PA
1.2	12/03/2009	Updates on GeoEye-1	Image providers
1.31	23/03/2009,	Administrative routines, image return, change on EROS B and SPOT backup;	PA, ME, CA
	02/04/2009, 22/06/2009	Final check, minor corrections on image return, and GE1 sw suites	PA
2.0	01/05/2010	New edits 2010: WV1, WV2, copyrights	EUSI, PA
3.0-3.1	10/02/2011, 25/02/2011	Update of document for the 2011 Campaign: introduction of auto-backup; introduction of new backup approach; elevation angle restrictions; introduction of 2010 year's edits including WV2 (ref. doc. JRC IPSC/G03/C/PAR/par (2010)(11936)); introduction of the THEOS sensor; invoicing issues; other miscellaneous issues (e.g. sensor formats, zones: no 500/5 km rule on shapes); all edits in RED	PA
3.2	05/03/2011	Further updates according to EG, BW (minor clarifications, and edit to pricing issue), updates on LioDotNet by EG (e.g. upload with shapefile, plus minor other changes); introduction of checksum by image providers and contractors to be able to check correct image data delivery by FTP (AB)	EG, BV, SG, AB
3.3	13/03/2011	Clarifications on data return, introduction of functional e-mail LioDotNet, ref. THEOS FWC no., and THEOS products, elevation angle clarifications, clarifications upon EUSI input 10/3/2011 (e.g. inserted WV2 tiling options, deleted minimum width of an area of interest (AOI), clarification on feasibility iterations, and references on benchmarks inserted)	PA
3.31	17/03/2011	Grammatical edits and minor clarification on elevation angle and image data access	CA, PA
3.32	04/04/2011	Accept of image providers: EUSI (no further input); e-GEOS (minor corrections allowing panchromatic (PAN) to be prime upon Member State's (MS's) request with possible additional high resolution (HR)/very high resolution (VHR) if requested); renumbering of erroneously numbered chapters	MW, BB, RN, (image providers)
4.0	20/10/2011	New version for 2012 and future: constellation tasking, feasibility categories; elevation angle thresholds for LPIS QA and for hilly/mountainous control zones; no dedicated VHR backup; tiling; LioDotNet upgrades on zone definition parameters and on ordering. Moreover, some chapters have been rearranged to avoid repetitions (e.g. the sensor zone description chapter has been moved to be with the sensor product description)	PA
4.1	21/11/2011	Introduction of Constellation WV2 and WV1; update on chapter on feasibility; updates on F2, Theos products	PA, BB, MW
4.2	16/12/2011	Inputs after Tallinn Conference November 2011; e-GEOS (elevation angle typo, on copyright text, GE1 specs, IK2 specs); EUSI (recommendation is to keep shapes simple but no compulsory limit; QB may be chosen as prime; QB tiling)	PA, AO, ES

Version	Date	Comment	Author
4.3	26/10/2012	Updates on unit name; introduction of the new VHR sensor – Pleiades (PL1); updates on zone parameters; updates on speculative backup; updates on licensing text	EG, BV, PA
5.0	10/02/2013	Rework of document to fit the framework contract for supply of satellite remote sensing (SRS) data and associated services in support to checks within the Common Agricultural Policy (CAP) –VHR sensor-independent profile	PA
5.1	26/03/2013	Edits after CID-IAT, and AB input on 5.0: roles of stakeholders; other edits on zone parameters, acquisition windows (AWs), feasibility, delivery image data return, and VHR profile sensors	PA, EG, BV, ISM, AB
5.2	26/06/2013	Corrections for LioDotNet, and final review before outsource tendering	CW, SG, PA, CD
6.0	03/02/2014	Corrections for changes due to the upgrade of LioDotNet to G-LIO.NET	GDM, PA
6.1	10/02/2014	Minor edits on delivery notes and finalisation of the document	GDM, PA, ISM
6.2	20/02/2014	Various edits and comments by FWC VHR profile EUSI	EUSI (ES, SO, AK, MW)
7.0	16/03/2014	Finalisation of Campaign 2014 specification	PA
7.1	29/09/2014	Draft for improved VHR specifications 2015	EUSI
7.2	15/11/2014	Check, acceptance and insertion of certain elements regarding iteration of specified area/shapefile/corrections; update of profiles, and complete check of document for the 2015 Campaign	Joint Research Centre (JRC) (PA, JB, GDM, BV, CW)
7.3	01/12/2014	Update of image return (provision to the JRC)	JRC (PA, JB)
7.5	17/12/2014	Update of feasibility assessment (EUSI); update of profiles (JRC)	EUSI/JRC (PA, JB, GDM, BV, CW)
7.6	30/09/2015	Updates by EUSI for Campaign 2015	EUSI
7.7	06/10/2015	Updates for the use of G ⁴ CAP; smaller textual edits	JRC (GDM)
7.8	21/11/2015	Updates by the JRC after meeting with EUSI (12/10/2015) and AB(29/10/2015)	JRC (PA, JB, GDM, BV, CW)
8.0	29/02/2016	Final version after MS administrations and their contractors input and LPIS A5 issue update (section 12.1.3 and Table 1, p. 28)	JRC (PA, JB, GDM, BV, CW)
8.1	15/03/2016	Final version after EUSI input on above, and on percentage of A5/A2 (section 4.1.7–8); JRC edits in dense haze flag (becomes dense haze/snow/flood flag or MeteoFlag section 7.1.8)	JRC (PA, JB, GDM, BV, CW)/EUSI
9.0	14/11/2016	JRC draft after input from EUSI as of Del. D.3.1 (17/10/2016)	JRC (PA, JB, GDM, BV, CW)
9.1	13/03/2017	JRC final check, and edits on, for example, feasibility and profiles	JRC (PA, JB, GDM, BV, CW)
9.3	29/03/2017	Delete column root mean square error to be proven in benchmark (Table 1); and error in section 12.1.4: 75 cm. Finalisation of feasibility section after having concluded FEASIBILITY module development in G ⁴ CAP	JRC (PA, JB, GDM, BV, CW)
9.4	17/10/2017	Added details on buffers around zones; AComp possibility; procedure with an exchange of letters; pre-image request chapter; LPIS QA separate chapter; image return (source) Update of profile characteristics, zone and AW parameters; link to Digital Globe's archive; copyrights (WV4 added, EROS B deleted); references (WV4 and S2B added); XML metadata file structure	JRC (PA, JB, GDM, BV, CW)/EUSI

Version	Date	Comment	Author
9.5	13/11/2017	LPIS chapter updated; invoice chapter updated	JRC (SL, PA, GDM, CW, BV)
9.51	05/01/2018	Final update of section 4.1.13 on feasibility classes; removal of suggested additional input percentage and reduction of class 2 (medium, yellow) to 70%; final update of LPIS chapter	JRC (PA, GDM, BV, SL)
10.0	01/03/2018	Proof read final	JRC proof read service, checked by JRC staff (SL, PA, GDM, CW, BV)

Authors' initials

ACRONYM	FULL NAME	ORGANISATION
AB	Armin Burger	JRC
AK	Ansgar Kornhoff	EUSI
AO	Axel Oddone	e-Geos
BB	Bruno Biagini	e-Geos
BV	Blanka Vajsova	JRC
CA	Cherith Aspinall	JRC
CD	Catarina Doldrina	JRC
CW	Csaba Wirnhardt	JRC
EG	Eugenio Gervasini	JRC
ES	Edith Simon	EUSI
GDM	Giovanni Di Matteo	JRC
ISM	Ignacio San Miguel	JRC
JB	Juergen Breunig	JRC
ME	Maria Ehrlandson	JRC
MW	Michela Weber, now Neumann	EUSI
PA	Pär Johan Åstrand	JRC
RN	Ricardo Nasini	e-Geos
SG	Simone Gentilini	JRC
SL	Slavko Lemajic	JRC
SO	Susanne Oberdorf, now Hain	EUSI

Abbreviations, acronyms and terms

Abbreviation/term	Explanation
AComp	Atmospheric Compensation algorithm
AOI	Area of interest (e.g. a control zone)
AR	Acquisition request; a <i>closed AR</i> is an AR that has one of the following statuses: Accepted/Full, Accepted/Partial or Failed
(AR) ID	Identifier of an acquisition request
AW	Acquisition window
CAP	Common Agricultural Policy
CAPI	Computer-assisted photo interpretation
CC	Cloud cover
Contractor	A contractor of the MS administration responsible for the CAP subsidy diagnosis of the MS using the SRS imagery; not to be confused with the successful tenderer (ST) of the framework contract (FWC) signed in [1]
CTS	Common technical specifications
CwRS	Control with Remote Sensing
DEM	Digital elevation model
DG AGRI	Directorate-General for Agriculture and Rural Development
DRA	Dynamic range adjustment
EC	European Commission
ECA	European Court of Auditors
EFA	Ecological Focus Area
EPSG	European Petroleum Survey Group
EU	European Union
EULA	End-user licence agreement
FW contractor	The successful tenderer(s) who has/have been awarded an FWC with the JRC as of [1] – the equivalent of IP (see below)
FWC	Framework contract
G ⁴ CAP	Final evolution of *LIO systems, available from August 2015
GAEC	Good agricultural and environmental condition (CAP cross compliance)
GCP	Ground control point
GIS	Geographic Information System
GSD	Ground sampling distance, the nominal size of one sensor pixel projected onto the imaged surface
HHR	High High Resolution (SRS imagery)
HR	High resolution (SRS imagery) - used also as generic term for high-resolution imagery in this document
IACS	Integrated Administration and Control System (CAP)
IDQA	Input Data Quality Assessment
IES	Institute for Environment and Sustainability, Joint Research Centre
IP	Image Provider, in this document, the successful FW contractor or successful consortium of image providers who signed an FWC with the JRC [1]
JRC	Joint Research Centre of the European Commission
LF	Landscape Feature

Abbreviation/term	Explanation
LioDotNet, G-LIO.NET, NG-LIO.NET	JRC web-based systems for the management of image acquisitions from 2005 to 2015
LPIS	Land Parcel Identification System
LPIS QA	Land Parcel Identification System Quality Assurance
MARS	Monitoring Agricultural ResourceS
MD5 (md5sum)	MD5 is one in a series of message digest algorithms; md5sum is used to verify the integrity of files, as virtually any change to a file will cause its MD5 hash to change
MS	Member State
MS administrations (or contractors)	MS administrations or appointed contractors of the MS administration responsible for the CAP subsidy diagnosis using the SRS imagery delivered by the JRC
MSP	Multispectral
ONA	Off-Nadir Angle
OTSC	On-The-Spot Check
PAN	Panchromatic
Pre-IR	Pre-Image Request
PSH	Pansharpened
QA	Quality Assurance
QC	Quality Control
QCR	Quality Control Record
QL	Quick-Look, reduced resolution browse image
RFV	Rapid Field Visit
RMSE	Root mean square error
RP	(Agricultural) Reference Parcel
SC	Specific Contract
SMR	Statutory Management Requirement (CAP Cross Compliance)
SPS	Single Payment Scheme
SMR	Statutory Management Requirement (CAP Cross Compliance)
SRS	Satellite Remote Sensing
SWIR	Short Wavelength InfraRed
UTM	Universal Trasverse Mercator
VHR	Very High Resolution (SRS imagery)
UTM	Universal Transverse Mercator
WGS 84	World Geodetic System 1984

1. **Introduction**

1.1. VHR image acquisition for the CAP checks programme

- 1.1.1. Since 1993, the Directorate-General for Agriculture and Rural Development (DG AGRI) has promoted the use of 'Control with Remote Sensing' (CwRS) as an appropriate control system suitable for checking whether or not aid is granted correctly. The legal basis of CwRS is Regulation (EC) 1306/2013 (Article 6(b)21) and its implementing Regulations No 908/2014 (Article 26), No 809/2014 (Articles 24, 38, 39 and 40) and No 2333/2015 [2]. On this basis, the European Commission (EC) Services are required to centralise satellite remote sensing (SRS) image acquisition. This task was transferred to the Joint Research Centre of the European Commission (JRC) in 1998 (September 1998/VI/34942) and it is managed through a horizontal co-delegation (Type I) between DG AGRI and the JRC (via the Directorate-General for Budget) (internal ref. Ares (2015)1215220) to implement the yearly Common Agricultural Policy (CAP) image acquisition work programme.
- 1.1.2. Regarding the timing of the operations, Commission Implementing Regulation (EU) No 908/2014, mentioned above, specifies, in Article 26:
1. For the purposes of Article 21 of Regulation (EU) No 1306/2013, each Member State shall inform the Commission by 1 November of each year at the latest, as to: (a) whether it wishes the Commission to acquire the satellite images necessary for its programme of checks and/or for its Land Parcel Identification System Quality Assessment; (b) the area to be checked and the number of planned control zones.
 2. Member States requesting the Commission to obtain the satellite images shall finalise, in cooperation with the latter and before 15 January, following the communication of information referred to paragraph 1, the zones to be covered and the timetable for obtaining those images.
- 1.1.3. Following the real-time evaluation in 2003 and the successful operational application since 2004, the JRC, in agreement with DG AGRI, continues to supply very high-resolution (VHR) SRS imagery to the Member State (MS) administrations for their CwRS for area-based subsidies.
- 1.1.4. Since 2010, DG AGRI has called for a yearly Land Parcel Identification System Quality Assurance (LPIS QA). Reference is made to the legal basis for the LPIS QA, given in Delegated Regulation (EU) No 640/2014 (Article 6). Specific VHR imagery satisfying the technical LPIS QA recommendations, for example including specific conditions of elevation angle and cloud cover (CC) (see section 13.2), is acquired for this purpose (see section 3.1.2 and [3]).
- 1.1.5. Since the 2014 Campaign, the detailed management of VHR image acquisition – to cover the correct areas at the correct times of the growing season required for the CAP checks – has passed to industry to carry out within quality specifications managed by the JRC. This choice has been made because there are currently several suppliers of SRS imagery that have proven competency in supplying the JRC efficiently with the SRS data needed for the CAP checks.

1.1.6. There may be one or more framework (FW) contractors appointed by the contracting authority, the JRC, to perform this task. In these specifications, the image provider (IP) therefore refers to the FW contractor, with which the JRC has signed a framework contract (FWC) [1].

1.2. Objectives, referencing and structure of this document

1.2.1. This document defines the VHR profile-based specifications to be used within the CAP checks programme (CwRS and LPIS QA). Its objective is to give the stakeholders¹ in the image acquisition process clarity in the technical details of the process, and it describes the process flow starting from zone definition, through image use, to image return and possible re-use of imagery at the end of the Campaign (see Figure 1).

1.2.2. The JRC has an overarching role to be responsible for the functioning of the FWCs and for the quality control (QC) of the operations, while most of the interaction necessary within the image acquisition process takes place between the FW contractor and the MS administrations (or contractors) performing the CAP checks. These specifications are intended to describe these interactions.

1.2.3. This document is available in the 'Documentation' section of the G⁴CAP Web application [4].

1.2.4. Several references are made here to the common technical specifications for the remote sensing controls of area-based subsidies [5], and relevant guidance documents found at the Monitoring Agricultural Resources (MARS) WikiCAP [3], to the Guidelines for Best Practice and Quality Checking of Ortho Imagery [6] and to the high-resolution (HR) profile-based specifications [7], which should be used in conjunction with the present document. Reference is also made to the terms and conditions of the FWCs for image procurement with the JRC [1].

¹ The stakeholders, or actors, are the JRC, DG AGRI and the FW contractor acting as IPs and operators, and the MS administrations (or their contractor) performing the CAP checks.

1.2.5. Figure 1, depicts the overall process of the SRS image acquisition process, split into macro-actions and coloured by the function of the type of user responsible for the single macro-action. This document tries to follow the same flow as that shown here.

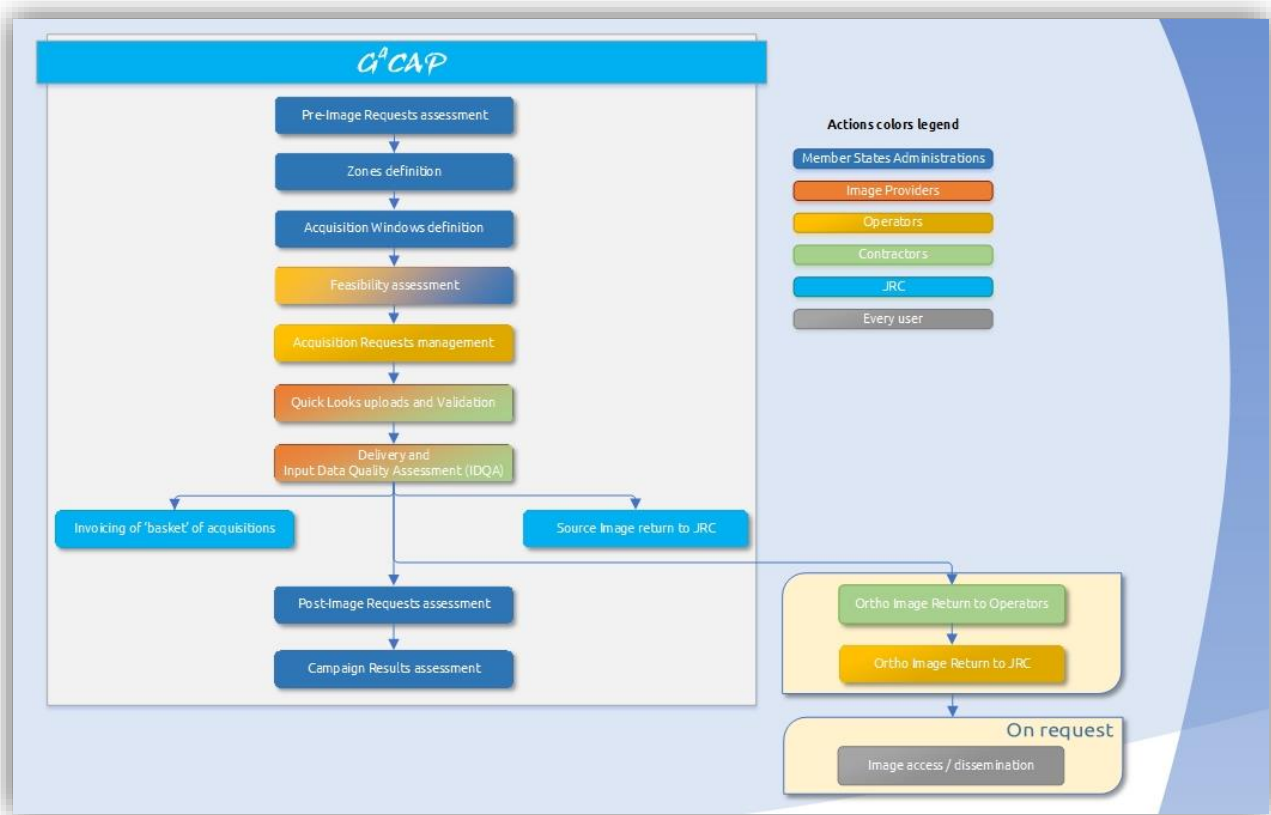


Figure 1 - The structure of this document and the SRS image acquisition process

1.3. G⁴CAP

1.3.1. *LIO systems, which were created in 2005 to manage the CwRS campaigns online, were replaced in 2015 by the G⁴CAP system, a Web application that is kept updated and constantly improved by the JRC to enhance the daily work of the campaign stakeholders and in line with the CAP evolution.

1.3.2. G⁴CAP is the Web-based application used to manage the whole campaign workflow. Its functionalities are described in its manual, available online at the G⁴CAP Website under the 'Documentations' section [8]. G⁴CAP is also the main communication tool between the CAP check actors during the campaign: its automatic e-mail notifications are used to synchronise actions between different actors.

1.3.3. It is compulsory for all the stakeholders involved in the CAP checks to use G⁴CAP.

2. Pre-image request

- 2.1.1. All MS administrations participating in the CAP checks campaign must input their forecasted requests for imagery into the pre-image request (pre-IR) module of G⁴CAP for the campaign to start. This input provides the JRC with information on:
- basic on-the-spot check (OTSC) information;
 - basic CwRS information;
 - details of planned CwRS methods, with relevant justifications;
 - VHR/HR profile requests² (for each type of profile; see chapter 13, and [7]).
- 2.1.2. In accordance with Regulation (EU) No 908/2014; Article 26 (see section 1.1.2), each MS shall finalise insertion of the pre-IR by 1 November before the campaign starts.
- 2.1.3. Imagery will be allocated only if MS administrations justify their image choice as needed for effective CAP checks. The JRC will use inserted information to efficiently model image allocation. This will be done to fit established budgetary envelopes (indices such as efficient image use and fair image cost/OTSC area are used).
- 2.1.4. It is strongly advised that the MS administration refer to G⁴CAP online help (information and tip-over) when the pre-IR is inserted and also refer to the instructions given in Chapter 4: Feasibility assessment.
- 2.1.5. The JRC recommendation is to use one VHR AW and between one and a maximum of three HR AWs (plus any number of Copernicus Sentinel-1/2 (S1, S2)), but exceptions to this rule may occur: the methodology must be justifiable by the MS administrations in the pre-IR module.
- 2.1.6. The JRC also recommends substituting a second VHR AW with a VHR aerial AW, or with a fixed high high resolution (HHR) AW (setting the earliest and latest start dates to be the same) and defining a suitable AW length (e.g. 6 weeks).

² Special profiles may be requested by the JRC; these will allow elevation angle uplift or certain ground sampling distance (GSD) requirements (e.g. VHR+ Topographic, or VHR_EFA_LF, etc. or 8/16 bands and pan bundle data), but MS administrations will have to justify these options in detail; see Chapter 13.

3. **Data requests**

3.1. **General**

- 3.1.1. The regulatory basis for the CwRS programme (see section 1.1.1) allows MSs to use remote sensing techniques as a mean of carrying out OTSCs on agricultural parcels. Guidance to this Regulation is given in the documents in ref. [3], including the 'Guidance for on-the-spot checks and area measurement' which describes a 'control zone' as a geographical area defined on the basis of GIS analysis, taking account of technical constraints (e.g. standard satellite 'scenes'). These technical constraints, which are further detailed below, include swath widths, elevation angles, area of interest (AOI) definition, AW adjustments, feasibility assessment, etc.
- 3.1.2. The Regulation (see section 1.1.4) also calls for a yearly LPIS QA [3]. Specific VHR imagery is acquired during the CwRS campaign for this QA exercise (see section 13.2). Also MS administrations not participating in the CwRS programme can obtain specific acquisitions for LPIS QA assessment through the JRC.
- 3.1.3. The MS administration (or contractor), the FW contractor and the JRC must name at least one contact person (or functional e-mail address) for communicating with each other regarding the issues listed above and for all other communication during the campaign. For any changes of contact person, the stakeholder shall contact the JRC.
- 3.1.4. **In accordance with Regulation (EU) No 908/2014, Article 26, each MS shall finalise its image requests in G⁴CAP before 15 January, providing all parameters (zone and AW parameters) necessary for image acquisition initialisation.**
- 3.1.5. As the MS administrations finish inserting their image requests, the FW contractor will start the feasibility assessment. The FW contractors are responsible for checking the completeness of the MS's inserted parameters and reporting to the JRC if any error or discrepancy is discovered before the start. After JRC validation, the zones and AW parameters are used as the basis for the feasibility assessment and the image acquisition.

3.2. **Zone definition**

- 3.2.1. A CAP control zone (or AOI) consists of a minimum of 4 and a maximum of 999 vertices in latitude/longitude geographic coordinates (decimal degrees, World Geodetic System 1984 (WGS 84) ellipsoid), represented by a shapefile containing files with the extension(s) .shp, .shx, .dbf, .sbx, .sbn and/or .prj, and should be provided by the MS administration, using the safe and secure mechanism provided by G⁴CAP, to the FW contractor. The MS administration should strive to make shapefiles that define simple, regular shapes and to avoid creating corridors that are too narrow (e.g. < 5 km width, since the FW contractor is not obliged to deliver a larger area which would allow a smooth orthorectification of such image). There is no regulatory minimum distance between the vertices of the shapefile. The MS administration should, however, strive to create the simplest suitable zone, which must have a minimum size of 100 km².

3.2.2. JRC will reject zones' shapefiles if they:

- overlap within the MS (this may be allowed only in exceptional cases, for example where the control schemes/measures over the overlapping area are different and require separate AWs, such as crops and vineyards);
- overlap with adjoining MS borders (this includes MS regions handling CAP claims individually, for example Scotland/England/Wales);
- cover large amounts of mountainous or other non-agricultural areas;
- stretch into coastal waters;
- have $\geq 1\,000$ vertices;
- contain corridors narrower than 5 km.

3.2.3. MSs that have selected control zones in topographically 'difficult' terrain must consider a buffer around their zones of at least 0.2 km (in extremely hilly terrain, 0.5 km is recommended), depending on topography, to ensure complete coverage of the zone after orthorectification. This is because the FW contractor delivers Ortho Ready Standard products that are geo-referenced to the average base height of a given AOI and there could therefore be a horizontal offset for each individual pixel depending on the difference between the actual local height of the pixel and the average base height of the AOI, which therefore, in orthorectification, may cause a further 'shift' as a result of topography. It is therefore highly recommended that a sufficient buffer around an AOI should be considered to ensure that the AOI is still completely covered by satellite data after orthorectification. The required buffer (equal to the maximum horizontal offset) can be calculated as follows, taking into account the terrain differences inside the AOI, as well as the minimum allowable satellite elevation angle:

$$\frac{H_{\max} - H_{\text{average}}}{\tan(ELA_{\min})}$$

(maximum possible height difference of the local height to the average base height of the AOI/tangent of the minimum allowable SatElevation angle).

Care should be taken to calculate the average base height from the heights of all pixels inside the AOI (not just using the highest and lowest heights inside the AOI and making an average). See Annex 19.2 for detailed examples and a downloadable Excel spreadsheet from the G⁴CAP documentation section for individual calculations.

3.2.4. In summary, the relevant zone parameters in G⁴CAP are:

- control zone shapefile (specifications as described above);
- zone name (≤ 5 characters); this must be unique for the whole campaign and shall not include special country-specific characters such as 'é', 'Ç', etc. (i.e. only ISO basic Latin characters and numbers allowed);
- zone (AOI) area (rounded to a whole km², Universal Transverse Mercator (UTM)) in accordance with the shapefile area;

- European Petroleum Survey Group (EPSG) code (optional); this is the final output national projection used by the MS. Currently, this is relevant to HR image acquisitions only if the HHR ORTHO profile is requested (i.e. the HHR F2 profile).

3.3. Acquisition window definition

- 3.3.1. There can be either one or two VHR image AWs (VHR1 and/or VHR2 periods) defined for each CAP control zone. These AWs will be defined by the MS administrations and will be scheduled as suitable for the measurement and computer-assisted photo interpretation (CAPI) of the largest number of agricultural parcels possible. Exact dates will depend on crop cycles and will vary with latitude. The tasking of the second AW depends on the budget available and is determined by the JRC at the pre-IR stage or, at the latest, at the image requests definition stage (see section 2.1.2).
- 3.3.2. As imagery is acquired, depending on the sensor's technical characteristics, the AW's zone is gradually covered entirely or partially. The FW contractor, who is responsible for the implementation of an efficient image acquisition set-up, always aims to cover the zone in as few acquisitions as possible, but multi-temporal collection is considered valid if performed within the time limit of the AW. Such multi-temporal acquisitions should be as close as possible in time to favour crop interpretation (CAPI); that is, 'multi-temporality' should be as short as possible.
- 3.3.3. MS administrations will request a VHR prime profile to be used to cover the zone. The MS administration could have to accept a profile that is less strict after feasibility assessment and/or also agree to a backup profile for the best chance of acquisition success (see Chapter 4 – Feasibility assessment). The FW contractor will task within the agreed AW to cover the control zone efficiently.
- 3.3.4. The AW's zone may be covered by multiple sensors fitting the profile selected by the MS administration (i.e. multi-sensor and multi-temporal acquisitions are allowed). The FW contractor will task the sensors in an optimal manner to complete the zone as soon as possible with any of the sensors within the AW agreed. It has been shown in earlier campaigns that multiple sensor tasking has given an efficiency gain by completing zones more quickly, that is, a reduction of the acquisition time by adding satellite capacity. Moreover, it has also been shown that there will be a greater chance that a second acquisition is closer in time to the first acquisition, that is, less multi-temporality.
- 3.3.5. If an MS administration accepts a VHR backup profile, a successful backup, if acquired, will be proposed to the MS administration (or contractor). If the MS administration (or contractor) does not accept this image, the contractor will continue in an optimal manner to task the prime profile until the end of the AW. If, on the other hand, the MS administration (or contractor) accepts the backup collection, tasking of the prime profile for the relevant zone will be closed. If the AW comes to an end without any prime profile acquisitions (or only a partial one), the MS administration (or contractor) can either accept the backup for the missing part, if a partial image is available, or ask for a further extension of the prime profile AW. After the maximum extension possible for a positive outcome for the MS administration's CAP checks, the MS administration will have to accept not only the acquisitions made by the prime but also the backup.

- 3.3.6. When completing any AW for a zone, the FW contractor shall guarantee an overlap (east–west or north–south) between subsequent acquisitions or strips of a minimum of 0.5 km. Moreover, there shall be an overlap of a minimum of 0.5 km between any partial acquisitions between different sensors. Such overlap is necessary for the orthorectification process.
- 3.3.7. The VHR zone in a relevant AW will be covered by a bundle product (panchromatic (PAN) and multispectral (MSP) as separate bands), the pansharpened (PSH) product³ or the PAN-only product. If the profile A4 (VHR stereo) is requested, a stereo product will be delivered.
- 3.3.8. It is recommended that defining many zones with profiles with elevation angle restrictions close to each other should be avoided, as this decreases satellite capacity and will risk that no acquisition being made within the AW.
- 3.3.9. The VHR1 and/or VHR2 periods should be preferably 8 weeks but never shorter than 6 weeks (42 calendar days).
- 3.3.10. If, on the day before a VHR AW is going to open, the previous HR AW is still open, the HR AW will be closed automatically. Communication on the closure is made via G⁴CAP.
- 3.3.11. When defining the VHR1 and VHR2 AWs, the MS administrations shall keep in mind in their planning that the final AWs might have to be longer than that initially requested to make an acquisitions feasible. It shall also be taken into account that a potential shift of the VHR1 AW end date may occur and the subsequent AW start date may have to be postponed.
- 3.3.12. If extraordinary weather conditions prevail in any region, an AW may change (opening and closing dates will move). This will be dealt with on a case-by-case basis. Such AW dates changes should occur only in very rare cases. Notice shall be given by the MS administration (or contractor) to the FW contractor at least 2 weeks before the scheduled opening.
- 3.3.13. It is not useful to open an AW too early in the season, as the sun angle is generally low and the crops may not have developed sufficiently to provide a scene with adequate contrast for a good delineation of the parcels. It is suggested that no AWs be opened when sun angle is still below 20 degrees to ensure sufficient contrast and to minimise the effect of shadows.
- 3.3.14. Conversely, this is also true for late start dates of the VHR2 AW, when the sun elevation could drop below 20 degrees.
- 3.3.15. If a VHR profile sensor (see section 13.1.2) acquires imagery late in the AW, the MS administration may request an archive search for an earlier HR sensor acquisition within the AW. In this case, the FW contractor shall contact the JRC, which may (or may not) give clearance. This must be communicated to the FW contractor. It is, however, strongly advised that Copernicus S1/S2 imagery be used.

³ Please note that a PSH four-band product always comes with the 4 first bands, that is, blue, green, red and near-IR1 (so-called MS1). It is not possible to produce a PSH four-band product using the remaining 4 bands (so-called MS2) or SWIR bands.

- 3.3.16. The MS administrations (or contractors) may 'pre-extend' AWs. This 'pre-extension' can be used for any AW that has not opened yet, if it has to be shifted to an earlier start date than agreed during the feasibility process. No extra feasibility assessment (see Chapter 4) has to be performed by the FW contractor, since the end date of the AW remains as agreed, while the start date is set to an earlier date (according to the request from the MS administration or contractor), resulting in an overall longer AW. The option to 'pre-extend' an AW should be used carefully by the MS administrations (or contractors) whenever the weather conditions and CAP checks method allow such a change. The FW contractor shall be notified in due time (e.g. from 5 days to a minimum of 2 days in advance of the new AW start) to allow the FW contractor to change its satellite tasking. The 'pre-extend' request will trigger an automatic notification to the responsible FW contractor, who will have the right to accept or refuse the request, providing explanations. If the request is accepted by the IP, G⁴CAP will manage all the edits required to the AW automatically, within a maximum of 24 hours.
- 3.3.17. An AW may be extended if none of the prime or backup profile tasking has been successfully completed over the zone with input data quality assessment (IDQA)-accepted acquisitions. With effect from the 2018 Campaign, G⁴CAP automatically manages the extension of AWs that have been agreed by an MS administration, by a maximum 1 or 2 (default) weeks at a time. To come to such an agreement, the MS administration must set the extension flag in either the AW or the acquisition request (AR) module. G⁴CAP will send an automatic notice of the extension to the FW contractor at least 3 working days before the AW closure. This will allow the FW contractor to continue tasking. Such extensions will be allowed if the crop cycle allows and shall be as long as possible. AW will not be extended if there are some proposed or backup acquisitions not yet managed by the MS administration (or contractor) that could potentially cover the whole zone area.
- 3.3.18. The procedure outlined below will apply at the end of the AW:
- Acquisitions outside elevation angle specifications or outside CC thresholds may be uploaded by the FW contractor, as proposed, and may be accepted by the MS administration (or contractor).
 - If the above option does not provide enough images to complete the area, the AW can be extended for the prime and backup VHR profiles. The MS administration (or contractor) will evaluate the maximum acceptable AW extension based on the status of the crop phenology.
- 3.3.19. If the IP is able to acquire valid imagery within the original AW, even if this AW was already extended, the AW will be automatically de-extended by G⁴CAP.
- 3.3.20. The MS administration (or contractor) is notified about an AW that is coming to an end by selecting the dedicated notification option in G⁴CAP. If no request for the extension of an AW is set in G⁴CAP, the AW will close on the planned closure date (defined end date of the AW).
- 3.3.21. Upon request from the JRC, the FW contractor shall inform the JRC and the MS administrations (or contractors) of image acquisition status over the zone (e.g. number of attempts left before AW closure or possible attempts soon afterwards).
- 3.3.22. MS administrations should not allow an AW to extend beyond any MS contractor contract end date. If the MS administrations allow this, they will be responsible for the proper use of the imagery in their controls procedure.

3.3.23. The relevant AW parameters are summarised as follows (each AW is identified in G⁴CAP by a unique integer value called ID):

- period: VHR1, VHR2;
- image profile (see Table 1);
- start and end dates;
- previous AW, where applicable;
- Image mode: Bundle/PSH³/Multispectral (MSP)/PAN (possible choices are dependent on chosen image profile);
- delivery method: DVD/file transfer protocol (FTP)
- possibility of automatic extension of AW.

4. **Feasibility assessment**

- 4.1.1. The basic zone and AWs parameters explained above are received by the FW contractor through the 'Reporting' or the 'Zones' and 'Image Requests' modules in G⁴CAP. They shall be made available to the FW contractor 6 weeks before the first AW starts. These parameters also form the basis for the relevant specific contracts (SCs) set up between the JRC and the VHR FW contractor.
- 4.1.2. The FW contractors are then responsible (see section 3.1.5) for interacting with the MS administrations (or contractors) to check and finalise any remaining feasibility parameters, and perform the feasibility study in G⁴CAP. For these tasks, a time frame of at least 4 weeks shall be given to the FW contractor.
- 4.1.3. Since feasibility assessment is no longer carried out in one single batch, but by period and zone, if any AW is requested with an start earlier than others its feasibility assessment can be performed earlier. It is up to the IP to make the feasibility assessment as efficient as possible and start with the earliest AWs in the period undergoing feasibility assessment.
- 4.1.4. A technical and competitive feasibility assessment by the FW contractor includes, among other things, assessments of satellite characteristics, zone size, zone shape, zone latitude, elevation angle, AW, priority level, CC, statistical weather forecasting and other competitive tasking requests. **All tasking shall be placed at priority level for the CwRS and LPIS zones.**
- 4.1.5. One of the parameters of the feasibility assessment is the elevation angle. It is well known that a lower elevation angle places higher demands on ancillary data (digital elevation model (DEM), ground control points (GCPs), etc.) to reach orthorectification accuracy specification thresholds (see chapter 13, and [6]). The FW contractor should keep the elevation angle as high as possible to facilitate orthocorrection.
- 4.1.6. A higher elevation angle threshold may be requested for certain control zones, for example if the control zone is situated in hilly or mountainous areas or has complex topology (see chapter 13). The total area allowed for such elevation angle uplift will have been agreed between the MS administration and the JRC prior to the feasibility assessment at the pre-IR stage, and the basic AW parameters (see chapter 2) will include relevant profiles for each MS.
- 4.1.7. **MS administrations should be aware that feasibility assessment suffers if control zones with an elevation angle restriction are too concentrated and close to each other; collection attempts will decrease substantially from an A.1 profile to an A.2, A5 or A.6 profile (see Chapter 13: VHR image profiles).** Therefore, MS administrations are advised to consider the maximum possible AW length for control zones with an elevation angle restriction when defining their image requests.
- 4.1.8. MS administrations are reminded that they should keep their requests for the A.2 plus A.6 plus A.5 profile elevation angle restriction to $\leq 25\%$ of their overall VHR campaign control area.
- 4.1.9. MS administrations are reminded that they should keep their requests for the A.5 profile to $\leq 10\%$ of their overall VHR campaign control area (preferably well distributed for best acquisition success).

- 4.1.10. MS administrations should also have in mind that they should keep their requests for the A.4, A.11, A.51, A.61, A.62, A.71 and A.81 profiles to be $\leq 1\,000\text{ km}^2$ of their overall VHR campaign control area (see Chapter 13: VHR image profiles, and G⁴CAP pre-IRs tip-over help under the VHR 'Profiles' tab).
- 4.1.11. Special profiles, such as A.11, A.12, A.51, A.52, A.61 and A.62, that is, 8/16 bands with relative elevation angles, will be provided depending on feasibility and budget availability. These should already have been requested by the MS administrations in the pre-IR stage, since they require bilateral agreement with the JRC.
- 4.1.12. If the FW contractor, when checking, notices any discrepancies between the areas/parameters, with respect to section 2.1.1 in the pre-IRs, and the areas/parameters inserted in the subsequent data requests (zones and AWs) in G⁴CAP by the MS administrations, a final acceptance must be obtained from the JRC before feasibility assessment can start.

4.1.13. The feasibility assessment performed by the FW contractor shall divide the AWs into three categories:

- 1 GOOD (GREEN) - FEASIBLE WITHIN AW - approaching 100% probability; 90–100%;
- 2 MEDIUM (YELLOW) - FEASIBLE WITHIN AW – 70% probability (may need EXTENSION) - suggestions can be made to improve possibility of success; 70 - 89%;
- 3 LOW (RED) - NOT FEASIBLE WITHIN AW – with suggestions to make it feasible (e.g. AW extension with the suggestion of a new start/end date; change profile allowing a less strict elevation angle; accept backups); < 70%.

In G⁴CAP, if suggestions made by the IP are accepted to change the original AW with respect to its dates or image profile, or to accept backups, the AW will have an improved feasibility status compared with the original and the FW contractor will specify this status in the new suggestion.

If the original AW was not feasible and it was not possible to find a valid agreement between the FW contractor and the MS administration, the FW contractor has two options, exploiting a fourth category:

- 4 BLACK - acquisition is not feasible within the requested AW and 'no agreement has been reached between FW contractor and MS administration to make it feasible'.

The FW contractor can:

- Task the AW anyway, even if the feasibility is still 'not feasible' or the AW length is not compliant with technical specifications. In this case, the FW contractor will make a new proposal with a BLACK feasibility status with the same or changed new dates agreed with the MS administration, even if such changes will not make the AW feasible. In the event of failure, such AWs will NOT be counted in the campaign statistics for the FW contractor, and the MS administrations MUST BE PREPARED TO USE AN ALTERNATIVE CONTROL METHOD, SINCE NO IMAGE IS GUARANTEED. This situation is called BLACK-BLACK feasibility.
- Choose NOT to task the AW. The FW contractor will upload a black status feasibility without proposing a new solution. The AW will be marked as 'Refused' and no AR will be opened. The MS administrations MUST USE AN ALTERNATIVE CONTROL METHOD, SINCE NO IMAGE WILL BE PROVIDED.

4.1.14. Following feasibility assessment, the results will require some iterations between the MS administrations and the FW contractor. These will normally be made during the first months of the calendar year before the campaign

starts (however, see sections 4.1.1, and 4.1.3). All interactions between the MS administration and the FW contractor in this feasibility process are performed in the G⁴CAP 'Feasibility' module.

- 4.1.15. Finally, an optimum acquisition scenario will be reached, with clearly defined profiles, zone constraints, final AWs and products to be delivered, etc. This result, completed in G⁴CAP and accepted by the MS administrations, will form the basis for the campaign (accepted by all parties, including the JRC) for each zone AW.
- 4.1.16. The feasibility assessment should be ready not later than 2 weeks before the AW opens, on condition that the timelines under sections 4.1.1 and 4.1.2 are met. If a phased feasibility assessment is performed (see section 4.1.3), the FW contractor and the JRC shall agree on a shorter time frame to finalise the first feasibility assessment for the early zones (e.g. 1 week before the first VHR AW of the early zones opens).

5. Acquisition requests

- 5.1.1. An AR is defined as the implementation by the FW contractor of an AW of the MS administration to cover a zone, with its defined ancillary parameters.
- 5.1.2. After the feasibility assessment, G⁴CAP will automatically open an AR 3 days before the AW start date is reached. Each AR has a unique identifier called ID.
- 5.1.3. If no request for the extension of an AW is received by the FW contractor, its AR will close on the planned closure date (defined end date of the AW) (see section 3.3.20).

6. Quick-look image upload

- 6.1.1. The FW contractor will notify an acquisition through its upload in the G⁴CAP system (or by e-mail in the case of temporary system unavailability) within 2 working days⁴ from the acquisition date (validated/proposed, or partial/full upload). In the exceptional case of multiple national holidays or after a weekend, this time limit will be extended so that those days do not count.
- 6.1.2. IPs can upload image acquisitions details into G⁴CAP either via batch upload, available in the AR module, or by clicking on the proper AR. Required acquisition metadata must be defined in the metadata XML⁵ file. This XML file must be compressed in a zip archive together with 'quick-look' images (QLs), shapefiles and other necessary metadata files and uploaded into G⁴CAP (see Annex 19.1 for details).
- 6.1.3. Upon upload of an acquisition, the G⁴CAP system will automatically send a dedicated notification to interested actors. Users' subscriptions to these notifications are managed through the G⁴CAP system. By default, all users receive this message, unless they specifically deactivated the notification option for this item (see under G⁴CAP Tab Acquisition acceptance).
- 6.1.4. Uploaded QLs can be previewed using the G⁴CAP QL Browser, which is an online Web application for displaying and browsing QLs, metadata and shapefiles from the image acquisitions. It can be reached directly from within G⁴CAP. Every user can also use this tool at any time during the campaign to check the overall status of the acquisitions over zones for which it is responsible for a specific campaign in the Zones module of G⁴CAP.
- 6.1.5. The MS administrations (or contractors) may consult the FW contractor's archives [9]. Services are normally free of charge, but often require a subscription. The MS administrations (or contractors) may propose any imagery for upload to the FW contractor that is suitable for their controls activity. The FW contractor will proceed to upload QLs of such imagery into G⁴CAP for acceptance by the MS administrations (or their contractors).
- 6.1.6. From the 2018 Image Acquisition Campaign onwards, the VHR IP has the option of using the Atmospheric Compensation Algorithm (AComp)⁶ to improve image clarity by mitigating the effects of haze and atmospheric

⁴ Numbers of working days throughout this document are calculated as calendar days minus weekends (national holidays are not taken in account)

⁵ XML metadata file specification - see Annex 19.1.

⁶ For more information on the AComp algorithm, see <https://g4cap.jrc.ec.europa.eu/g4cap/Default.aspx?tabid=172>

scattering [10]. The AComp is currently available for imagery acquired by the GE1, WV2 and WV3 satellites. All QL images related to these satellites and uploaded in G⁴CAP are enhanced by the AComp algorithm.

7. Acquisition acceptance – validation

- 7.1.1. Acquisition acceptance or ‘validation’ is performed on the QLs uploaded by the FW contractors. They may cover a whole zone or just a part of a zone (partial upload, defining an area to be validated by a vector shapefile). The area to be validated has to be contiguous and should have a regular and simple shape. It can be composed of one strip or multiple strips. The validation of an acquisition is done on the basis of CC content. Snow, flooding and haze, which is not considered cloud by the FW contractor, do not result in rejection, but are flagged and may trigger extra re-tasking (see ‘MeteoFlag’).
- 7.1.2. VHR CC thresholds are defined as follows:
- A **validated** acquisition is defined by a $CC \leq 10\%$ over the AOI. Validation of this imagery does not require any interaction with the MS administration (or contractor). Validated images are delivered directly to the MS administration (or contractor) once they have passed through the FW contractor’s QC (see Chapters 9 and 14).
 - A **proposed** acquisition is defined by a $10\% < CC \leq 30\%$ over the AOI. Proposed images are delivered to the MS administration (or contractor) only once the MS administration (or contractor) has agreed in G⁴CAP. Tasking continues for better acquisitions during the period for accepting/declining, which must not exceed 3 working days. Once it has been accepted, the proposed image goes through QC with the FW contractor and is shipped to the MS administration (or its contractor).
- 7.1.3. For the validation of a series of proposed acquisitions, the FW contractor for the VHR FWCs has agreed to provide all proposed acquisitions to the MS administration (or contractor) if they accept one proposed acquisition over the control zone. The MS administration (or contractor) must keep in mind that, when further proposed acquisitions are made available over the same zone, they can be used together with previously rejected acquisitions.
- 7.1.4. The FW contractor will produce, on a best-effort basis, regular mosaics of proposed imagery to aid in decision making on the usability of a series of acquisitions. **Such mosaics can be sent to MS administrations (or contractor) bilaterally, copying in the JRC. The MS administration should keep in mind that** accepting a series of proposed acquisitions will allow the FW contractor to release satellite capacity for other zones.
- 7.1.5. The FW contractor may re-upload part of a rejected proposed acquisition if, in combination with a new validated acquisition, it will serve to complete a zone. The re-uploaded proposed acquisition has to be above the validated CC threshold, be acquired on one date, cover a contiguous area, and have a regular and simple shape.
- 7.1.6. In the case of a conglomeration of CC within part of a large acquisition, this part (minimum 100 km²) may be re-tasked. Even if the whole acquisition is validated, the MS administration (or contractor) may ask the FW contractor to perform such a re-task. The FW contractor will contact the JRC, which will make a decision based on technical and financial justification. **A new zone will be defined in G⁴CAP for this area, keeping a link with the original zone, and a new AW and AR will be issued for this area.** The MS administration (or contractor) will follow

a procedure similar to that described in the section below on the use of 'MeteoFlag' to prove that re-tasking is required.

7.1.7. An acquisition with the 'MeteoFlag' set on is validated as follows:

- If the acquisition with the 'MeteoFlag' set on for dense haze/snow/flood/mixed is uploaded, this flag will add dedicated information in the upload notification to the MS administration (or contractor). The MS administration (or contractor) will, within 3 working days, assess if the dense haze/snow/flood/mixed situation prevents control of the parcels, by:
 - firstly, assessing whether or not the haze image can be used if an atmospheric correction or local lookup table stretch is applied to the imagery; it should be kept in mind that the image viewed is a QL, which is always inferior in quality compared with the real source image;
 - secondly, if the above does not solve the issue, provide the JRC with information regarding the following issues for a decision on possible re-tasking to be taken:
 - preparing a shapefile of the control parcels structure (latitude/longitude DD WGS 84),
 - assessing preliminary technical coding (e.g. T4⁷) due to haze (see the guidance for OTSC [5]),
 - checking if any proposed image is available.
- If the above steps cannot ensure a successful control procedure, the following actions should be undertaken:
 - if the whole zone is not to be re-collected, preparing a new shapefile to be re-collected for the AOI (minimum 100 km²),
 - deciding on a new AW and assessing the time delay that re-tasking implies for the success of the control procedure.
- Upon receiving the information indicated above from the MS administration (or contractor), the JRC will make a decision on whether or not to collect additional imagery (re-task) over a part of the control zone based on technical and financial justification.

7.1.8. For the 2018 Campaign, it has been decided to perform AComp processing automatically on all 'MeteoFlag'-tagged imagery to reduce haze, water vapour and particulates (see section 6.1.6). An MS administration (or contractor) may ask for re-processing after receiving the imagery with AComp, if not satisfied by result.

7.1.9. If the acquisition uploaded with the MeteoFlag set for dense haze/snow/flood/mixed is proposed, it will be treated like any other proposed acquisition.

⁷ T4 is the technical code in parcel level observation diagnosis meaning "parcel covered by clouds, haze, snow, or flooding".

8. **Ordering**

- 8.1.1. Ordering follows the procedures set up in the FWC signed by the FW contractor and the JRC [1]. This is managed by the signature of SCs within the FWC.
- 8.1.2. Changes to image requests during the Image Acquisition Campaign that result in the addition of area (adding new zones, re-tasking) require an update in the form of a relevant SC. The update is managed via an 'exchange of letters' between the Commission and FW contractor. In this case, the new requests are inserted in G⁴CAP only when the whole financial/contractual procedure is finished to allow the feasibility assessment to start.

9. **Delivery**

- 9.1.1. Validated partial acquisitions covering a minimum of a 100 km² contiguous area with a regular and simple shape, as defined in section 7.1.1, will be delivered in the format and on the media requested. **If, however, a remaining area required to complete an AOI is less than 100 km², smaller validated acquisitions are acceptable.** If demanded by the MS administration (or contractor), the delivery of validated proposed imagery will include all proposed uploads over the zone.
- 9.1.2. The contractual delivery period, which includes production, internal QC and ex-works availability, is 6 working days after acquisition for VHR data.
- 9.1.3. Images (after acquisition acceptance, according to the procedure laid out in Chapter 7) are delivered directly to the MS administration (or contractor) after they have passed through the internal QC of the FW contractor.
- 9.1.4. The MS administration (or contractor) receives a delivery notification through G⁴CAP as soon as the product is confirmed as shipped by the FW contractor. This delivery notification includes the AR ID and the acquisition identifier. If the product is delivered via FTP, G⁴CAP displays the FTP address, and the username and password required for access; if it is delivered on DVD, a delivery note is uploaded on G⁴CAP containing information on the shipment. **Even in the case of DVD delivery, an FTP account must be set up to deliver the acquisition to the JRC and its details must be entered into G⁴CAP, as for FTP-delivered acquisitions.**
- 9.1.5. The MS administration (or contractor) must download the product within 6 working days from the day it was placed on FTP server by the FW contractor.
- 9.1.6. The FW contractor will use checksum for correct delivery between the FW contractor and MS administration (or contractor), and for image data provision to the JRC (see Chapter 12).
- 9.1.7. At the request of the JRC, the FW contractor will inform the JRC about the image production/QC status (production pending, production finished and production date) at any time during the campaign.

10. **Input data quality assessment**

- 10.1.1. The MS administration (or contractor) will fill in the IDQA on the acquisition page of G⁴CAP within 8 working days after the image has been delivered. This action will allow the JRC to obtain QC records (QCRs) on products and on the delivery performance of the FW contractor.
- 10.1.2. If an MS administration experiences a delay in nominating a contractor, the MS administration will have to perform all the necessary actions by itself. This means that the MS administration will act as a contractor in G⁴CAP, to avoid delaying the process.
- 10.1.3. When an acquisition has passed its IDQA, the JRC will set the acquisition as 'ready to be invoiced' and move it to the 'basket' of invoiceable acquisitions.
- 10.1.4. If the required IDQA is not filled in by the MS administration (or contractor) in 8 working days (maximum 12 calendar days) from delivery of the imagery, the IDQA status will be assumed to be 'accepted', to allow its timely

categorisation as invoiceable. Although the contractual relation is between the JRC and the FW contractor, in these cases an automatic notification will be sent via G⁴CAP to the responsible MS administration and contractor stating that they will not be able to file any complaint on any image characteristics that could have been discovered in the IDQA. This means that all imagery that was delivered more than 12 calendar days previously will be classified as IDQA/Accepted and categorised as invoiceable at the beginning of each month. **Exemption from the above workflow is granted to acquisitions on which the MS administration/contractor has already filed a complaint (see below).**

- 10.1.5. If a MS administration (or contractor) experiences a proven technical malfunction in performing an IDQA within the required time, the JRC must be informed and, if this is confirmed, the IDQA will be put on hold and not automatically accepted.**
- 10.1.6. If, in the IDQA procedure, the MS administration (or contractor) notes that the image area delivered⁸ does not match the area specified by the FW contractor, **it will note this discrepancy and upload a corrected shapefile in G⁴CAP.** The JRC will have a final validation role in cases of non-compliance.
- 10.1.7. If, in the IDQA procedure, the MS administration (or contractor) notes that the metadata on which sensor acquired the imagery are wrong, or that the received image mode is not the requested one, it will be able to correct it directly in G⁴CAP when performing the IDQA. The system will trigger an automatic correction notification to IPs and FWCs. In the latter case, the acquisition will be re-delivered in the correct image mode.**
- 10.1.8. An AR is closed only after the whole area has been imaged and the acquisitions have been accepted through the IDQA by the contractor (unless other circumstance cause closure; for example, the AW comes to an end).
- 10.1.9. If the IDQA is not satisfactory for any other reason, the FW contractor and the MS administration (or contractor) shall solve the situation bilaterally by either an acceptance by the MS administration (or contractor), or a reproduction (e.g. different product type or product of specified quality) or a partial or complete re-task by the FW contractor. If no agreement is reached, the FW contractor will report to the JRC, which has a final decisive role in determining the action to be undertaken. The relevant provisions of the FWC [1] shall apply.

⁸ Calculated (rounded to whole km²) as the intersection between the validated acquisition (using final ephemeris data) and the zone in geographic projection UTM/WGS 84.

11. Pricing and invoicing

11.1. Pricing

11.1.1. Pricing for products will be in accordance with the FWC signed by the FW contractor and the JRC [1].

11.2. Invoicing - the VHR 'basket'

11.2.1. The FW contractor can invoice any single acquisition:

- that has been accepted (IDQA/Accepted) by the MS administration (or contractor);
- that the JRC has thereafter set to the status 'ready to be invoiced' (for all acquisitions for which the time delay from delivery is more than 12 calendar days, see section 10.1.4). G⁴CAP will, at this point, move the acquisition to the 'VHR basket' of invoiceable acquisitions.

11.2.2. Such invoicing shall normally be made cumulatively once per month, according to the rules established in the FWC signed by the FW contractor and the JRC [1]. The identification value for an acquisition to be invoiced is the **Acq ID** displayed in the basket.

11.2.3. If, when accepted and delivered, imagery turns out to be inadequate, the relevant provisions of the FWC shall apply [1], where FW contractor image warranty applies.

12. Image data provision to the JRC (image return) and image access

12.1. Image return to the JRC by FW contractor - introduction

12.1.1. Image return involves returning the imagery, purchased for the purpose of the CAP checks by DG AGRI for the MS administration, to the JRC. This follows Article 21 of Regulation (EU) No 1306/2013: '...The Commission shall supply ... satellite images free of charge to the control bodies or to suppliers of services authorised by those bodies to represent them. The Commission shall remain the owner of the satellite images and shall recover them on completion of the work ...'.

12.1.2. Both source and orthorectified SRS data shall be returned to the JRC, as described in the following sections.

12.2. Source image return to the JRC by the FW contractor

12.2.1. The source data shall be made available to the JRC by the FW contractor directly after data acquisition, with minimum delay, contemporaneously with data provision to the MSs and their contractors. The FTP address and credentials will be the same for the contractor and the JRC. G⁴CAP will automatically harvest this account as soon as possible after the IDQA is completed with acceptance by the MS administration (or contractor) (see section - 9.1.4 and chapter 10).

12.2.2. The source data shall be provided to the JRC via standard FTP⁹ protocol. The FW contractor shall ensure that the minimum transfer speed of the FTP service is 150 Mbit/s, with a minimum of four possible connections at the same time, and guarantee that the service has an uptime of at least 99.0%. The minimum retention time for data on the FTP server of the FW contractor shall be 2 weeks from IDQA Acceptance.

12.2.3. Finally, to enable the JRC (and the MS administrations or their contractors) to run checks for complete data transfer, the FW contractor shall provide MD5 checksums for every file included in an acquisition. These MD5 checksums shall be added to checksum files that are named checksum.md5 and shall be placed in the same folder as the data, referencing to all files in that folder. The content and structure of the checksum files must follow the syntax of the md5sum tool,¹⁰ using UNIX style line breaks (newline). The creation of the MD5 checksum files must be performed at the earliest possible stage of the data acquisition workflow. If the source imagery is returned as a ZIP file, the MD5 checksum of the archive shall be included in the root folder of the archive.

12.3. Ortho image return to the JRC by the FW contractor

12.3.1. The FW contractor shall collect the orthorectified data at the end of every campaign from the MS administrations (and/or their contractors) on behalf of the JRC and provide them to the JRC. The deadline for this data collection

⁹ <http://en.wikipedia.org/wiki/Ftp>

¹⁰ <http://en.wikipedia.org/wiki/Md5sum>

is at the end of the control campaign year (i.e. 31 December of each year for CwRS and 31 January of the year after the campaign for LPIS QA).

12.3.2. The modality of how this process will be managed (a new module is being created for this purpose in G⁴CAP) will be communicated in an update of these specifications in time for ortho image return in 2018).

12.4. VHR image access

12.4.1. MS administrations (and their contractors) may access imagery purchased through the FWCs [1]. This image access must follow the principles set up in the licensing agreement between the FW contractor and the JRC, as agreed in the FWC. An end-user licence agreement (EULA)[11] based on the same principles will bind the users from the moment of their registration to G⁴CAP [4].

12.4.2. In accordance with the EULA [11], images used in the abovementioned operations may not be disseminated and the resulting products may not be sold. Image access should be arranged through the JRC.

12.4.3. The JRC purchase a limited right of use, but the images themselves remain the property of the FW contractor. In addition, according to the EULA [11], paragraph 6 on IPRs, imagery must have proper references. When using the imagery, the licensee must refer to the supplier with the exact display of the credits as specified in the product's metadata, which will take the form:

'© owner or supplier name or mission name (year of acquisition, or validity of Framework Contract), all rights reserved)'.

In addition, the end user should indicate the following information:

'Data received via the Joint Research Centre of the European Commission under FWC xxx.yyy'

where the FWC number is available from the JRC.

For the presently running FWCs [1] with European Space Imaging (EUSI), the first sentence above shall be substituted with one of the following:

- 'WorldView-1 data, © European Space Imaging/DigitalGlobe™, year of acquisition, distributed by European Space Imaging';
- 'WorldView-2 data, © European Space Imaging/DigitalGlobe™, year of acquisition, distributed by European Space Imaging';
- 'WorldView-3-data, © European Space Imaging/DigitalGlobe™, year of acquisition, distributed by European Space Imaging';
- 'WorldView-4-data, ©European Space Imaging/DigitalGlobe™, year of acquisition, distributed by European Space Imaging';
- 'GeoEye-1 data © European Space Imaging/DigitalGlobe™, year of acquisition, distributed by European Space Imaging';
- 'Komsat 3 data, © Satrec Initiative, provided by European Space Imaging'.

13. VHR image profiles

13.1.1. Since the 2014 Campaign, the MS administrations are able to request a sensor-independent profile of interest for a control zone from an available menu of profiles (see Table 1). Each profile is defined by certain parameters and it is in the FW contractor’s responsibility to coordinate the collection and assign the sensors in the most efficient and suitable way.

13.1.2. A summary of the profile characteristics is given in Table 1.

Image Profile ID	Description	Spatial resolution requirement (*)	Radiometric resolution (**) and spectral bands	Minimum Elevation Angle restriction (***)	Cloud Cover (CC) over AOI	Acquisition programming	Resampling	Remarks	Example of sensors
A1. VHR prime - CwRS [std]	Pan+Multispectral (Bundle)	GSD≤0.75m	PAN	> 50	≤10%	Priority programming	sensor dependent	standard CwRS profile	WV4, WV3, WV2, GE1, K3, possibly others not benchmarked yet
		GSD≤3m	MS (at least 4 bands)						
	Pan-sharpened	PAN GSD≤0.75m, MS GSD≤3m	at least 4 bands						
A11. VHR prime - CwRS [VHR+][8]	Pan+Multispectral (Bundle)	GSD≤0.75m	PAN	> 50	≤10%	Priority programming	0.50m		WV3, WV2, possibly others not benchmarked yet
		GSD≤3m	MS (at least 8 bands)				2m		
A12. VHR prime - CwRS [VHR+][16]	Pan+Multispectral (Bundle)	GSD≤0.75m	PAN	> 50	≤10%	Priority programming	0.50m		WV3, possibly others not benchmarked yet
		GSD≤3m	MS (16 bands; 8 SWIR bands may have coarser resolution)				2m		
A2. VHR prime - [Topographic] [less strict than A5]	Pan+Multispectral (Bundle)	GSD≤0.75m	PAN	> 56	≤10%	Priority programming	sensor dependent		WV4,WV3,WV2, GE1, K3, possibly others not benchmarked yet
		GSD≤3m	MS (at least 4 bands)						
	Pan-sharpened	PAN GSD≤0.75m, MS GSD≤3m	at least 4 bands						
A3. VHR prime - CwRS [Pan only]	Pan	GSD≤0.75m	PAN	> 50	≤10%	Priority programming	sensor dependent		WV4,WV3, WV2, GE1, WV1, possibly others not benchmarked yet
A4. VHR prime - CwRS [Stereo]	Pan+Multispectral (Bundle)	GSD≤0.75m	PAN	according to IP specifications	≤10%	Priority programming	sensor dependent		WV3, WV2, GE1, possibly others not benchmarked yet
		GSD≤3m	MS (at least 4 bands)						
	Pan-sharpened	PAN GSD≤0.75m, MS GSD≤3m	at least 4 bands						
A5. VHR prime - CwRS [VHR+ Topographic]	Pan+Multispectral (Bundle)	GSD≤0.50m	PAN	> 67	≤10%	Priority programming	0.40m		WV4,WV3,WV2, GE1, possibly others not benchmarked yet
		GSD≤2m	MS (at least 4 bands)	> 67			1.60m		
	Pan-sharpened	PAN GSD≤0.50m, MS GSD≤2m	at least 4 bands	> 67			0.40m		
A51. VHR prime - CwRS [VHR+ Topographic][8]	Pan+Multispectral (Bundle)	GSD≤0.50m	PAN	> 67	≤10%	Priority programming	0.40m		WV3, WV2, possibly others not benchmarked yet
		GSD≤2m	MS (at least 8 bands)	> 67			1.60m		
A52. VHR prime - CwRS [VHR+ Topographic][16]	Pan+Multispectral (Bundle)	GSD≤0.50m	PAN	> 67	≤10%	Priority programming	0.40m		WV3, possibly others not benchmarked yet
		GSD≤2m	MS (16 bands; 8 SWIR bands may have coarser resolution)	> 67			1.60m		
A6. VHR prime - CwRS [VHR_EFA_LF]	Pan+Multispectral (Bundle)	GSD≤0.50m	PAN	> 50	≤10%	Priority programming	0.50m		WV4,WV3,WV2, GE1, possibly others not benchmarked yet
		GSD≤2m	MS (at least 4 bands)				2m		
	Pan-sharpened	PAN GSD≤0.50m, MS GSD≤2m	at least 4 bands				0.50m		
A61. VHR prime - CwRS [VHR_EFA_LF][8]	Pan+Multispectral (Bundle)	GSD≤0.50m	PAN	> 50	≤10%	Priority programming	0.50m		WV3, WV2, possibly others not benchmarked yet
		GSD≤2m	MS (at least 8 bands)				2m		
A62. VHR prime - CwRS [VHR_EFA_LF][16]	Pan+Multispectral (Bundle)	GSD≤0.50m	PAN	> 50	≤10%	Priority programming	0.50m		WV3, possibly others not benchmarked yet
		GSD≤2m	MS (16 bands; 8 SWIR bands may have coarser resolution)				2m		

Image Profile ID	Description	Spatial resolution requirement (*)	Radiometric resolution (**) and spectral bands	Minimum Elevation Angle restriction (***)	Cloud Cover (CC) over AOI	Acquisition programming	Resampling	Remarks	Example of sensors
A7. VHR prime - near nadir profile [VHR_NN_50]; LPIS	Pan+Multispectral (Bundle)	GSD≤0.50m	PAN	> 80	close to cloud free, haze free, better than ≤10%	Image Provider (IP) best programming, when sensor available	0.50m	new profile; longer acquisition window: typically March-August; AOI chosen by IP within large areas given by JRC	WV2, GE1, possibly others not benchmarked yet
		GSD≤2m	MS (at least 4 bands)	> 80			2m		
	Pan-sharpened	PAN GSD≤0.50m, MS GSD≤2m	at least 4 bands	> 80			0.50m		
A71. VHR prime - near nadir profile [VHR_NN_50]	Pan+Multispectral (Bundle)	GSD≤0.50m	PAN	> 80	≤10%	Priority programming	0.50m	new profile	WV4,WV3, WV2, GE1, possibly others not benchmarked yet
		GSD≤2m	MS (at least 4 bands)	> 80			2m		
	Pan-sharpened	PAN GSD≤0.50m, MS GSD≤2m	at least 4 bands	> 80			0.50m		
A8. VHR prime - near nadir profile [VHR_NN_40]; LPIS	Pan+Multispectral (Bundle)	GSD≤0.40m	PAN	> 80	close to cloud free, haze free, better than ≤10%	Image Provider (IP) best programming, when sensor available	0.40m	new profile; longer acquisition window: typically March-August; AOI chosen by IP within large areas given by JRC	WV4,WV3, possibly others not benchmarked yet
		GSD≤1.60m	MS (at least 4 bands)	> 80			1.60m		
	Pan-sharpened	PAN GSD≤0.40m, MS GSD≤1.6m	at least 4 bands	> 80			0.40m		
A81 VHR prime - near nadir profile [VHR_NN_40]	Pan+Multispectral (Bundle)	GSD≤0.40m	PAN	> 80	≤10%	Priority programming	0.40m		WV4,WV3, possibly others not benchmarked yet
		GSD≤1.60m	MS (at least 4 bands)	> 80			1.60m		
	Pan-sharpened	PAN GSD≤0.40m, MS GSD≤1.6m	at least 4 bands	> 80			0.40m		
B. VHR archive	as any of above	as any of above	as any of above		as any of above	Archive	sensor dependent	used for archive search for any profile	WV4,WV3,WV2, GE1, K3, WV1
	as any of above	as any of above	as any of above		as any of above	Priority programming	sensor dependent	used for re-task for any profile	WV4,WV3,WV2, GE1, K3, WV1
	as any of above	as any of above	as any of above		10%>CC≤30%	Priority programming	sensor dependent	proposed for any profile	WV4,WV3,WV2, GE1, K3, WV1
E. VHR back up	Pan+Multispectral (Bundle)	GSD≤3m	PAN		≤10%	Priority programming	sensor dependent	back up for any profile	WV4,WV3,WV2, GE1, K3, WV1
		GSD≤12m	MS (at least 3 bands)						
	Panchromatic	GSD≤3m	PAN						
	Pan-sharpened	GSD≤3m	at least 3 bands						

(*) GSD in both directions (across track, along track) including the effect of earth curvature should satisfy this criterion

(**) Dynamic range, minimum ≥ 11 bits/pixel

(***) Elevation angle (ELA) of any uploaded strip of an acquisition should satisfy this criterion

Table 1 - VHR profiles adopted within the CAP OTSCs, and the LPIS QA

13.1.3. To fulfil the new CAP requirements, all VHR imagery should have a spatial resolution that is compliant with at least 1:5 000 or larger accuracies. This translates into a required positional accuracy of a maximum 1.25 m 1-D root mean square error (RMSE) and a ground sampling distance (GSD)/pixel size of 75 cm or smaller. The requirements for absolute accuracy for the VHR sensors are in the FWCs [1] and are set to 2 m/1.5 m, depending on the sensor. The RMSEs of the VHR sensors (WV1 [16], WV2 [14], WV3 [13], WV4 [12], GE1 [14]) were, however, shown to be below 1.25 m in the JRC’s geometry benchmark studies. Regarding Kompsat-3, the RMSE for a maximum allowed off-nadir angle of 15° was 1.5m; however, in other, more extensive, studies dealing with the geolocation accuracy of Kompsat-3 imagery, an RMSE below 1 m can be found [15], which is why Kompsat-3 is also allowed as a prime VHR sensor under those restrictions.

13.1.4. For a better overview of the existing profiles, and to help the MS administrations in their choice of correct profiles for their controls, the profiles can be represented in a graph of GSD versus elevation angle. See Figure 2.

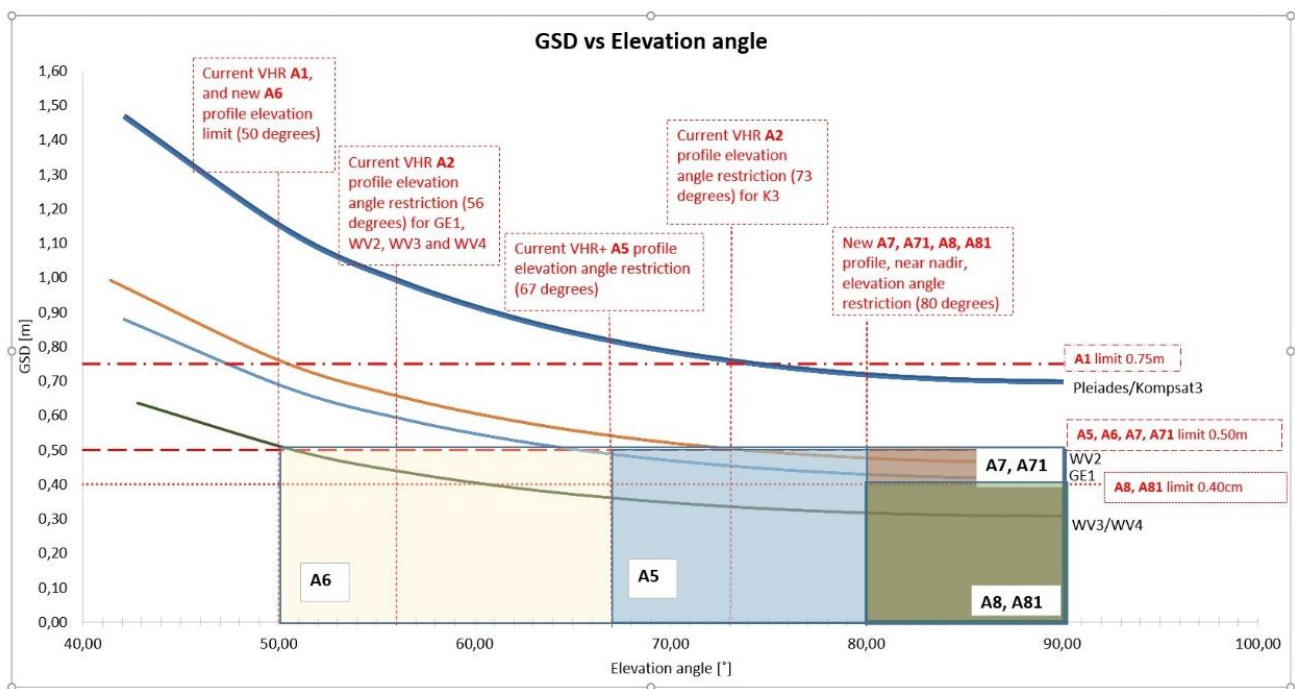


Figure 2 - GSD versus elevation angle for the VHR profiles

13.1.5. The VHR zone will be covered by a bundle product (PAN and 4 bands MSP as separate bands), the PSH product or the PAN-only product. If the profile A4 (VHR stereo) is requested, a stereo product will be delivered. PAN and 8 bands MSP products (A.11/A.51/A.61 profiles) or PAN and 16 bands MSP products (A.12/A.52/A.62 profiles) are also options, but the requirement for such profiles must be negotiated bilaterally with the JRC at the pre-IR stage.

13.1.6. The technical details of the sensors that fit the abovementioned profiles are explained in Annex 19.4.

13.2. LPIS-specific profiles

- 13.2.1. For the LPIS QA Campaign, the VHR image acquisition approach guarantees close to nadir (threshold > 80 degree elevation angle), haze-free and nearly cloud-free (0–10% CC) imagery. See Table 1 for the specific profiles used in the LPIS QA. See Chapter 16 for a more detailed description of LPIS QA image acquisition.

14. Quality assurance/quality control

14.1. Quality assurance/quality control

- 14.1.1. The principal objective of the CAP image acquisition is to reach the goal of a minimum 95% success rate of images supplied on time and according to specifications. To ensure this, an adequate QA/QC process must be put in place; the FW contractor shall therefore apply QA and internal QC to the imagery and to the process of performing image acquisition. The JRC will have an overarching role in applying external QC to the procedures that the FW contractor has set up. This is performed through specific deliverables, QCRs and QC visits throughout the contract between the FW contractor and the JRC [1].
- 14.1.2. QA may be defined as the steps performed to ensure that the production of a product meets a set of accepted standards. QC aims to detect non-conformities in a product.
- 14.1.3. QC includes assessment of issues such as data integrity, data completeness, CC, haze or thin clouds, cloud shadows, fog, smoke, smog, snow, flares, etc. It also includes assessing the product geometry, radiometry, image characteristics (dropouts, etc.), the production parameters (resampling algorithm, bit depth), etc.
- 14.1.4. The FW contractor will follow their internally defined QA/QC procedures on their products including at least the issues mentioned above. They will deliver a conforming product or propose a non-conforming product for evaluation, clearly stating reasons for QC failure – such an image will be treated as a ‘proposed’ image. A proposed image can also be, for example, an acquisition at an elevation angle below the requirement.

14.2. Specificities on cloud cover

- 14.2.1. Cloud will be defined as a white opaque area with little or no image information available of the ground features below. It does not include cloud shadow. Dense haze, which causes consistent muting of imagery, should be included.
- 14.2.2. There are different CC assessment routines, for example:
- a) Automatic or semi-automatic thresholding, with subsequent quality factor including issues of dense haze, haze, smoke, pollution, snow, shadow, etc. A visual observation after classification is required to adjust CC, taking into account issues of dense haze, cloud conglomeration, etc.
 - b) Manual photo interpretation and subsequent vector digitising. If a definite boundary between affected pixels and unaffected pixels is visible, it is a cloud.
- 14.2.3. The JRC decided that imposing a common CC assessment approach on the FW contractor is not efficient. The CC assessment should result in an agreement between the FW contractor and the MS administrations (or contractors), otherwise the FW contractor must report to the JRC, which has the right to decide.
- 14.2.4. Both approaches in section 14.2.2 are accepted by the JRC. However, to arrive at an efficient CAP checks programme with a successful outcome, the MS administration (or contractor) and the FW contractor should aim for optimisation of the image use.

- 14.2.5. CC validation and MeteoFlagging should follow the procedure described in Chapter 7.
- 14.2.6. The accuracy to which CC assessment will be performed is better than 1% of CC definition.

15. Risk of satellite failure

- 15.1.1. The FW contractor is responsible for communicating any technical problem connected to a satellite sensor, the receiving station or the processing chain as soon as possible to the JRC. This is important to limit risks to the campaign by allowing switching to other satellite sensors or switching to traditional OTSC for the checks of the area-based subsidies.

16. LPIS QA image acquisition

16.1. LPIS QA introduction

- 16.1.1. The LPIS QA is a yearly exercise that has been jointly organised since 2010 by the EC (through the JRC) and the MS administrations. It consists in an evaluation of the quality of the LPIS systems based on a sample of the reference parcels (RPs) and a recent photo-interpretation of the parcel boundaries and interiors. A set of quality elements have been defined by the EC and compared with limiting quality thresholds. The LPIS QA sample requirements are driven by ISO Standard 2859/2 [3].
- 16.1.2. In practice, the JRC orders the images directly from the IP. The images are stored and kept confidentially until the MS administrations upload the full population, subject to the LPIS QA exercise of the campaign. After several quality checks on the population sent, the JRC crops the submitted population to the zone delimited by the images and proceeds with a random selection of the *sample pre-selection*, which consists of a 3 times the target sample size (i.e. 500/800/1 250 RPs), depending on the population size [3].
- 16.1.3. The LPIS QA exercise is performed at LPIS system level. Belgium, Germany and the United Kingdom split their national territories following their administrative regional boundaries: Belgium is split into two regions (Wallonia and Flanders), Germany into 13 *Bundesländer* and the United Kingdom into four countries (England, Scotland, Wales and Northern Ireland). It means that the MSs inspect what they consider a homogeneous population (lot) of their RPs. All MSs send one lot for each sub-population. It directly affects the creation of the LPIS QA zones.
- 16.1.4. Until 2014 inclusive, the samples were taken from a subset of the CwRS zones from the current campaign's OTS control period, to minimise the inspection burden for the MSs. The selection of the zones was, in this case, known in advance by the MS administrations.
- 16.1.5. After an evaluation in 2014, the JRC set up an image acquisition procedure in which the LPIS QA zones are not known by the MS administrations before the beginning of the LPIS QA measurements. The objectives of the procedure were to:
- rely on better quality images for the inspections;
 - reduce the logistical burdens of control zone selection and RP sample generation;
 - as a result of the point above, facilitate complementary field observations; and
 - most importantly, rely on random zone selection.

16.2. Pre-image requests assessment

16.2.1. No input is required from the MS administrations for this exercise except the preparatory work described in Chapter 2.

16.3. LPIS QA zones definition

16.3.1. The number of LPIS QA zones by LPIS system will be determined based on the proper characteristics of the corresponding LPIS system and according to the statistical analysis performed considering the RP population. Basically, the concept of determining the number of zones is as follows:

- One image will be assigned for small countries/LPIS systems, such as Malta and DE_SL (Saarland in Germany) requiring a sample of 500 RPs.
- Two or three images will automatically be assigned to LPIS systems requiring samples of 800 and 1 250 RPs, respectively.
- Extra image(s) will be allocated to larger LPIS systems:
- +1 when $0.05 \leq \sin(lat_{max}) - \sin(lat_{min}) \leq 0.07$;
- +2 when $\sin(lat_{max}) - \sin(lat_{min}) \geq 0.07$,

where lat_{min} and lat_{max} are, respectively, the minimum and maximum latitudes of the corresponding LPIS system. This latitude parameter is chosen because it is closely linked the bio-geographical zoning.

In addition, additional images might be allocated based on the statistical analysis of the representativeness of the sample; that is, for LPIS systems with one or two images, an additional image will be proposed. Relying on a single image (where sample size is 500 RPs), according to the abovementioned concept, might not be appropriate when extending the result of the sample to the whole population. The reason is that it could be affected by where this unique zone is located. To avoid this possibility, according to the recommendations of the ECA, it was decided to guarantee two or three images per LPIS system (except for DE_SL and Malta, for which the representativeness of the samples is already satisfactory and for which the $15 \times km$ unique image already represents a significant percentage of their total territory: 9% for DE_SL and 70% for Malta).

16.3.2. This gives a total of 44 LPIS systems, to which will be allocated between 1 and 6 zones each. For the systems that will be allocated extra zones, a sub-division of the system will be created as a spatial aggregation of the NUTS2 regions, with the constraint that each aggregation should contain roughly the same number of RPs.

16.3.3. Finally, the zones with a density of RPs lower than two parcels per km^2 will be regrouped into a single zone (PAN EU) for which two LPIS QA images will be requested to guarantee the chance of selection for RPs inside these low-density areas. The zones with no RPs are completely excluded for the acquisition of the images.

16.3.4. In practice, the European Union (EU) territory will be split into a number of different zones (86 in 2017) for which a number of images are expected to be acquired for the purpose of the LPIS QA. The resulting zones will be uploaded directly to G⁴CAP.

16.4. Acquisition window definition

16.4.1. The AW for the LPIS QA VHR imagery to be acquired will normally be February/March to August. There are no common criteria for the definition of AW dates; however, the following principles form a basis:

- The decision was made that the starting date of LPIS QA acquisition of an LPIS (or a neighbouring system if an MS does not participate in the CwRS campaign) will be 1 month before starting its earliest CwRS acquisition.
- For the PAN EU zone, the most restrictive criteria will be used, that is, the latest starting date for the CwRS over the PAN EU mask (includes the parts of Europe with a low density of agriculture parcels).
- The end date for all zones will be 31 August 2018.

16.4.2. The proposed dates of AWs will be communicated bilaterally between the JRC and the MSs. MSs can propose an alternative AW only with an appropriate reason. The final AW will be inserted for each LPIS QA zone directly in G⁴CAP.

16.5. Feasibility assessment

16.5.1. No feasibility assessment is performed by the IP. Acquisition is performed without a feasibility assessment, since the IP will be responsible for acquiring the requested number of LPIS images per LPIS region/zone. It will select LPIS image(s) randomly, taking into account collection efficiency (within priority tasking), weather forecast and real time weather development and in accordance with the image profile requirement (see Chapter 13 for image profiles).

16.6. Image acquisition

16.6.1. The LPIS QA image acquisition (ARs, QLs, acquisition acceptance (validation) and ordering) is managed by the IP and the JRC, without interfacing with the MS administration (or contractor).

16.6.2. For the LPIS QA Campaign, the VHR image acquisition approach guarantees images with the following basic characteristics: close to nadir (threshold > 80 degree elevation angle), haze-free and nearly cloud-free (0–10% CC) imagery (see Chapter 13 for image profiles).

16.6.3. The IP is in exceptional cases allowed to upload a slightly hazy image. The acquisition is uploaded as 'validated', but with the meteo-flag ON, and with a comment like: "LPIS haze image; to be checked at IDQA". JRC will at IDQA verify usability and if QC accepts image, the IP shall stop programming.

16.6.4. The IP that collects the data will decide upon the LPIS QA image extent (225 km² or 169 km²) depending on profile used. The resampling will be carried out to best accommodate a 1:1 ratio of acquired GSD:delivered output pixels.

16.6.5. General restrictions for the data collections per satellite overpass are as follows:

- It is possible to collect only one image per LPIS QA zone in one pass (exceptionally it is possible to collect two images in regions with very bad weather conditions, but this has to be communicated during the campaign).
- For the PAN EU zone, two images are planned but they will be taken in two passes (i.e. one in the north, Sweden, Finland, Estonia and Scotland (UK); and one in the south, Bulgaria, Romania, Hungary and France).

16.7. Image delivery

16.7.1. The shape of the resulting image shall be as simple as possible and is normally, as mentioned above, a 13 km × 13 km (169 km²) or 15 km × 15 km (225 km²) plain image. However, it is possible that an LPIS QA zone (large area) has an irregular/complex shape, which will affect the resulting image.

- Shapes with only four vertices:
 - square shape (a = b);
 - rectangular shape (a ≠ b);
 - regular, but not rectangular, shapes (parallelogram, rhombus, kite, etc.);
 - irregular shapes.
- Shapes with more than four vertices (where the shape depends on a borderline, coastline or area of inland water or was created to exclude cloud). These cases will be dealt with bilaterally before delivery.
- Manual creation of the shape to exclude clouds (and larger parts of the lakes/seas at the borders of small area). This applies only when excluding the outer perimeter of the initial shape.
- A shape defined by using a coastal line shapefile provided by the JRC. Small islands (without agricultural parcels) and reefs shall also be excluded.

16.7.2. Bonus images may be required as follows:

- After the MS finishes the LPIS population upload, the JRC performs an evaluation of whether or not the required number of the RPs can be selected within the acquired images. If the required number of RPs cannot be selected within the already acquired images, a bonus image will be requested from the IP.
- The AW for the requested bonus image should be at least 8 weeks. If it is not possible to guarantee this minimum length of AW, an eventual failure of the acquisition is not counted in the statistics for the LPIS success rate.

16.7.3. Contingency – in the case of an image acquisition failure, the following contingency measures shall apply:

- extension of the AW;
- use of a CwRS image;
- use of an archive image.

16.8. Workflow - simplified

16.8.1. The LPIS QA image acquisition workflow can be summarised as follows:

- The JRC manages the image acquisition for all LPIS systems together with the IP.
- The zone is determined:
- There are a total of 44 LPIS systems – Germany is divided into 13 systems, Belgium into two and the United Kingdom into four system,.
- Based on the RP population (from the previous year), the JRC calculates the density map.
- The JRC performs the analysis of the density and makes a decision regarding divisions at the country (or LPIS system) level.
- The JRC uploads the final polygons into G⁴CAP (LPIS systems, subdivided polygons, PAN EU polygon) with the number of images for each polygon.
- The JRC defines the AWs.
- The IP performs image acquisition.
- The JRC performs IDQA.
- The success rate of the acquisition of LPIS QA imagery, which should strive towards 100% after all contingency measures, is kept separate from the calculated 95% contractual threshold on CwRS.

17. JRC responsible staff and e-mail addresses

17.1.1. Directorate D Sustainable Resources/Unit D.5/image acquisition: par-johan.astrand@ec.europa.eu.

17.1.2. Directorate D Sustainable resources/Unit D.5/contractual FWC: philippe.loudjani@ec.europa.eu.

18. References

- 1 FWCs for satellite image purchase held at the JRC:
 - a. Framework contracts for supply of Satellite Remote Sensing (SRS) data and associated services in support to checks within the Common Agricultural Policy (CAP); (1) VHR profile II FWC 931.886, VHR+ profile FWC 199.309, with European Space Imaging GmbH; (2) HHR profile FWC 198.995 with Airbus Defence and Space.
 - b. Framework contract for supply of any type of satellite remote sensing data, Broker FWC 391.782.
- 2 Access to European Union law. Available online: <http://eur-lex.europa.eu/homepage.html>
- 3 LPIS QA and OTSC guidance (WikiCAP). Available online: https://marswiki.jrc.ec.europa.eu/wikicap/index.php/Main_Page
- 4 G⁴CAP. Available online: <https://g4cap.jrc.ec.europa.eu>
- 5 Common technical specifications (CTS) and guidance documentation. Available online: https://marswiki.jrc.ec.europa.eu/wikicap/index.php/Main_Page
- 6 Kapnias, D., Milenov, P. and Kay, S., Guidelines for best practice and quality checking of ortho imagery, Issue 3.0. Available online: <https://g4cap.jrc.ec.europa.eu/g4cap/Portals/0/Documents/10133.pdf>
- 7 HR 'profile based' specifications. See "Documentation" section in G⁴CAP Web site.
- 8 G⁴CAP manual. Available online: <https://g4cap.jrc.ec.europa.eu/g4cap/Portals/0/Documents/G4CAP%20user%20manual%201.2.pdf?ver=2016-02-03-110656-263>
- 9 Archives for the VHR FWC search tools. Available online: <http://www.euspaceimaging.com/imagery-search>; <https://discover.digitalglobe.com/> for GE1 and WV1–4; <http://arirang.kari.re.kr/> for KOMPSAT-3.
- 10 *Digital globe atmospheric compensation*, white paper. Available online: http://digitalglobe-marketing.s3.amazonaws.com/files/documents/AComp_WP_ACOMP.pdf
- 11 Satellite remote sensing data EULA. Available online: <https://g4cap.jrc.ec.europa.eu/g4cap/EULA.htm>
- 12 Vajsova, B., Walczynska, A., Åstrand, P., Bärtsch, S. and Hain, S., New sensors benchmark report on WorldView-4. Geometric benchmarking over Maussane test site for CAP purposes, PUBSY JRC107673, EUR 28761 EN, ISBN 978-92-79-73187-7, ISSN 1831-9424, doi: 10.2760/872158, 2017. Available online: <http://publications.jrc.ec.europa.eu/repository/handle/JRC107673>
- 13 Benchmarking Worldview-3 sensor for use in the CAP CwRS programme: Vajsova, B., Walczynska, A., Åstrand, P., Bärtsch, S. and Hain, S., New sensors benchmark report on WorldView-3. Geometric benchmarking over Maussane test site for CAP purposes, PUBSY JRC99433, EUR 27673 EN, ISBN 978-92-79-54236-7, ISSN 1831-9424, doi:10.2788/237561, 2015. Available online: <http://publications.jrc.ec.europa.eu/repository/handle/JRC99433>
- 14 Benchmarking Worldview-2, GE1, DMCII, THEOS, Kompsat-2 for use in the CAP CwRS programme:
 - Nowak Da Costa, J. and Walczynska, A., Evaluating the WorldView-2, GeoEye-1, DMCII, THEOS and KOMPSAT-2 imagery for use in the Common Agricultural Policy Control with Remote Sensing Programme, oral presentation (JRC61995), 16th Conference on 'Geomatics in support of the CAP',

GeoCAP Action of the MARS Unit, IPSC, JRC (organiser), 24 November 2010, Bergamo, Italy. PUBSY: <http://publications.jrc.ec.europa.eu/repository/>

- Nowak Da Costa, J. K., Geometric quality analysis of the WorldView2 Basic (level 1A) and OrthoReady (level 2A) images acquired over the JRC MARS Unit's Maussane terrestrial test site, JRC Scientific and Technical Report No 24525 EN, 2010, ISSN 1018-5593, ISBN 978-92-79-15625, JRC PUBSY Category 2.2, No JRC60424 <http://publications.jrc.ec.europa.eu/repository/handle/JRC60424>
- Sensitivity analysis of the WorldView-2 satellite orthoimage horizontal accuracy... (ref. JRC IES/H04/C/PAR/par D(2011)(13754)), PUBSY JRC66797. <http://publications.jrc.ec.europa.eu/repository/handle/JRC66797>
- WorldView-2 potentialities for orthoimage production within the Control with Remote Sensing Programme of the European Commission ,PUBSY JRC67516, <http://publications.jrc.ec.europa.eu/repository/handle/JRC67516>

15 Benchmarking the Kompsat-3 for use in the CAP CwRS programme:

- Vajsová, B., Walczynska, A., Bärish, S., Aastrand, P. and Hain, S., New sensors benchmark report on Kompsat-3, PUBSY JRC93093, EUR 27064 EN, ISBN 978-92-79-45054-9, ISSN 1831-9424, doi:10.2788/240349, 2015. Available online: <http://publications.jrc.ec.europa.eu/repository/handle/JRC93093>
- Jeong, J., Kim, J. and Kim, T., 'Analysis of geolocation accuracy of KOMPSAT-3 imagery', Korean Journal of Remote Sensing, Vol. 30, pp. 37–45, DOI: 10.7780/kjrs.2014.30.1.4. Available online: http://koreascience.or.kr/article/ArticleFullRecord.jsp?cn=OGCSBN_2014_v30n1_37

16 Benchmarking the WorldView-1 sensor for use in the CAP CwRS programme (PUBSY JRC 49378), Category 3.4, oral presentation; <http://publications.jrc.ec.europa.eu/repository/>

19. Annexes

19.1. XML metadata file specification for image providers used for the QL upload

For more details, please see G⁴CAP user manual [8].

Zip archive

The IP must upload a zip archive containing the following files:

- one XML file with the metadata of the image file(s) or shape(s) to be uploaded;
- image file(s);
- shapefile(s);
- other file(s) for geo-referencing (if applicable).

This is an example of XML upload to upload two different acquisitions in the same AR. Green nodes and attributes are the ones differing from the previous *LIO XML upload file.

Code 1 - Example of xml metadata file for G⁴CAP QL upload

```
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<G4CAP xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:noNamespaceSchemaLocation="https://g4cap.jrc.ec.europa.eu/Portals/0/g4capAcquisitionUpload.
xsd">
<Acquisition>
<ARID>65843</ARID>
<AcquisitionDate>12.02.2016</AcquisitionDate>
<Sensor backup="true" imageMode="psh">WORLDVIEW02</Sensor>
  <Comment>This is a comment for you.</Comment>
  <CloudCover>1.98</CloudCover>
  <MeteoFlag>SNOW</MeteoFlag>
  <Shape>
    <Filename>test.shp</Filename>
  </Shape>
  <Strips>
    <Strip>
      <Elevation>64.15</Elevation>
      <Filename>WV20250071G101P_000040462_Browse_0.jpg</Filename>
    </Strip>
    <Strip>
      <Elevation>68</Elevation>
      <Filename>WV20250071G101P_000040462_Browse_1.jpg</Filename>
    </Strip>
  </Strips>
</Acquisition>
</G4CAP>
```

```

    </Strips>
  </Acquisition>
<Acquisition>
  <ARID>65843</ARID>
  <AcquisitionDate>15/02/2016</AcquisitionDate>
  <Sensor>WORLDVIEW04</Sensor>
  <Comment>This is a new comment for you.</Comment>
  <CloudCover>0.0</CloudCover>
  <MeteoFlag/>
  <Shape>
    <Filename>test2.shp</Filename>
  </Shape>
  <Strips>
    <Strip>
      <Elevation>61.15</Elevation>
      <Filename>WV20250071G123P_000040462_Browse_0.jpg</Filename>
    </Strip>
    <Strip>
      <Elevation>60</Elevation>
      <Filename>WV22350071G101P_000040462_Browse_1.jpg</Filename>
    </Strip>
  </Strips>
</Acquisition>
</G4CAP>

```

XML Schema Definition (XSD)

This XSD is publicly available at <https://g4cap.jrc.ec.europa.eu/Portals/0/g4capAcquisitionUpload.xsd>.

Code 2 - XML metadata file structure

```

<xs:schema attributeFormDefault="unqualified" elementFormDefault="qualified"
  xmlns:xs="http://www.w3.org/2001/XMLSchema">
  <xs:element name="G4CAP">
    <xs:complexType>
      <xs:sequence>
        <xs:element name="Acquisition" maxOccurs="unbounded" minOccurs="1">
          <xs:complexType>
            <xs:sequence>
              <xs:element type="xs:int" name="ARID"/>
              <xs:element type="xs:string" name="AcquisitionDate"/>
              <xs:element name="Sensor">
                <xs:complexType>

```



```

        <xs:simpleContent>
            <xs:extension base="xs:string">
                <xs:attribute type="xs:boolean" name="backup"/>
                <xs:attribute type="xs:string" name="imageMode"/>
            </xs:extension>
        </xs:simpleContent>
    </xs:complexType>
</xs:element>
<xs:element type="xs:string" name="Comment" minOccurs="0"/>
<xs:element type="xs:float" name="CloudCover"/>
<xs:element type="xs:string" name="MeteoFlag" minOccurs="0"/>
<xs:element name="Shape">
    <xs:complexType>
        <xs:sequence>
            <xs:element type="xs:string" name="Filename"/>
        </xs:sequence>
    </xs:complexType>
</xs:element>
<xs:element name="Strips">
    <xs:complexType>
        <xs:sequence>
            <xs:element name="Strip" maxOccurs="unbounded"
minOccurs="1">
                <xs:complexType>
                    <xs:sequence>
                        <xs:element type="xs:float" name="Elevation"/>
                        <xs:element type="xs:string" name="Filename"/>
                    </xs:sequence>
                </xs:complexType>
            </xs:element>
        </xs:sequence>
    </xs:complexType>
</xs:element>
</xs:sequence>
</xs:complexType>
</xs:element>
</xs:sequence>
</xs:complexType>
</xs:element>
</xs:sequence>
</xs:complexType>
</xs:element>
</xs:schema>

```

Table 2 - Main structure nodes

TAG	DESCRIPTION	CARDINALITY
G⁴CAP	Main container	1
Acquisition	Main container for a single acquisition	1-n
Shape	Container for shapefile information	1
Strips	Container for strips information	1
Strip	Container for single strip information	1-n

Table 3 - XML metadata file, values

METADATUM	TYPE	DESCRIPTION	VALUES	REQ.
ARID	Integer	AR unique identifier	The ID of AR (where to upload this acquisition)	X
AcquisitionDate	Date	Date of acquisition	dd.MM.yyyy or dd/MM/yyyy – this must be inside the AW and not in the future	X
Sensor	Enum	Name or abbreviation of sensor used to acquire the imagery	See <i>Sensors</i> table	X
Comment	String (4096)	Acquisition comment, to be used for any kind of non-standard communication about the acquisition itself, for issues that could be useful at AUDIT level, or as a future reminder	Free text (4 096 characters)	
CloudCover	Double	Cloud coverage percentage over the whole acquisition area	$0.00 \leq CC < 100.00$	X
MeteoFlag	Enum	Whether or not the imagery presents a meteorological issue	See <i>MeteoFlag</i> table	
Filename	String	Name of the file inside the .zip archive	Name of one of the files in the uploaded .zip archive	X
Elevation	Double	Elevation angle of the single strip	$50.00 \leq \text{elevation angle} \leq 90.00$	X

Table 4 - Possible values for the sensor tag, their allowed abbreviations and their combination with profiles

VALUE	ABBREVIATION	POSSIBLE PROFILES
UK-DMC2	DMC2	F0, G
GEOEYE-1	GE01	A1, A2, A3, A4, A5, A6, A7, A71, B, C, E
WORLDVIEW-1	WV01	A3, B, C, E
WORLDVIEW-2	WV02	A1, A11, A2, A3, A4, A5, A51, A6, A61, A7, A71, B, C, E
WORLDVIEW-3	WV03	A1, A11, A12, A2, A3, A4, A5, A51, A52, A6, A61, A62, A7, A71, A8, A81, B, C, E
WORLDVIEW-4	WV04	A1, A2, A3, A4, A5, A6, A7, A71, A8, A81, B, C, E
KOMPSAT-3	K03	A1, A2, B, C, E
KOMPSAT-3A	K03A	A1, A2, B, C, E
SPOT6	S6	F0, F1, F2, G
SPOT7	S7	F0, F1, F2, G
PLEIADES-1A	PL1A	Broker
PLEIADES-1B	PL1B	Broker
DEIMOS-1	D1	F0, G
DEIMOS-2	D2	F1, F2, G
SENTINEL-2A	S2A	n/a

Table 5 - Possible values for MeteoFlag and their description

VALUE	DESCRIPTION
Haze	Haze in the imagery
Snow	Presence of snow in the imagery
Flood	Presence of floods in the imagery
Mixed	Presence of different issues in the imagery, or the issue cannot be determined

Table 6 - Possible values for ImageMode node and their description

VALUE	DESCRIPTION
PAN	Panchromatic
MSP	Multispectral
PSH	Pansharpened
BUN	Bundle

19.2. General recommendations for a buffer creation around CwRS zones

Minimum elevation angle 50° Relevant profiles: A1, A11, A12, A3, A6, A61, A62	
Max. height difference [m]	Recommended buffer [m]
100	84
200	168
300	252
400	336
500	420
600	503
700	587
800	671
900	755
1000	839
1500	1259
2000	1678

Minimum elevation angle 56° Relevant profiles: A2	
Max. height difference [m]	Recommended buffer [m]
100	67
200	135
300	202
400	270
500	337
600	405
700	472
800	540
900	607
1000	675
1500	1012
2000	1349

Minimum elevation angle 67° Relevant profiles: A5, A51, A52	
Max. height difference [m]	Recommended buffer [m]
100	42
200	85
300	127
400	170
500	212
600	255
700	297
800	340
900	382
1000	424
1500	637
2000	849

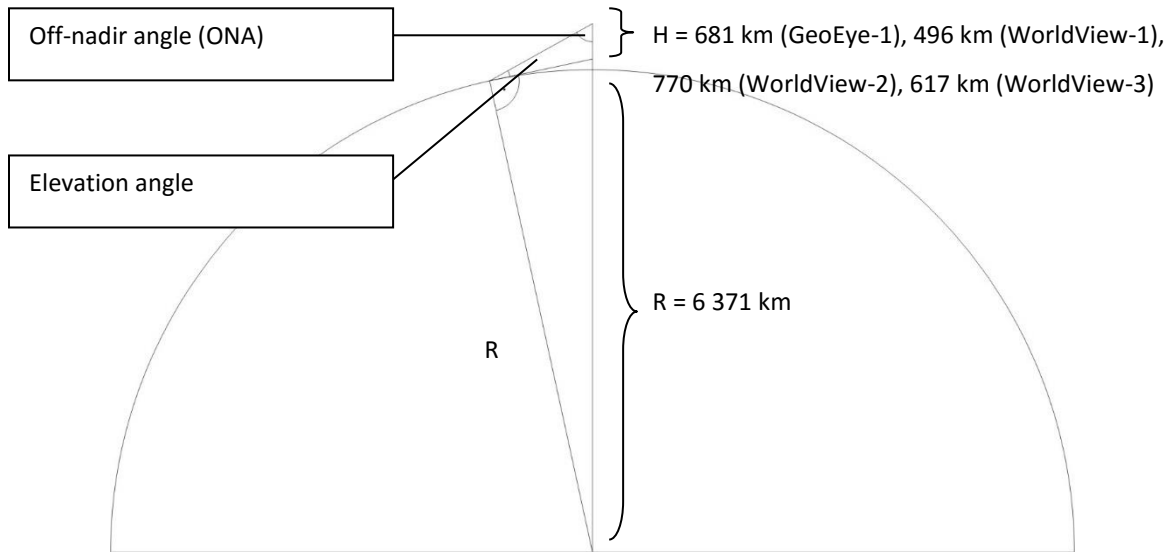
Minimum elevation angle 73°	
Max. height difference [m]	Recommended buffer [m]
100	31
200	61
300	92
400	122
500	153
600	183
700	214
800	245
900	275
1000	306
1500	459
2000	611

Minimum elevation angle 80°	
Max. height difference [m]	Recommended buffer [m]
100	18
200	35
300	53
400	71
500	88
600	106
700	123
800	141
900	159
1000	176
1500	264
2000	353

Maximal height difference = Maximal height of the AOI - Average base height of the AOI

Figure 3 - General recommendations for a buffer creation around CwRS zones

19.3. Relation elevation angle versus off-nadir angle and some satellite angles of importance



$$\frac{R}{R+H} = \frac{\sin(ONA)}{\sin(90^\circ+ELA)} = \frac{\sin(ONA)}{\cos(ELA)}$$

$$ELA = \arccos\left[\sin(ONA) * \frac{R+H}{R}\right]$$

$$ONA = \arcsin\left[\cos(ELA) * \frac{R}{R+H}\right]$$

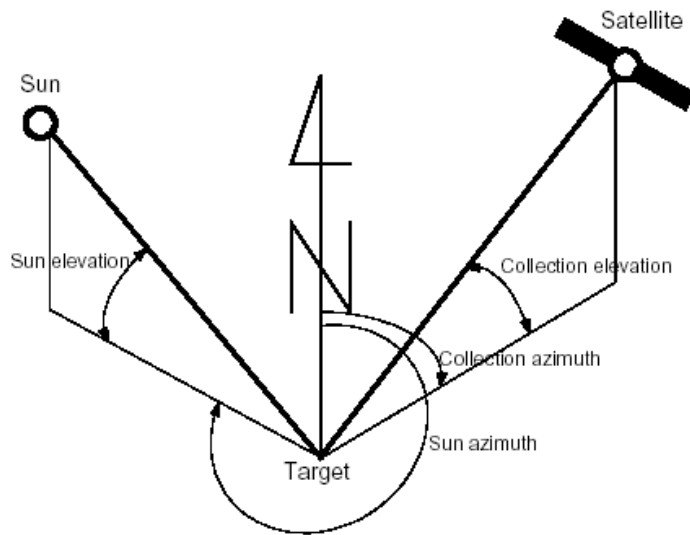


Figure 4 - Relation elevation angle versus off-nadir angle and some satellite angles of importance

19.4. VHR sensors

WorldView-2	
Satellite specification	
Launch information	Date: 8 October 2009 Launch Vehicle: Delta 7920 (9 strap-ons) Launch Site: Vandenberg Air Force Base, California
Orbit	Altitude: 770 km Type: Sun-synchronous, 10:30 a.m. descending node Period: 100 minutes
Sensor bands	PAN: 450–800 nm 8 MSP: Four standard colours: blue/green/red/NIR1 + 4 new colours: coastal/yellow/red edge/NIR2 coastal blue: 400–450 nm; blue: 450–510 nm yellow: 585–625 nm; green: 510–580 nm red: 630–690 nm, red edge: 705–745 nm NIR1: 760–900 nm, NIR2: 860–1040 nm
Sensor resolution GSD	PAN: 0.46 m at nadir MSP: 1.85 m at nadir
Dynamic range	11 bits per pixel
Swath width	16.4 km at nadir
Retargeting agility	Time to slew 200 km: 10 seconds
Maximum contiguous area collected in a single pass (at 30° ONA)	138 × 112 km mono (8 strips) 63 × 112 km stereo (4 pairs)
Revisit frequency	1.1 days at 1 m GSD or less 3.7 days at 20° off nadir or less (0.52 metre GSD)
Geolocation accuracy (CE 90)	Demonstrated < 3.5 m CE90 without ground control
Product specification	
Tasking level	Special Priority Tasking (Select Plus Level)
Product options	Ortho Ready Standard Bundle 4 bands (PAN plus 4 bands MSP (BGRNIR1)) Ortho Ready Standard PSH 4 bands (BGRNIR) Ortho Ready Standard PAN only Ortho Ready Standard Bundle 8 bands (PAN plus 4 bands MSP (BGRNIR1) plus 4 bands MSP2 (Coastal, Yellow, RedEdge, NIR2)) Ortho Ready Standard Stereo Bundle 4 bands (PAN plus 4 bands MSP (BGRNIR1)) Ortho Ready Standard Stereo PSH 4 bands (BGRNIR) Ortho Ready Standard Stereo PAN only Ortho Ready Standard Stereo Bundle 8 bands (PAN plus 4 bands MSP (BGRNIR1) plus 4 bands MSP2 (Coastal, Yellow, RedEdge, NIR2))
Resolution	PAN: 0.5 m for VHR+ profiles; 0.4 m for A5, A51, A52, A8, A81 MSP: 2.0 m for VHR+ profile; 1.6 m for A5, A51, A52, A8, A81
CC	CC ‘validated’: 0 to ≤ 10%; ‘proposed’: 10% to ≤ 30%
Resampling kernel	Cubic convolution
Format	GeoTIFF
DRA	Off
Bit depth	16 bit
Projection/datum	UTM/WGS 84
Tiling	4 band bundle (32 k × 32 k tiling): MUL files have a maximum of 537 MB/tile, PAN files have a maximum of 2 140 GB/tile 8 band bundle (32 k × 32 k tiling): MUL files have a maximum of 1 073 GB/tile, PAN files have a maximum of 2 140 GB/tile 4 bands PSH (22 k × 22 k tiling): files have a maximum of 3 872 GB/tile
Delivery medium	DVD or FTP

WorldView-3	
Satellite specification	
Launch information	Date: 13 August 2014 Launch Vehicle: Atlas V – 401 Launch Site: Vandenberg Air Force Base, California
Orbit	Altitude: 617 km Type: Sun-synchronous, 10:30 a.m. descending node Period: 97 minutes
Sensor bands	PAN: 450–800 nm 8 VNIR bands: 4 standard colours: blue/green/red/NIR1 (MSP) + 4 new colours: coastal/yellow/red edge/NIR2 coastal blue: 400–450 nm; blue: 450–510 nm yellow: 585–625 nm; green: 510–580 nm red: 630–690 nm, red edge: 705–745 nm NIR1: 770–895 nm, NIR2: 860–1 040 nm 8 SWIR bands: SWIR-1: 1 195–1 225 nm; SWIR-2: 1 550–1 590 nm (MSP) SWIR-3: 1 640–1 680 nm; SWIR-4: 1 710–1 750 nm SWIR-5: 2 145–2 185 nm; SWIR-6: 2 185–2 225 nm SWIR-7: 2 235–2 285 nm; SWIR-8: 2 295–2 365 nm 12 CAVIS bands: Desert Clouds: 405–420 nm; Aerosol-1; Aerosol-1: 459–509 nm; Green: 525–585 nm; Aerosol-2: 635–685 nm; Water-1: 845–885 nm; Water-2: 897–927 nm; Water-3: 930–965 nm; NDVI-SWIR: 1 220–1 252 nm; Cirrus: 1 365–1 405 nm; Snow: 1 620–1 680 nm; Aerosol-1: 2 105–2 245 nm; Aerosol-2: 2 105–2 245 nm
Sensor resolution GSD	PAN: 0.31 m at nadir VNIR: 1.24 m at nadir SWIR: 3.70 m at nadir CAVIS: 30 m at nadir
Dynamic range	11 bits per pixel (Pan, MSP), 14 bits per pixel (SWIR)
Swath width	13.1 km at nadir
Retargeting agility	Time to slew 200 km: 12 seconds
Maximum contiguous area collected in a single pass (at 30° ONA)	65.5 × 112 km mono (5 strips) 26.2 × 112 km stereo (2 pairs)
Revisit frequency	1.0 days at 1 metre GSD or less 4.5 days at 20° off nadir or less
Geolocation accuracy (CE 90)	Predicted < 3.5 m CE90 without ground control
Product specification	
Tasking level	Special Priority Tasking (Select Plus Level)
Product options	Ortho Ready Standard Bundle 4 bands (PAN plus 4 bands MSP (BGRNIR1)) Ortho Ready Standard PSH 4 bands (BGRNIR) Ortho Ready Standard PAN only Ortho Ready Standard Bundle 8 bands (PAN plus 4 bands MSP (BGRNIR1) plus 4 bands MSP2 (Coastal, Yellow, RedEdge, NIR2)) Ortho Ready Standard Stereo Bundle 4 bands (PAN plus 4 bands MSP (BGRNIR1)) Ortho Ready Standard Stereo PSH 4 bands (BGRNIR) Ortho Ready Standard Stereo PAN only Ortho Ready Standard Stereo Bundle 8 bands (PAN plus 4 bands MSP (BGRNIR1) plus 4 bands MSP2 (Coastal, Yellow, RedEdge, NIR2)) SWIR band Product 1
Resolution	PAN: 0.5 m for VHR+ profiles; 0.4 m for A5, A51, A52, A8, A81 MSP: 2.0 m for VHR+ profile; 1.6 m for A5, A51, A52, A8, A81 SWIR: 7.5 m
CC	CC 'validated': 0 to ≤ 10%; 'proposed': 10% to ≤ 30%
Resampling kernel	Cubic convolution
Format	GeoTIFF

DRA	Off
Bit depth	16 bit
Projection/datum	UTM/WGS 84
Tiling	4 band bundle (32 k × 32 k tiling): MUL files have a maximum of 537 MB/tile, PAN files have a maximum of 2 140 GB/tile 8 band bundle (32 k × 32 k tiling): MUL files have a maximum of 1 073 GB/tile, PAN files have a maximum of 2 140 GB/tile 4 bands PSH (22 k × 22 k tiling): files have a maximum of 3 872 GB/tile SWIR Product 1 default tiling
Delivery medium	DVD or FTP

GeoEye-1	
Satellite specification	
Launch information	Date: 6 September 2008 Launch Vehicle: Delta II Launch Site: Vandenberg Air Force Base, California
Orbit	Altitude: 681 km Type: Sun-synchronous, 10:30 a.m. descending node Period: 98 minutes
Sensor bands	PAN: 450–800 nm 4 MSP: Blue: 450–510 nm Green: 510–580 nm Red: 655–690 nm NIR: 780–920 nm
Sensor resolution GSD	PAN: 0.41 m at nadir MSP: 1.65 m at nadir
Dynamic range	11 bits per pixel
Swath width	15.3 km at nadir
Retargeting agility	Time to slew 200 km: 20 seconds
Maximum contiguous area collected in a single pass (at 30° ONA)	44 × 112 km mono (3 strips) 28 × 224 km stereo (2 pairs)
Revisit frequency	2.6 days at 30° off nadir
Geolocation accuracy (CE 90)	5 m CE90 without ground control
Product specification	
Tasking level	Special Priority Tasking (Select Plus Level)
Product options	Ortho Ready Standard Bundle 4 bands (PAN plus 4 bands MSP (BGRNIR1)) Ortho Ready Standard PSH 4 bands (BGRNIR) Ortho Ready Standard PAN only Ortho Ready Standard Stereo Bundle 4 bands (PAN plus 4 bands MSP (BGRNIR1)) Ortho Ready Standard Stereo PSH 4 bands (BGRNIR) Ortho Ready Standard Stereo PAN only
Resolution	PAN: 0.5 m for VHR+ profiles; 0.4 m for A5, A51, A52, A8, A81 MSP: 2.0 m for VHR+ profile; 1.6 m for A5, A51, A52, A8, A81
CC	CC 'validated': 0 to ≤ 10%; 'proposed': 10% to ≤ 30%
Resampling kernel	Cubic convolution
Format	GeoTIFF
DRA	Off
Bit depth	16 bit
Projection/datum	UTM/WGS 84
Tiling	4 band bundle (32 k × 32 k tiling): MUL files have a maximum of 537 MB/tile, PAN files have a maximum of 2 140 GB/tile 4 bands PSH (22 k × 22 k tiling): files have a maximum of 3 872 GB/tile
Delivery medium	DVD or FTP

WorldView-1	
Satellite specification	
Launch information	Date: 18 September 2007 Launch Vehicle: Delta 7920 (9 strap-ons) Launch Site: Vandenberg Air Force Base, California
Orbit	Altitude: 496 km Type: Sun-synchronous, 10:30 a.m. descending node Period: 95 minutes
Sensor bands	PAN: 400–900 nm
Sensor resolution GSD	PAN: 0.5 m at nadir
Dynamic range	11 bits per pixel
Swath width	17.7 km at nadir
Retargeting agility	Time to slew 200 km: 10 seconds
Maximum contiguous area collected in a single pass (at 30° ONA)	111 × 112 km mono (6 strips) 51 × 112 km stereo (3 pairs)
Revisit frequency	1.7 days at 1 metre GSD or less 5.4 days at 25° off nadir or less (0.55 metre GSD)
Geolocation accuracy (CE 90)	Demonstrated < 4.0 m CE90 without ground control
Product specification	
Tasking level	Special Priority Tasking (Select Plus Level)
Product options	Ortho Ready Standard PAN only Ortho Ready Standard Stereo PAN only
Resolution	PAN: 0.5 m
CC	CC 'validated': 0 to ≤ 10%; 'proposed': 10% to ≤ 30%
Resampling kernel	Cubic convolution
Format	GeoTIFF
DRA	Off
Bit depth	16 bit
Projection/datum	UTM/WGS 84
Tiling	32 k × 32 k, PAN files have a maximum of 2 140 GB/tile
Delivery medium	DVD or FTP

WorldView-4	
Satellite specification	
Launch information	Date: 11 November 2016 Launch Vehicle: Atlas V – 401 Launch Site: Vandenberg Air Force Base, California
Orbit	Altitude: 617 km Type: Sun-synchronous, 10:30 a.m. descending node Period: 97 minutes
Sensor bands	PAN: 450–800 nm 4 VNIR bands: 4 standard colours: blue/green/red/NIR1 (MSP)
Sensor resolution GSD	PAN: 0.31 m at nadir VNIR: 1.24 m at nadir
Dynamic range	11 bits per pixel
Swath width	13.1 km at nadir
Retargeting agility	Time to slew 200 km: 10.6 seconds
Maximum contiguous area collected in a single pass (at 30° ONA)	65.5 × 112 km mono (5 strips) 26.2 × 112 km stereo (2 pairs)
Revisit frequency	1.0 days at 1 metre GSD or less 4.5 days at 20° off nadir or less
Geolocation accuracy (CE 90)	Predicted < 4 m CE90 without ground control
Product specification	
Tasking level	Special Priority Tasking (Select Plus Level)
Product options	Ortho Ready Standard Bundle 4 bands (PAN plus 4 bands MSP (BGRNIR1)) Ortho Ready Standard PSH 4 bands (BGRNIR) Ortho Ready Standard PAN only Ortho Ready Standard Stereo Bundle 4 bands (PAN plus 4 bands MSP (BGRNIR1)) Ortho Ready Standard Stereo PSH 4 bands (BGRNIR) Ortho Ready Standard Stereo PAN only
Resolution	PAN: 0.5 m for VHR+ profiles; 0.4 m for A5, A51, A52, A8, A81 MSP: 2.0 m for VHR+ profile; 1.6 m for A5, A51, A52, A8, A81
CC	CC 'validated': 0 to ≤ 10%; 'proposed': 10% to ≤ 30%;
Resampling kernel	Cubic convolution
Format	GeoTIFF
DRA	Off
Bit depth	16 bit
Projection/datum	UTM/WGS 84
Tiling	4 band bundle (32 k × 32 k tiling): MUL files have a maximum of 537 MB/tile, PAN files have a maximum of 2 140 GB/tile 4 bands PSH (22 k × 22 k tiling): files have a maximum of 3 872 GB/tile
Delivery medium	DVD or FTP

Kompsat-3	
Satellite specification	
Launch information	Date: 18 May 2012 Launch Vehicle: H-IIA launch system Launch Site: Tanegashima Space Centre, Japan
Orbit	Altitude: 685 km Type: Sun-synchronous, 13:30 p.m. ascending node Period: 98 minutes
Sensor bands	PAN: 450–900 nm 4 MSP: Blue: 450–520 nm Green: 520–600 nm Red: 630–690 nm NIR: 760–900 nm
Sensor Resolution GSD	PAN: 0.7 m at nadir MSP: 2.8 m at nadir
Dynamic range	14 bits per pixel
Swath width	16 km at nadir
Retargeting agility	Time to slew 200 km: 10 seconds
Maximum contiguous area collected in a single pass (at 30° ONA)	48 × 110 km mono (3 strips) 16 × 200 km stereo (2 pairs)
Revisit frequency	3.5 days at 30° off nadir
Geolocation accuracy (CE 90)	70 m (50 cm expectation) CE90 without ground control
Product specification	
Tasking level	Priority Plus Tasking
Product options	Level 1R Option Bundle 4 bands (PAN plus 4 bands MSP (BGRNIR1)) Level 1R Option PSH 4 bands (BGRNIR)
Resolution	PAN: 0.7 m MSP: 2.8 m
CC	CC 'validated': 0 to ≤ 10%; 'proposed': 10% to ≤ 30%
Resampling kernel	Cubic convolution
Format	GeoTIFF
DRA	Off
Bit depth	14 bit
Projection/datum	UTM/WGS 84
Tiling	Default
Delivery medium	DVD or FTP

Komsat-3A (available after benchmarking)	
Satellite specification	
Launch information	Date: 26 March 2015 Launch Vehicle: RS20 rocket (Dnepr Launch Vehicle) Launch Site: Yasny Launch Base, Orenburg region, Russia
Orbit	Altitude: 528 km Type: Sun-synchronous, 13:30 p.m. ascending node Period: 98.5 minutes
Sensor bands	PAN: 450–900 nm 4 MSP: Blue: 450–520 nm Green: 520–600 nm Red: 630–690 nm NIR: 760–900 nm
Sensor resolution GSD	PAN: 0.55 m at nadir MSP: 2.2 m at nadir Infrared: 5.5 m at nadir
Dynamic range	14 bits per pixel
Swath width	> 12 km at nadir
Retargeting agility	Time to slew 200 km: 10 seconds
Maximum contiguous area collected in a single pass (at 30° ONA)	48 × 110 km mono (3 strips) 16 × 200 km stereo (2 pairs)
Revisit frequency	3.5 days at 30° off nadir
Geolocation accuracy (CE 90)	70 m (50 cm expectation) CE90 without ground control
Product specification	
Tasking level	Priority Plus Tasking
Product options	Level 1R Option Bundle 4 bands (PAN plus 4 bands MSP (BGRNIR1)) Level 1R Option PSH 4 bands (BGRNIR)
Resolution	PAN: 0.55 m MSP: 2.2 m Infrared: 5.5 m
CC	CC 'validated': 0 to ≤ 10%; 'proposed': 10% to ≤ 30%
Resampling kernel	Cubic convolution
Format	GeoTIFF
DRA	Off
Bit depth	14 bit
Projection/datum	UTM/WGS 84
Tiling	Default
Delivery medium	DVD or FTP

(end document)

Europe Direct is a service to help you find answers to your questions about the European Union
Free phone number (*): 00 800 6 7 8 9 10 11
(*) Certain mobile telephone operators do not allow access to 00 800 numbers or these calls may be billed.

A great deal of additional information on the European Union is available on the Internet.
It can be accessed through the Europa server <http://europa.eu>

How to obtain EU publications

Our publications are available from EU Bookshop (<http://bookshop.europa.eu>),
where you can place an order with the sales agent of your choice.

The Publications Office has a worldwide network of sales agents.
You can obtain their contact details by sending a fax to (352) 29 29-42758.

JRC Mission

As the science and knowledge service of the European Commission, the Joint Research Centre's mission is to support EU policies with independent evidence throughout the whole policy cycle.



EU Science Hub

ec.europa.eu/jrc



@EU_ScienceHub



EU Science Hub - Joint Research Centre



Joint Research Centre



EU Science Hub