Ionosphere Prediction Service

Progress Report

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Deliverable description

This document provides the description of the project status until the AR milestone

Authoring & Approval

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1. INTRODUCTION

This document provides the project status till the PRR milestone.

1.1 Applicable Documents

Id.	Title	Reference	Ver.	Date
[AD-1]	European Commission Invitation To Tender:	Brussels, GROW/L2/DT/vw/Ares(2015)1990179		
[AD-2]	Tender Specification	434/PP/GRO/RCH/15/8381		

1.2 Acronyms

Acronym	Explanation
CDD	Concept Definition Document
CRR	Core Research areas Report
CCP	Coordination and Communication Plan
DDD	Design Definition Document
DJF	Design Justification File
DVP	Development plan
EXS	Executive summary
PDR	Preliminary Design Review
PRR	Preliminary Requirement Review
RPF	Remote Processing Facility
SDR	System Requirement Document

2. PROJECT STATUS REPORT

The project Final Report provides the synthesis of all the different tasks carried out during the project execution.

The report includes the following information:

- list of all submitted deliverables
- list of all meeting attendance
- status of all accomplished work (for each task foreseen in the project)
- list of all problems, limitations or unexpected points
- assessment of the risk management
- list of all coordination issues.

2.1 List of all the submitted deliverables

Milestone	Task	File name
PRR		
Coordination and Communication Plan	Task	SSA-SN-IPS-CCP.00.10.docx
Progress Report	Task 1	SSA-SN-IPS-REP-01.00.10.docx
Review of State of the Art	Task 2	SSA-SN-IPS-RSA.00.10.docx
Review of Institutional Landscape	Task 2	SSA-SN-IPS-RSI.00.10.docx
Research Plan	Task 3	SSA-SN-IPS-RSP.00.10.docx
Technology Gap Assessment	Task 3	SSA-SN-IPS-TGA-01.00.10.docx
Core Research areas Report	Task 3	SSA-SN-IPS-URD.00.10.docx

PRR second issue		
User Requirement Document	Task 2	SSA-SN--IPS-URD.00.11.docx
Progress Report		SSA-SN-IPS-REP-01.00.11.docx
Review of State of the Art	Task 2	SSA-SN-IPS-RSA.00.11.docx
Review of Institutional Landscape	Task 2	SSA-SN-IPS-RSI.00.11.docx
PDR		
Concept Definition Document	Task 4	SSA-SN-IPS-CDD-00.10.docx
Development Plan	Task 4	SSA-SN-IPS-DVP-00.10.docx
Progress Report		SSA-SN-IPS-REP-02.00.10.docx
CDR		
Appendix to the Design Definition Document	Task 5	Appendix_to_the_DDD_IPS Web_Portal_01.00.doc
Coordination and Communication Plan	Task 8	SSA-SN-IPS-CCP.01.00.docx
Core Research areas Report	Task 3	SSA-SN-IPS-CRR-01.00.docx
Design Definition Document	Task 5	SSA-SN-IPS-DDD-01.00.docx
Design Justification File	Task 5	SSA-SN-IPS-DJF-00.03.docx
Executive Summary	Task 8	SSA-SN-IPS-EXE-00.01.docx
Progress Report	Task 1	SSA-SN-IPS-REP-03.00.10.docx
System Requirement Document	Task 5	SSA-SN-IPS-SRD-01.00.docx

Delta CDR		
Coordination and Communication Plan	Task 8	SSA-SN-IPS-CCP.01.00.docx
Core Research areas Report	Task 3	SSA-SN-IPS-CRR-02.01_FINAL.docx
Design Justification File	Task 5	SSA-SN-IPS-DJF-01.20.docx
Progress report	Task 1	SSA-SN-IPS-REP-03.00.20_FR_revEG.docx
System Requirement Document	Task 5	SSA-SN-IPS-SRD-02.00_V1.4_FINAL.docx
Technical note	Task 5	SSA-SN-IPS-TEC-1-02.00.docx
QR		
Interface control document	Task 6	SSA-SN-IPS-ICD-00.09.00.docx
Prototype User Manual	Task 6	SSA-SN-IPS-PUM-00.00.10.docx
Qualification Procedure Map	Task 6	SSA-SN-IPS-QPM-00.06.00.docx
Progress report	Task 1	SSA-SN-IPS-REP-04.00.00_draft.docx
AR		
Leaflet	Task 8	Tes119_Leaflet IPS_240718.pdf
Core Research areas Report	Task 3	SSA-SN-IPS-CRR-03.10.docx
Second issue of the Interface Control Document	Task 6	SSA-SN-IPS-ICD-00.10.00.docx
Implementation Roadmap	Task 7	SSA-SN-IPS-IMP-00.01.00_v6.docx
Operational procedures and maintenance plan, V1	Task 6	SSA-SN-IPS-OPM-00.01.00_v4.docx
Prototype User Manual	Task 6	SSA-SN-IPS-PUM-

		00.20.docx
Qualification Procedure Map	Task 6	SSA-SN-IPS-QPM-00.06.docx
Progress Report	Task 1	SSA-SN-IPS-REP-04.01.00_revEG_mod.docx
Ionospheric prediction service prototype, V1	Task 6	Delivered source code
FR		
Ionospheric prediction service prototype, V2	Task 6	Delivered source code
Operational procedures and maintenance plan, V2	Task 6	SSA-SN-IPS-OPM-00.03.00
Observation and Anomalies Report	Task 9	SSA-SN-IPS-OAR-00.01.03
User Feedback Report	Task 9	SSA-SN-IPS-UFR-00.01.03
Executive Summary	Task 8	SSA-SN-IPS-EXE-01.00.00
Technology Gap Assessment	Task 3	SSA-SN-IPS-TGA-00.01.01
Final Progress Report	Task 1	This document

2.2 List of all meeting attendance

Date of the meeting	Subject of the meeting
February 2nd, 2016, EC, Avenue d'Auderghem, 45, Brussels, Belgium	Kick off Meeting
June 14th, 2016, Telespazio Roma DG	Preliminary Requirement Review
Informal meeting on September 2016	Preliminary Architecture overview
October 18th, 2016, Telespazio Roma DG	Preliminary Design Review
February 21st-22nd, 2017, INGV premises	Critical Design Review
February 27th-28th, 2018, TPZ RomeDG premises	Qualification Review
27 March 2018 – Videoconference	Videoconference with EC and GSA about Implementation plan
Brussels, June 6, 2018 Auditorium Breydel building (DG GROW), avenue d'Auderghem, 45	Workshop on Horizon 2020 EGNSS Mission And Services

June 11th-12th, 2018, TPZ RomeDG premises	Acceptance Review
29th and 30th November 2018 Telespazio Premises	A dedicated meeting was organized in Telespazio with EC and JRC with the objective to provide clarification for the installation of the IPS platform and details on the documentation.
January 29th 2019, JRC premises (Ispra)	IPS User Workshop
January 30th – 31th 2019, JRC premises (Ispra)	Training in JRC premises
January 31th 2019, JRC premises (Ispra)	Final Review

2.2.1 Task 2 status

Task 2 is completely accomplished. Review of the state of the Art and Review of the Institutional landscape were carried on by Telespazio with the contributions of the Research Centres.

For the definition of the contributions and the overall coordination, two internal meetings took place during the period, on 31 March 2016 and on 3 May 2016 in Telespazio premises.

User requirements collection was carried on by NSL with the support of Telespazio. In particular, NSL carried on the analysis concerning aviation and high precision communities and Telespazio carried on the analysis concerning the mass market and critical infrastructures domains.

The analysis was carried on sending a questionnaire and collecting interviews with the potential users. Few answers were have been received before PRR.

Telespazio and NSL were coordinating through frequent teleconferences and mail exchange.

2.2.2 Task 3 status

Task 3 started at PRR; the Research centres during this period, coordinated by Telespazio, provided input for the definition of the Architecture of IPS.

The task 3 main delivery for the CDR is the CRR with the preliminary validation of the algorithms. The CRR was reviewed and it was decided after the CDR meeting for a new issue of the document at the Delta CDR (see Task 5 status) in order to solve the remaining missing details. The new issue was delivered on 25 May 2017.

The second issue of the CRR was due at the AR that took place on June 11th-12th 2018. Details about the work done in the CRR are reported in the task 6 because strictly linked with the progress of the development of the platform and the related validation.

2.2.3 Task 4 status

Task 4 started on May 2016, and it was carried on essentially by Telespazio, trying to define in this early stage the first high level architecture of the system. The objective was to highlight problems or constraints that need to be shared with the other partners as soon as possible to avoid any problem in the development of the platform.

A first iteration was carried on with the partners on 3 May 2016 during the second internal meeting in Telespazio.

A second iteration informally was carried on with the European Commission (teleconference on 13th September 2016) to present the preliminary architecture of IPS and the service concept and collect suggestion for a better design of the prototype.

A further consultation with the partners took place on wed 14th September 2016 to consolidate the inputs for the CDD and DVP and coordinate the next contributions.

Two separate meetings took place with INGV and UNOTT on 27th September 2016 about RPF 2 and 3 and with UTOV on 28th September 2016 about RPF 1.

The interaction with the Research Centres allowed to better understand the conditions and any possible constraints in the use of the data sources that are the most important elements of the Sensors network of IPS prototype.

Finally another intermediate draft of the CDD was sent to EC on 30th September 2016 for further comments before the official delivery during the PDR that took place in Telespazio premises on 18th October 2016.

2.2.4 Task 5 status

Task 5 was fully accomplished. It started on October 2016, and it was carried on essentially by Telespazio with the inputs of the Research Centres.

Regarding the development of the IPS Web Portal, since it is a very specific sw development activity, Telespazio sub contracted this task to an external provider (Inter-Consulting). This

decision was taken in order to support Telespazio for the design and development of a full fledged portal, characterized with the newest technological solutions that, even if used for a prototype, can be still evolved to support the final service.

The main objectives are:

- The definition of the system requirements, including the traceability between the User requirements (as output of the task 2) and the IPS services and products.
- The definition of the detailed design of the IPS system, namely the SRD and DDD documents. Starting from the CDD document, each element is further analysed and decomposed in its main functions. A specific annex is dedicated to the design of the Web Portal; to carry out this activity Telespazio is supported by the above mentioned sub contractor that is carrying out the design of the web components under the coordination of Telespazio itself.

  The SRD and DDD activities required a strong interaction among the partners especially with the Research Centres in order to design the RPF to be able to run the algorithms and to exchange the products.
- The Justification file that includes the retrovalidation explanation for each RPF. The choice is to define specific functions in the IPS architecture devoted to the retrovalidation service of some products (only the products that will be provided directly to the user and that the user can analyse).

Two separate meetings/teleconference took place with INGV, UNOTT and UTOV on November and December 2016 about RPF 1, 2 and 3.

A specific analysis about SW and HW standards in the GSC is requested as part of the DDD. Since there isn't officially public GSC programme documentation, the SOW for the set up of the GSC and a recent paper published in the ION 2015 were used as main reference

The main output of the Task 5 was the SRD, the other outputs were the DJF, CCP, EXS and a technical note explaining the concept of the retro-validation of the forecasts.

After the CDR meeting held on 21 - 22 February 2017 at INGV premises, EC invited the consortium to complete and improve the SRD document since several functions were missing or not fully described, and to better specify in it the requirements in order to remove any possible ambiguities in their interpretation.

Therefore it was decided to introduce an intermediate milestone, the delta CDR. A number of interactions with EC and JRC took place in this delta phase to steer the delta CDR and lead it to

a successful completion, notably by collecting comments and suggestions and complete in the best way the documents.

The new SRD was delivered by the consortium on June 19th 2017. EC reviewed it, expressed its satisfaction over the improvements made, and approved the conclusion of task 5 and of the CDR milestone overall.

2.2.5 Task 6 status

The task 6 was fully accomplished at the AR.

The main task before QR was the development and functional tests of the IPS prototype platform.

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During the development phase several critical issues were solved in particular the integration between the RPF 2 and RPF 3, due to the difficulty to schedule and synchronize correctly the operations of the two processors.

The final solution was the tight integration of the two SW and the use of a single scheduler.

Therefore RPF 1, 2, 3, 4 together with Alert generator and statistics generator were working since early February.

RPF 4 development started with delay during November 2017 and the development of the algorithms finished before the QR. Initially the RPF 4 was not requested by the SOW nevertheless Telespazio proposal suggested the importance of such products to complete the IPS offer and better cover the aviation community requirements.

Finally the Web Portal requested very specific sw solutions to better the overall user experience and to implement all the features for the access to the IPS products.

The Qualification review (QR), nominally 6 months after the conclusion of the CDR, took place in Rome on 27 – 28 February 2018.

The project at the QR had 8 months of delay, 6 months before the beginning of the task 6.

The delay at the end of the development phase was a total of 8 months (i.e. 2 months accumulated during the development).

The development was concluded with minor bugs to be solved

The main task between the QR and the AR was concerning the validation of the end to end service.

The validation was carried out through two different strategies. The first provided a statistical characterization of the behaviour of the service using the “retro-validation” IPS products, measuring the discrepancy between the prediction and the actual value of the specific event.

A sufficient number of retro-validation realizations can be used to derive a statistic of the specific product. The historical data of IPS will be retained in order to enrich such statistics in benefit of the users.

The second method was based on the direct comparison of the IPS forecasting and nowcasting products against external ones (i.e. coming from other services). Typical external sources are IGS real time products, against which the IPS predictions are compared.

Since IPS development was carried out in a period of quiet solar activity, historical analysis is needed in order to provide evidence of the behaviour of the service in presence of events of different magnitude.

The activity was carried out following the recommendations of EC and JRC and the methodology agreed at the QR.

Each Research Centre provided within the weeks following the QR a preliminary report with the results of the activities. After few iterations the complete task was performed and the results were included into the CRR.

In general the results were satisfying and in line with the expectations and several details were provided to EC and the JRC during this phase.

At the same time the service was continuously running and EC and JRC were provided with full access to the features of the platform.

Comments and suggestions were provided and they were implemented bringing the IPS prototype to the sufficient maturity to be ready for operations.

The task 6 ended at the AR.

2.2.6 Task 7 status

The task 7 was fully accomplished at the AR. During the period between QR and AR a videoconference was organized with the GNSS Service Centre to present possible strategies for the deployment of IPS at the GSC and collect suggestions for the analysis.

The same suggestion were useful for the deployment of the IPS platform at JRC premises.

2.2.7 Task 8 status

The objectives of the task 8 were to coordinate with other initiatives and to disseminate as much as possible results and concepts behind IPS in order to collect feedbacks from final users and other parallel initiatives.

A first contact tool place in 2016 with another H2020 project (MISW) where a clearer view of the real outputs of MISW and its relation with the IPS framework were obtained. Contact was taken with prof. Biagio Forte who is the coordinator of MISW. The objectives of the respective programmes were shared.

In parallel, contacts with the Finnish Meteorological institute (FMI) were organized. Telespazio will exchange info about the research when it will be more mature. FMI forwarded to TPZ an alternative contact inside the National Land Survey (NLS) to exploit the possible use of an open national reference network (FINREF). This network is part of the EUREF network.

Regarding the networking activities with European actors and initiatives in the framework of IPS, it has to be highlighted that at URSI GASS 2017, G. De Franceschi has been appointed as the new URSI Commission G Vice –Chair (Chair: Pat Doherty) in the period 2017-2020 (see the link http://www.ursi.org/commission.php?id=G). Among the others, the involvement and role of G. De Franceschi in IPS has been considered of interest to serve within the URSI ionospheric forecasting community.

IPS was of great interest within the TREASURE project (Training Research and Applications network to Support the Ultimate Real Time High Accuracy EGNSS solution), 2017-2021, funded by EC - H2020 Marie Sklodowska Curie Actions. The project developed advanced models and algorithms to achieve real time high accuracy positioning, starting from the research carried out in IPS among the others, through research that will be conducted by 13 early career Fellows. Two of these Fellows (named ESR1 and ESR11) were involved in “TEC and scintillation forecasting models” and “ICT technical feasibility study”, respectively, under the supervision of INGV where they are hosted for 3 years (2017-2020).

Moreover Telespazio supported EC for the preparation of papers to be submitted to the ICAO NAV panel Navigation Systems Panel (NSP), informing the ICAO authorities about the development of a ionospheric prediction service that is of interest for the aviation community.

A first information paper has been submitted on ICAO NSP in October 2017 to present for the first time the initiative and its relevance for aviation users (refJWGs/2-WP/02,07/05/2017).

A second paper on April 2018 followed on that of 2017,and described the state of play of the prototype, compared its ergonomic with existing similar platform, discussed the validation approach and introduced the first results of the predictions generated. The paper has been very

well received and fits well within current discussions aiming at setting a similar service at international level.

The achievements of the task 8 related activities along the entire duration of the project is summarized by the following table. In the Note Column there are some comments about the results of the specific dissemination event.

All the publications are also downloadable from the IPS web portal.

Id	Conference	Title	Type	Notes
1	Participation to the NAVITEC 2016 conference in ESA ESTEC on 14-16 December 2016.	Ionosphere Prediction Service	Paper and Poster	
2	Participation to the International School of Space Science (ISSS) - L'Aquila 2016 – Director Prof. U. Villante (http://www.cifs-isss.org/) and "Ground based and space instruments for researches in Solar-Terrestrial physics" Directors: F. Berrilli (UNITOV), S. Jefferies (GSU), C. Scotto (INGV)	Telespazio held a presentation with the title "A Ionospheric Prediction service" on Friday, 10th (Chairs: F. Berrilli, S. Jefferies, C. Scotto)	Oral presentation	Location: Gran Sasso Space Institute – GSSI (http://www.gssi.infn.it/) The School is organized by the Consorzio Interuniversitario per la Fisica Spaziale (C.I.F.S.) which joins several Italian Universities active in the field of Space Science (Catania, Firenze, L'Aquila, Milano, Roma "La Sapienza", Roma "Tor Vergata", Torino, Trieste) and Istituto Nazionale di Astrofisica (INAF). Since foundation ISSS is directed by prof. U. Villante.
3	IAU Symposium 335 EXETER	Ronchini et al., 2017, IPS	poster	
4	NAVIGATION SYSTEMS PANEL (NSP) JOINT WORKING GROUPS MEETING Montréal, 13 June – 23 June 2016 Agenda Item 2 f) Other Issues	"Ionospheric Prediction Service for GNSS users" (Presented by Eric Châtre) (Prepared by Eric Guyader, Filippo Rodriguez, Roberto Ronchini, Stefano Di Rollo)	Paper and presentation	
5	(International Space Weather Initiative) ISWI Workshop in Boston, Boston College, August 2017	"Italian Contributions to SW studies: recent progress", by Y. Migoya-Orue, V. Romano et al. (including F. Rodriguez, C. Cesaroni, G. De Franceschi, L. Alfonsi)	Poster	
6	ISWI Workshop in Boston August 2017	"Ionospheric prediction tools in IPS EU-Project" by V.Romano, C. Cesaroni, L. Spogli, G. Defranceschi, I.Hunstad, F. Rodriguez	Presentation	ISWI (International Space Weather Initiative) is an international initiative supported by NASA and UN. Visit the link to consider the high-level audience and to download the pdf. http://www.unoosa.org/oosa/en/ourwork/psa/schedule/2017/2017-un-usa-workshop-on-international-space-weather-initiative-presentations.html

7	URSI GASS Montreal 2017 (http://www.ursi2017.org/)	Cesaroni et al., 2017 THE IONOSPHERE PREDICTION SERVICE PROJECT,	poster #2866	Two poster sessions have been organized from 16.00 to 19.00 without overlapping with oral sessions. This allowed successful discussions and interactions among scientists, more than during oral presentations. The poster on IPS has been discussed with about 20 colleagues, among them: P. Doherty (Boston College, USA), I. Galkin (Center for Atmospheric Research, UMass Lowell, USA), E. De Paula (INPE-EMBRACE, Br), N. Bergeot (GNSS at ROB, Be), F. De Gasperin (LOFAR, Univ Leiden, Nl), D. Bilitza (NASA/GSFC, Heliospheric Physics Lab, and Space Weather Lab., George Mason University, Fairfax, USA).
8	ESWW14 2017 Ostend, Belgium (http://www.stce.be/esww14/)	Cesaroni et al., 2017 The Ionosphere Prediction Service Project	e-poster	
9	IIN (Istituto Navigazione Italiano)	November 2017 Oral Presentation by Telespazio	Oral presentation	Rome Ministry of Transportation
10	J. Space Weather Space Clim. 2018, 8, A11 (	A probabilistic approach to the drag-based model by Napoletano, Forte, Del Moro, Pietropaolo, Giovannelli, Berrilli https://doi.org/10.1051/swsc/2018003)	Oral presentation	
11	IAGA Italy meeting, 22 February 2018, Italy, Rome	Oral presentation by University of Tor Vergata	Oral presentation	
12	Fourteenth European Space Weather Week, 27 November 2017, Belgium	Oral presentation by University of Tor Vergata	Oral presentation	
13	Journal of Space Weather and Space Climate 2018, 8, A11	A probabilistic approach to the drag-based model by Napoletano, Forte, Del Moro, Pietropaolo, Giovannelli, Berrilli	Peer Reviewed Paper	https://doi.org/10.1051/swsc/2018003 Download at: https://www.swsc-journal.org/articles/swsc/full_html/2018/01/swsc170019/swsc170019.html
14	IAGA Italy meeting, 22 February 2018, Italy, Rome	A probabilistic approach to the drag-based model by Napoletano et al.	Oral presentation	http://convegnoiaga.roma2.infn.it/?page_id=7

15	IAGA Italy meeting, 22 February 2018, Italy, Rome	P-DBM model for CME propagation by Del Moro et al.	Poster #P05	http://convegnoiaga.roma2.infn.it/?page_id=667
16	Fourteenth European Space Weather Week, 27 November 2017, Belgium	P-DBM: A probabilistic implementation for the Drag-Based Model by Del Moro et al.	Oral presentation #S2-O2-03	http://www.stce.be/esww14/contributions/public/S2-O2/S2-O2-03-DelMoroDario/delmoro.pdf
17	ENC 2018	May 2018	Oral Presentation	
18	TREASURE Training Research and Applications network to Support the Ultimate Real Time High Accuracy EGNSS solution	April 2018	Oral presentations (Telespazio and INGV)	
19	2nd URSI AT-RASC,	Gran Canaria, 28 May – 1 June 2018	Paper + oral presentation (INGV)	
20	European Geosciences Union General Assembly	Vienna, Austria on 8–13 April 2018	3 Posters (Telespazio, INGV and UoN)	
21	42° Assembly COSPAR,	15-22 July 2018	Pasadena (USA)	Presentation (INGV)
22	ION GNSS+		Miami	Paper (accepted) and presentation (UNOTT)
23	ITSNT	November 13-16	Toulouse	Oral presentation
24	European Space Weather Week ESWW15	2018		Presentation accepted Abstract submitted by TPZ as session 10. The presentation was carrier out by EC instead of TPZ due to a parallel event (Innovation award ceremony) Abstract submitted by Tor Vergata (other session)
25	Navitec	December 5-7	ESA ESTEC	Oral presentation and poster
26	SoHe3 meeting	October 2018	Italy	Participation (Tor Vergata)

Table 2-1 : presentations, papers and posters

2.2.7.1 Telespazio Innovation Award and Leonardo Innovation Award

During the project IPS was also proposed in the Telespazio contest for the Innovation Award.
The same was done for the parallel contest in the Leonardo Group.
IPS was awarded in both the contests as radical innovation and in the Leonardo contest was chosen among 750 other proposal coming from the entire Leonardo Group.

2.2.8 Task 9 status

The IPS platform has been published on internet on the 13th of July 2018, following green light by EC project officer. Regular teleconferences took place on a 3-weekly basis to follow-up the operation phase.
During this phase EC decided to start the deployment of the IPS platform in JRC premises.
Therefore several interactions took place among EC, JRC and Telespazio in order to organize the deployment activities.
During the operation phase about 60 users registered to the IPS portal, starting on September (due to the holiday period) and with tow peaks corresponding probably to the most important events/conferences where IPS attracted more interest.
A dedicated meeting was organized in Telespazio with EC and JRC on 29th and 30th November 2018 with the objective to provide clarification for the installation of the IPS platform and details on the documentation.
The source code of the RPF 1-4 and the backend-front end were delivered before Christmas holidays.
Telespazio continued to provide support to JRC for the technical activities concerting the building, installation and configuration of the service.

2.3 Problems, limitations or unexpected points

- The PRR milestone was delayed by 2 months to consolidate the user requirements through additional contacts of potential users.
- The accumulated delay at the Delta CDR, at the beginning of the development activities, was close to about 6 months. (Delta CDR is considered closed at mid-June), as 4

additional months were necessary to complete and improve the SRD document since several functions were missing or not fully described, and to better specify in it the requirements in order to remove any possible ambiguities in their interpretation.

- At the QR early 2018, 2 additional months of delay were added, due to the development delays in task 6.
- The planned duration of the AR tasks was originally 2 months but another shift of 2 months was necessary to finish the validation phase coupled with the difficulty to find a time window in the month of May where most of the partners were unable to participate to the AR meeting. The reason was mainly the large amount of conferences and teaching and exams commitments with exams that took place during the same month.
- The start of the task 9, so the beginning of the IPS operations, was on 13th July 2018. Therefore the end of the project was set on January 2019.

In the figure below a sketch of the new schedule is reported.

Year	2016											2017												2018												2019
Milestones					DELTA PRR				PDR				CDR	DELTA CDR											QR				AR								FR
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
	F	M	A	M	G	L	A	S	O	N	D	G	F	M	A	M	G	L	A	S	O	N	D	G	F	M	A	M	G	L	A	S	O	N	D	G
T2	1	2	3	4																																
T3								1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21								
T4							1	2																												
T5									1	2	3	4	5	6	7	8																				
T6																	1	2	3	4	5	6	7	8	9	10	11	12								
T7																										1	2									
T8	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
T9																														1	2	3	4	5	6	7

- In red: the tasks that were accomplished.
- In blue: the extension that was necessary to close the milestone (at PRR, at CDR and at QR). In particular the FR milestone was fixed at the end of January.

Analysis: Delay in the T3 activity had little incidence on the execution of the rest of the project (development phase, under tasks 6, 7 and 9), T3 activities being more of a continuous research nature.

Delays affecting T2 (2 months) and T5 (4 months) were deemed necessary to come to a more mature stage in the understanding of the user needs (T2) and in the specification of the system (T5).

Delays during task 6 (4 months) were due to the combination of some issue during the development (due to the web framework used for the front end, some unexpected inefficiency of

processors that required workarounds) and the time spent for the validation. At the end of the task 6 there were no pending problems and the platform was ready to be put in operations.

2.4 Risk management assessment

No major risks were foreseen during the project and no specific limitations or unexpected points (that could put in danger the success of the initiative) were encountered.

This risk has been mitigated through the interaction with EC before the official deliveries in order to collect by time any possible suggestion and indication to be included in the documentation.

Regarding the delay of 8 months as stated in the sec 2.3 delays affecting T2 (2 months) and T5 (4 months) were deemed necessary to come to a more mature stage in the understanding of the user needs (T2) and in the specification of the system (T5).

The remaining 2 months were necessary to solve some critical bug and to carry the IPS prototype platform to the right maturity.

Some refinement and tuning were still requested after the first delivery and during the 2 months of testing (between QR and AR). This process continued as debugging also in the next Task 9 (operation period) phase as foreseen by the SOW.

Another risk could be the delay in the activation of the demonstration phase, but also in this case there were no specific problems. Users started to register to the portal especially after the holiday period reaching 60 units. Positive feedbacks were collected and no major issues were communicated by users during operations.

Workshop, presentations and dissemination were important in the all duration of the project to mitigate the risk of a decrease of the interest in the IPS initiative due to the longer time then expected to publish the service and maintain the interest. In addition, recent developments at ICAO level on the rapid set up of a worldwide centre for space weather monitoring had suddenly attracted a renewed attention on ionospheric prediction services.

No major risks were foreseen during the operations phase.

Periodical teleconferences have been established on a 3-week basis to report EC and JRC about the operations and the status of the service. First teleconference was scheduled on 9th August 2018.

Some teleconferences and meetings/visits were organized involving EC/JRC and the consortium partners to discuss the deployment of the platform at the final location (JRC) to minimize unexpected problems and let the handover be ready for the FR. During this period

TPZ and the partners supported EC and JRC in order to let JRC be autonomous in operating the system after the FR.