RAPIDS II - version PASTEL, a web Propagation Tool for the calculation of tropospheric, ionospheric and environmental propagation effects and interferences effects

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The world-wide development of Telecommunication, Navigation and Earth Observation systems, with space segments operating in various frequency bands, increases the need for software able to simulate the impairments due to the troposphere, the ionosphere, the environment and interferences. The existing RAPIDS software [1] contains the ITU-R models, some classical cloud, gas and rain models. The software can handle geostationary as well as non-geostationary satellites but is limited to tropospheric effects. This new web tool is an extended and updated version of the previous RAPIDS software, available online via an ESA ESTEC server. The purpose of this new software is to update the ITU-R models, to add new models and to extend the effects to ionospheric effects, environment effects and interferences, for GEO satellites, LEO satellites and constellations, as well as other types of missions.

1. Objectives and structure of the software

The objective of the new RAPIDS II web based software is to generate statistics for selected satellites and ground stations, regions, as well as time series. Another novelty of this version is that it will be addressed to system engineers as well as propagation experts. An overview of the possibilities of the software was presented in [2] and the capabilities of the preliminary version will be described in this paper.

A user's friendly Web interface is based on the Spring Webflow framework. It orchestrates the sequence of steps to collect all information and generates input data, coming from stored databases, for the complex calculations the system needs to perform. As an alternative to the generated input data, the user will be able to upload a file with his experimental data. The wizards allow navigating forward/backward (or to specific pages) in a calculation job definition and change individual parameters in each screen. The workflow uses an icon header toolbar that helps the user to navigate through all steps of the workflow.

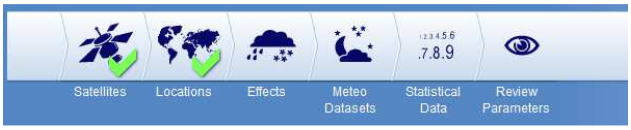

Figure 1: Header Toolbar used for the navigation between the successive screens

This software enables users to log-in, via the Internet, and perform propagation calculations following generic applications ("system user") or specific effects ("expert user"). Each application corresponds to a given workflow characterised by a succession of screens. The client will access the server through a public URL (public DNS name). RAPIDSII has been developed with the servlet specification 2.4 and deployed in a Java Web application server (Tomcat 6 compatible with this Java Servlet

specification). The database containing all the data used in the models and the datasets introduced by the user is a MySQL database. The Data layer uses the standard object-relation mapping (ORM) framework Hibernate to retrieve all entities from the database.

Once a job definition is complete, the job is submitted to a SunGrid job scheduler, which will asynchronously send the job to the MATLAB calculation engine and track its execution. Once the job is submitted the user can do other actions, including launching new jobs or logging out. He can be notified by e-mail of the conclusion of a job. The results of the calculation jobs are presented as tables and as graphs and sent to the user in HDF5 files.

2. Description of the proposed workflows

The development of satellite services is foreseen to increase during the next years. The satellites will increase in size and capacity, following a law comparable to the Moore's law in the computer industry. This capacity increase becomes possible with the use of higher frequencies, such as Ka-band.
The software developed is applicable to the following systems:

- fixed and mobile earth-space communications;
- GEO, non-GEO satellites and constellations;
- Frequencies extending from L-band to V-band.

The software is foreseen to be used by "system users" who are not specialists in the propagation effects. The first screen proposed is shown in Figure 2. Satellites and sites are proposed to the users but the user can enter his sites, regions and satellites and make them visible to the other users or not. The non-Geostationary satellites and constellations are defined by their orbit parameters provided by their YUMA, TLE or even own made CSV files. An orbit generator is included on the software and based on NORAD sgp4 algorithm [3].

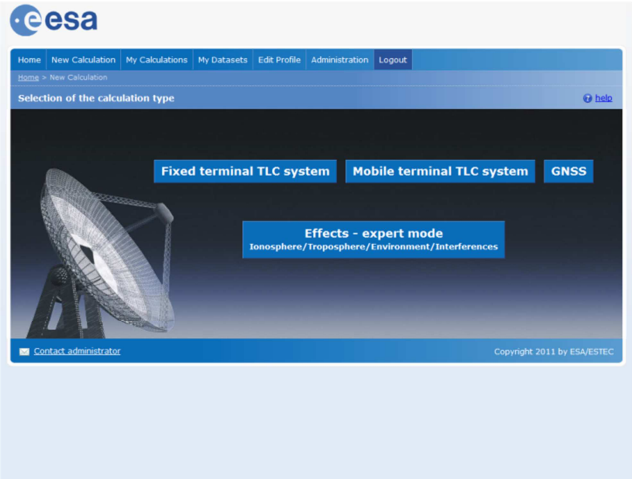

Figure 2: Screen proposing the three system workflows and the effects-expert mode workflow

The expert users can chose between the various propagation workflows (Fig. 3) calculating the different effects as well as time series and rain fields. For each workflow, various effects, models and datasets are proposed. For the three systems, a subset of possibilities is offered (one satellite, one site or one region) and a subset of models and datasets is chosen, including the ITU-R Recommendations. Figure 4 shows the screen proposed for Fixed Telecommunication Systems.

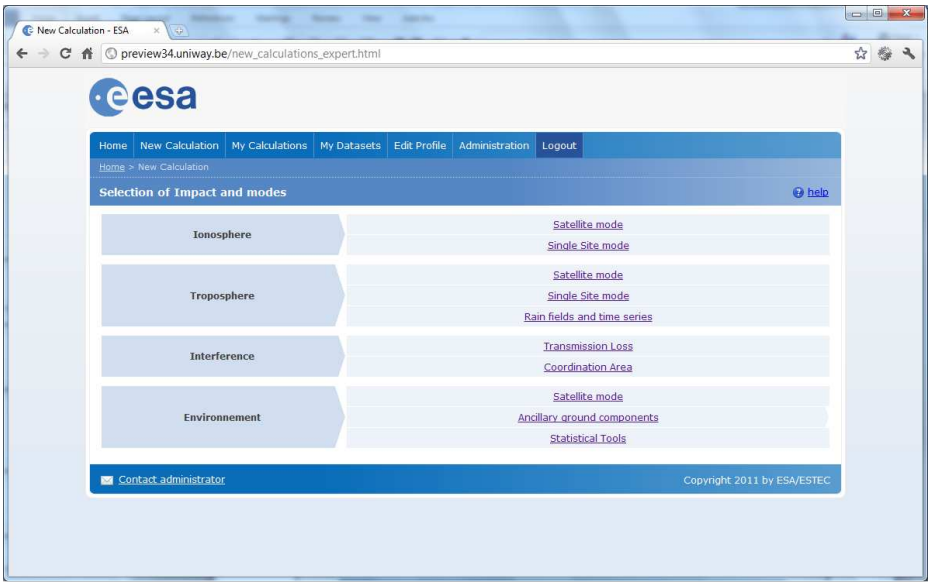

Figure 3: Ten Workflows proposed in the Expert mode

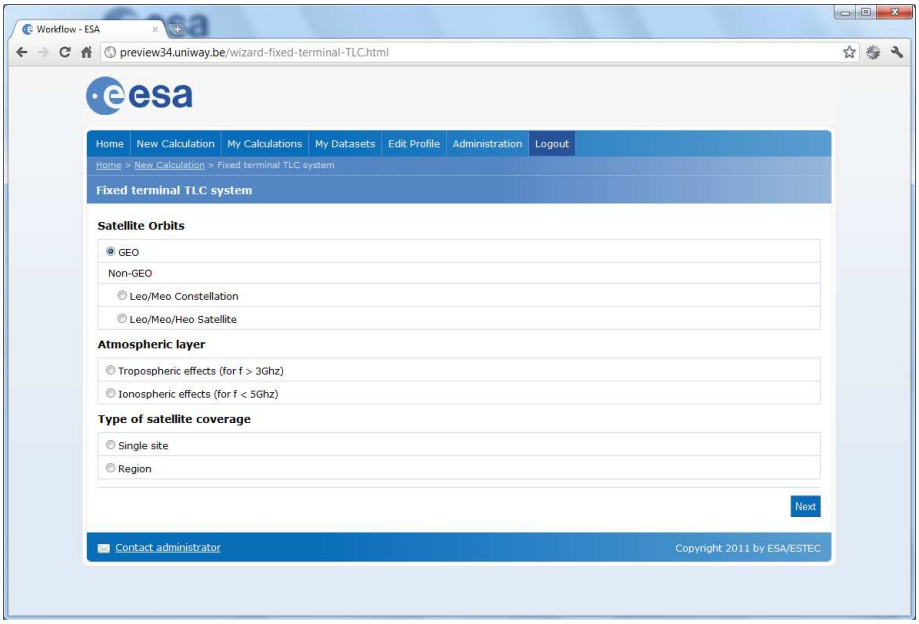

Figure 4: Workflow for Fixed Telecommunication Systems

3. Conclusion

New software will be presented for the calculation of the effect of the atmosphere and environment on the communication systems and GNSS. The results and the possibilities offered by RAPIDS II will be highlighted in the final paper.

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4. References

[1] Rogister A., Fisset R., Vanhoenacker-Janvier D., Vasseur H., Salonen E., Poiares-Baptista, “RAPIDS, an innovative database application for radio propagation prediction”, Proceedings of the 8th URSI Com. F. Triennal Symposium, Sept. 1998, Aveiro, pp. 20-23.

[2] Vanhoenacker-Janvier D., Pereira C., Segaert B. , Lechien L., Cheffena M. , Castanet L., Martellucci A., « RAPIDS II – Version PASTEL, A new Propagation Analysis Tool for Desin of Fixed and Mobile Systems », ESA Propagation Workshop, ESA/ESTEC, Noordwijk, The Netherlands, 30 november – 2 december 2011.
[3] Vallado D. A., Crawford P., Hujsak R., Kelso T. S., "Revisiting spacetrack report#3," in AIAA Astrodynamics Specialists Conference and Exhibit, August 2006.