

APIAN D9 – Summary Report

For the: Using Auctions for PI Activity Negotiations



This document was compiled by DigiUtopika Lda.. Areia Branca , 08/07/2009







Document Information

Project:	For the: Using Auctions for PI Activity Negotiations
Project Short Title:	APIAN
Work Package No.:	1000
Work Package Title:	1000
Document Title:	APIAN D9 – Summary Report
Document ID:	APIAN/080709/D9-SR/1.0
Version:	1.0
Date:	08/07/2009
Numbers of Pages:	22
File Name:	APIAN_D4-SR1-0.odt

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Document ID: APIAN/080709/D9-SR/1.0

Title:		APIAN	D9 – Summary Ro	eport	
Remark:					
1	1	08/07/2009	1	Pedro Branco	Pedro Branco
Edition	Revision	Date	- Change Note ID	Prepared by	Released by







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1. Scope

1.1. Identification

This document constitutes the "Summary Report" document for the Using Auctions for PI Activity Negotiations (APIAN) project developed by DigiUtopikA Lda. under an European Space Agency contract.

1.2. Document Overview

The purpose of this document is to present a global overview of the project activities itself and its conclusions.

Beside an introductory section the general architecture of the APIAN system is presented and the relevant project activities and events described.

1.3. Project Related Documents

1.3.1. Project-Internal Documents

1.3.1.1. Project-Internal Plans and Standards

Not applicable.

1.3.1.2. Other Project-Internal Documents

- [D1] APIAN Technical Note 1 -Survey of the Current Approaches on supporting Science Planning Process
- [D2] APIAN Technical Note 2 Survey of the State-of-the-art in Auction Theory
- [D3] APIAN Technical Note 3 Selection of the Case Studies
- [D4] APIAN Technical Note 4 Architectural Design Document
- [D6] APIAN Technical Note 6 Lessons learned and conclusions







1.3.2. Project-External Documents

- 1.3.2.1. Applicable Documents
- [SOW]Statement of Work "Design and Implementation",
Reference: DOPS-GEN-SOW-1002-OPS-HSC, Issue 1 Rev. 0, 10 February 2009[TP1.0]Using Auctions for PI Activity Negotiations Volume A Technical Proposal, Doc. Ref.:
UT/ESA-6011/TECH/APIAN/PB/1.0, DigiUtopikA Lda, March 19th, 2009

1.3.2.2. Reference Documents

Not applicable.







> Acronyms

ESA	European Space Agency
ESOC	European Space Operations Center
HQ	Headquarters
ISS	International Space Station
PI	Principal Investigator
SOW	Statement of Work
VA	Virtual Angle
WP	Work Package

Table 1: Acronyms Table







2. The APIAN Project

The initial goal of the developed study was to assess the feasibility of applying Auction Theory techniques to support, coordinate, and manage Principal Investigator requests but during the development of the project activities the scope of the project evolved to a more general concept of shared resource allocation/negotiation. A second objective was to implement a prototype for evaluating Auction-based approaches in support of science planning process (on two case studies selected) which during the development of the project activities also evolved to a more general framework focused in applying auction theory to shared resource allocation/negotiation. This goal required to identify feasible schemas and to perform a trade-off analysis with respect to agreed criteria. The third and last objective was to evaluate the performance of the system by using a simulation tool with a proper involvement of identified PI's, which, and in agreement with the two other objectives, was also extended to a broader and more general target audience involved in resource allocation/negotiation activities.

The activity took the following basic steps:

- The analyse of the difference resource allocation/negotiation processes and the role of the different agents (PI's, Science Operation Teams, Station Utilisation Scheduling, Corporate Resources Allocation etc.).
- Analyse of the Auction Theory State-of-the-art in order to design an Auction-based management approach.
- To select two Case Studies among current ESA missions, which represented both significant (and easy to generalize) cases and ideal candidates for applying Auction Theory techniques.
- To design and implement Auction-based schemas and to apply them to the selected cases in order to verify and validate the new approaches. The validation had to be done involving identified Principal Investigators.







• To identify the limitations of the current approaches for coordinating resource allocation/negotiation actors requests and to identify future work to be done in view of improving the current process to support the allocation of shared resources. [SoW]







3. Study Activities

This section describes the execution logic of the work that was performed by means of using graphical content.

The project had a duration of 10 months and it was mainly developed at the DigiUtopikA Lda. HQ in Portugal. During it's duration several meetings had ocurred including meetings at the ESA ESOC premises and teleconferences. Interaction with relevant user's was also established.



Figure 1: Project Technical Activities Flowchart







The work package 2000 was dedicated to the elicitation of the current approaches on supporting Science Planning Process. The tasks that were developed during this Work Package considered that each mission can have a different policy for coordinating the PIs requests. Also depending on the mission, PIs can specify observation requests with different levels of details and with different priorities [D1].

Menu Home Help Favorites Chat Administrator Login Welcome, Ricardo Logout				
	Title	Description	Auction	Auction Type
	PLA CEB	Satellite: PLA	5	English auction
	Specifications			
	Satellite	PLA		
	Station Site	CEB		
	Visibility Start	2010-07-3	31 18:58:44	
	Visibility End	2010-08-0	1 02:44:50	
	End Date			
	2010-07-31 18:58:44			
	Bid		You have 230 C	
	Actual Price: 0 C		Bid:	Bid
	Add to Favorites			
Upcoming The first APIAN case study u be the ESA Ground Stations utilisation scheduling.	Now available for Ea will Observation Auctions to access s resources for Earth	arth Now a Auctio satellite space Observation. experi Space	vailable for Space Science ns to access satellite and craft resources or ments in the International Station	Now available for Space Ground Segment Auctions to access facilities such as concurrent design facilities, labs, simulators
Copyright © 2009. DigiUtopikA Lda	a. All Rights reserved.			

Figure 2: APIAN Bidder's interface

The work package 3000 consisted of assessing the state of the art in the area of Auction Theory. After a general review from the standard auction types to the more recent techniques, particular emphasis was given to Auction frameworks which well suit to the characteristics of the problem of Principal Investigators coordination[D2].

The Work Package 4000 consisted of analysing and selecting two Case Studies among a list of possible







alternatives (see WP 2000) and to the definition of their requirements [D3]. The case study that was selected as preferred case is the Case Study 1 – Station Utilisation Scheduling which is focused in allowing ESA ground station managers to "sell" spare ground station communication capacity to third party entities. Interaction with relevant users was established and a real database, scenario rules and constrataints were analysed.

A second Case Study was also analysed and it was focused in the PV phase conflicts resolution of a scientific satellite which is a phase that is common to all the scientific satellites lifecycle. PIs may even have different requirements for the same targets and in consequence theo bservations must be therefore tailored and properly scheduled to try to meet all their requirements. Common sources of conflicts are among others the exposure time, the pointing direction and the pointing pattern. The possible application of APIAN in this are also ensures the results of the study may be used in the future too.

The reasons which justify this preference are mainly the availability of users for the requirements definition phase within the required timeline and availability of a scenario database within the required timeline.

During WP 5000 the implementation of the prototype for validating and evaluating the new concept was developed [D4].

In the January 2nd, 2010 the APIAN prototype was deployed in the US based DigiUtopikA Lda servers located. The DigiUtopikA Lda. Datacenter is a state of the art facility located in the United States in the state of Utah.

During the prototype development activities and also after the prototype development activities relevant interaction with the ESA users was established and allowed the fine tuning of the prototype.

During the work package 7000 of the APIAN project the tasks were dedicated to an "a posteriori" analysis of the work performed. In particular it will be identified the lessons learned during the proposed activity development and the limitations of the current approaches [D6]. The results of this WP were also used to develop this Final Report.







4. Project Data Dessimination



Figure 3: APIAN Website

A project website was develop to support the dissemination or project data and it was decided by the consortium to maintain and update it during the upcoming years with data related with the progress of the project and related activities.







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Figure 4: APIAN Project Brochures

APIAN technology promotional brochures were developed targeting the project itself and also it's application in some relevant ESA sectors including the Space Ground Segment, Earth Observation and Corporate Resources Management.



Figure 5: Promotional APIAN Technology brochures







5. Future Exploitation

During the APIAN project activities DigiUtopikA Lda also analysed and explored the possibilities of further commercial application of the APIAN results within ESA and outside ESA. A brief analysis of the findings is presented in the upcoming sub-chapters. It is relevant to say that this is considered to be an ongoing procedure at DigiUtopikA Lda since we intend to explore as much as possible the project results and conclusions and to exploit them at commercial leve.

5.1. Exploitation Within ESA

An obvious and natural channel for APIAN resutls exploitation is within the agency itself. ESA organisation includes several departments and activities where a framework like APIAN could be a valuable asset if well explored and used. In the following sub-chapters are presented guidelines about possible applications within some relevant ESA departmens, programs and activities.

5.1.1. Station Utilisation Scheduling applied to the Available Spare Capacity

APIAN first use case should be further simulated and assessed by ESA ground station managers to evaluate the potential benefit of using the APIAN approach to "sell" spare ground station communication capacity to third party entities. During the course of the project and in the final presentation itself it was clearly identified the potential of the APIAN framework when applied towards this type of applications.

In order to allow further promotion and potentiate this application DigiUtopikA Lda developed dedicated brochures and a promotional video and will ensure the maintenance of the project. website in the upcoming years. The APIAN prototype will also continue to be available and maintaned in the DigiUtopikA Lda servers and access credentials will be available at request.

5.1.2. Space Science

APIAN is based in a very simple, secure and flexible procedure: each user responsible for a payload will







have a budget that will allow him to purchase a time slot and the resources required. If there is another bid for the same resources at the same time, scientists will have to bid against each other, and the higher bidder will win the observation or experiment slot.

In this context, APIAN is a practical and cost-effective approach that applied to Space Science will facilitate scientists the access to satellite and spacecraft resources as well as experiments on ISS (International Space Station). APIAN will be an essential stepping stone for investigation, delivering scientists unprecedented opportunities to access multipurpose research facilities in orbit, with the possibility to choose how much they want to spend in each observation or experiment.

The APIAN Case Scenarios 1 and 2 that were analysed within the project are also relevant channels for further exploitation since the approach within the scope of the project was very brief due to the schedule and budget constraints of the acitivity itself neverthless the work developed pave the way towards a potential application of the project in a real environment related with the scenarios analysed.







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Home			Search			Create	Edit	Delete
Users Manage Users	Delete/Edit	id	Title	Description	End Date	Auction ID	Actual Price	Bids List
Auctions		1	HER CEB	Satellite: HER	2009-12-31 15:05:30	5	0	view
Manage Auctions Products Manage Auctions		2	PLA CEB	Satellite: PLA	2009-12-31 16:20:02	5	0	view
		3	ROS NNO	Satellite: ROS	2009-12-31 16:44:47	5	0	view
Statistics Statistics Engine		4	PhG CEB	Satellite: PhG	2009-12-31 17:21:31	5	0	view
News		5	MEX CEB	Satellite: MEX	2009-12-31 20:54:44	5	0	view
Manage News		6	VEX NNO	Satellite: VEX	2009-12-31 21:57:33	5	0	view
Configuration		7	ROS CEB	Satellite: ROS	2009-12-31 22:11:08	5	0	view
Website Configuration		8	XMM NNO	Satellite: XMM	2009-12-31 23:45:35	5	0	view
Back to site		9	VEX CEB	Satellite: VEX	2010-01-01 08:44:08	5	0	view
		10	HER NNO	Satellite: HER	2010-01-01 10:41:16	5	0	view
du.	1 Next Back to Home I	Page						
Copyright © 2009. DigiUtopikA	Lda. All Rights re	eserved.	_	_	_			

Figure 6: APIAN Administration Interface

5.1.3. Corporate Resources Allocation

Access specific facilities and resources for unique purposes of investigation is not always easy to get. Investigators loose time, money and possibly even the project they are working on. It is crucial to overcome these challenges so that investigators have the chance to achieve their scientific goals in an efficient, time-saving way.

Therefore, APIAN is a definitive solution that will allow investigators to access facilities, such as concurrent design facilities, laboratories or simulators, enabling the support, coordination and management of their schedules. Furthermore, APIAN will allow users to choose how much they want to spend for each facility resource, considering the relevance of each investigation purpose.







5.2. Exploitation Outside ESA by DigiUtopikA Lda

Currently DigiUtopikA Lda is developing a new line of services and products called "Virtual Angle". "Virtual Angle" (VA) will be a online enterprise platform to be released during this year which will allow users to have access to online applications in a common shared platform and environment. This platform will be based in the successful "Virtual Office" line of tools.

Virtual Office is an integrated Web-based application that provides users with the ability to access their applications and share information with the flexibility and accessibility of the Web. Using Web browsers, users can securely access applications from any location at any time.



Figure 7: The Virtual Office Environment







6. Major Project Results And Outlook For Future Activities

The APIAN project was a very successfull one in general terms.

The feedback from the audience was extremely positive and motivated the DigiUtopikA Lda to continue to invest in the improvement of the prototype and in the direction of commercial solutions based in the project outputs.

A quick assessment of the project activities is compiled below:

- Project Duration: 10 months;
- 1 Website Deployed;
- 6 Promotional Brochures Developed;
- I Online Prototype Deployed;
- 2 Case Studies were evaluated;
- 1 Case Study was implemented for demonstration purposes;
- More than 300 emails generated;
- Grounds for future project exploitation were launched.

The original planning was followed aside of the problems reference related with the distributed validation campaing. The efforts were then reallocated to the technological promotion and to gather means to promote the technology within the ESA community even after the project being concluded.

Fourteen deliverables were concluded with success including several technical notes, a website, 6 promotional brochures, software source code, UML diagrams and a online prototype available to the ESA community.

Technical conditions for a possible project expansion and exploitation were also planned and gathered.







DigiUtopikA Lda intends to exploit the auction technology in it's medium term business plans namely within the Virtual Angle platform.







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