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DELIVERABLE 1.1D1
THE INVENTORY ACTION (WP1.1-1) OF THE ANTENNA SOFTWARE INITIATIVE (ASI)

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KEYWORDS Antenna software tools, classification, data interfaces, file formats.

SUMMARY This report describes the activities performed and the results obtained within WP1.1-1, the Inventory Action, during the first year of the Antenna Software Initiative. In this first year, the first phase of the Inventory Action has been finished.

The result of this first phase is a detailed overview of the relevant software tools developed at the premises of the ASI partners.

A software template submission form was established, that was also implemented in the antenna Virtual Center of Excellence (VCE). The goal is to ease submissions from partners outside the ACE consortium in the future.

CONCLUSIONS The first phase of the Inventory Action, within the ACE consortium, was successfully completed. This action will continue to run for partners outside ACE, in order to obtain a complete overview.

Document Evolution		
Revision	Date	Reason of change
Rev. 1.0 draft	7/12/2004	Draft Edition
Rev. 1.0	15/12/04	Inclusion conformal antenna software

Document Change Record (Log)		
RNC	*Reference*	*Modification Description*

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1. Introduction

In many engineering fields there are well-established standard CAD tools that can be used with a high degree of reliability. Unfortunately, this is still not the case in antenna design. Although Europe has a strong background in fundamental modelling, most commercial antenna codes come from outside the EU and, compared to other engineering fields, these commercial antenna codes are premature and certainly do not give all the answers. As a consequence a lot of European universities, research institutes, and companies have developed and still are developing their own (in-house) antenna software.

However, this effort was very much a scattered effort. Nobody knew what exactly was available in Europe. In most cases only the people that had developed the software knew precisely what their software could do.

The goal of this WP1.1-1 is to solve this problem by establishing an inventory of the most important antenna software tools developed in Europe. This inventory is the basis for the other two WPs within the Antenna Software Initiative (ASI): WP1.1-2 (Benchmarking Structure Definition) and WP1.1-3 (Integrated Activity Selection). It is a mapping of existing knowledge and the foundation for a much more intense cooperation in Europe on the development and use of European antenna software tools.

2. The procedure followed

The procedure as it was followed is discussed below. It is also illustrated in Figure 1.

1.1. The inventory template

The kick-off meeting of ACE (30/1/2004) was also the start of the Inventory Action. The most important point discussed was the procedure towards a uniform description and the contents of this description of all the software tools of the ASI partners. The most important issues were already pointed out at this meeting, but in a 4-weeks brainstorming period afterwards (up to 30/2/2004), all items to be submitted to the inventory were defined. Based on this, a template document was finalized and distributed among the partners. It treats all important aspects:

- administrative aspects (ACE partner, names of developers)
- aspects important for users of the software (antenna topology treated, optimization capabilities, availability of a Graphical User Interface and User Manual)
- scientific aspects (architecture of the model used, validation used, extensions in the future))
- software aspects (hardware platforms, software platforms, software architecture, benchmarking, interfacing and formatting)
- commercial aspects (Intellectual Property Rights, availability to third parties)
- integrating aspects (related to WP1.1-3)
- educational aspects

This template was used by each partner to describe the software packages he judged relevant for this action. This was done in a 6 weeks period. The result was a detailed description of about 50 software tools. These descriptions were further processed by the WP leader.

The template is available on the VCE. It can be downloaded and consulted. The info submitted by the partners is available in full detail on the VCE in two forms: 1. a report file for each software of each partner in the file sharing section, 2. in a structured data base form, where for example a search can be performed based on keywords. ***The template, the reports by the partners, both as a file and on the VCE have to be considered part of this deliverable.***

1.2. The classification

Once all the information on all software tools had been gathered, a condensed info sheet was established by the WP leader, yielding a single page overview of the most important characteristics of the software tools. This info sheet is given in Table 1.

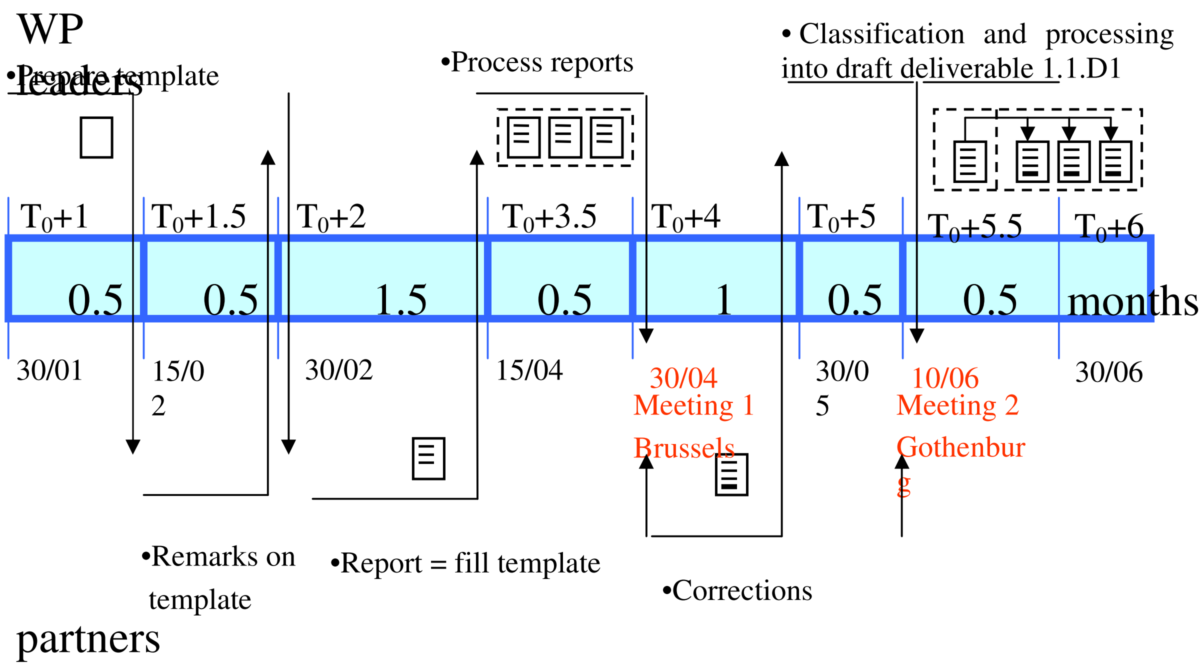

Figure 1. Procedure followed during the execution of WP1.1-1

WP1.1-1 Inventory action, overview status on 25/11/2004												
No.	Partner	pm	report	#	name	basic techniques	structures targeted	GUI	UM	Language	sugg. data format	suggestions for integration
1	IDS	1	:)	1	*ADF*	*framework*	*antennas in general*	*yes*	*yes*	*various*	*:), experienced !!!*	*integration of engines*
2	KUL	3	:))	1	MAGMAS	IE-MoM, EWC	planar and quasi-3D in multilayers	yes	yes	Fortran77,90	:)	GF, mesh, comp., M-level, asympt., opt.
4	TICRA	1	:))	>10	GRASP8	PO,PTD,GO,GTD	reflector antennas	yes	yes	Fortran90	:), specific, ascii	not suited for integration
8	FT R&D	0	:))	2	SRSRD	IE-MoM	symmetry of revolution	yes	yes	Fortran	:)	
					SR3D	IE-MoM, surface form.	3D	no	no	Fortran		
10	TAS	0	:)	1	*AD*	*IE-MoM, surface form.*	*3D*	*yes*	*yes*	*C, Fortran77,90*	*:), quantities !!!*	*done in ADF, MADS*
12	CNRS-LEAT	1	:))	1	FP&EMMA-TLM	FDTD-TLM	3D	no	no	Fortran90	:), 6 pm ?	spectral analysis, GA optimization
13	IETR	1	:))	4	ANTEF	FE	3D in free space	no	no	Fortran90	:), existing !!!	with opimization, periodicity
					IMELSI	FDTD	3D	yes	no	Fortran90		mesh, PML, hybrid., opt.
					SAPHIR	IE-MoM	2.5D in 2 layers	n/y	n/y	C, Fortran		GF, wavelets, opt.
					MR/FDTD	FDTD-Multiregion	3D	?	no	C		equiv. currents, TD-MoM, opt.
16	IMST	1	:)	1	*EMPIRE*	*FDTD*	*3D*	*yes*	*yes*	*C, C++, Python*	*:), E/H+J / ascii*	
18	ICCS/NTUA	1	:))	1	MMAS_CYL	MAS	cylindrically conformal	?	yes	Fortran90	pm	done in MADS
19	SAPIENZA	1	:))	3	Leaky_SDIA	IE-MoM	2D struct. of period. spaced strips	no	no	Fortran90	:)	
					Current Anal.	IE-MoM	2D struct. of period. spaced strips	no	no	Fortran90		with Ensemble
					Disp. diag._LW	IE-MoM	2D struct. of period. spaced strips	no	no	Fortran90		
20	POLITO	1	:)	4	*AntSim*	*IE-MoM*	*3D PEC in free space*	*yes*	*no*	*Fortran77, C*	*:), quant., ascii, 6 pm*	
					MR-MOM	*IE-MoM, multi-resolution*			*no*	*Matlab, Fortran*		*with MoM engines*
					SFX-MOM	*IE-MoM, Ent. Dom. BF*			*no*	*Fortran77,90*		*with MoM engines*
					TOPICA	*IE-MoM*	*plasma facing 3D antennas*	*yes*	*no*	*Fortran77*		
22	UNIFI	1	:))	2	BMIA/AIM	IE-MoM, weak interaction	3D PEC in free space	no	no	Fortran90		
					CPFEM3D	FEM-BE	axially periodic cylinder	no	no	Fortran90		
23	UNISI	1	:))	6	TFWMOM	IE-MoM, periodicity	large arrays open-ended wavegds	no	no	Fortran77	:), existing !!!, 1 pm	done in ADF
					TFWTaper	spectral calc. GF	array of elem. dip. in free space	no	no	Fortran77		
					TFW Irreg.	FW diffraction, UTD	array of elem. dip. in free space	no	no	Fortran90		using output of MoM inf. array
					Multilayer_GF	spectral calc. GF	arbit. oriented elem. dipole	no	yes	Fortran90		MoM code in MPIE formulation
					UTD_Wedge	GO, UTD	diffr. from wedge	no	no	Fortran90		in high-freq. codes
					ITD_Wedge	GO, ITD	diffr. from wedge	no	no	Fortran90		in high-freq. codes
26	UPC	1	:))	2	GRECO	high f - asymptotic	3D in free space	no	yes	C		not suited for integration
					FIESTA 3D	IE-MoM, matrix operat.	3D in free space, in layers ?	yes	no	Matlab, C		with EPFL
27	UPM	0	:))	1	SFELP	FEM, modes	3D, in dielectric sphere	?	no	Fortran77,90,95	existing !!!, quant. !!!	through modes in regions
28	UPV	1	:))	1	RLSA-CAD	IE-MoM	radial line slot arrays	no	no	Matlab	:), difficult, 9 pm	
29	CHALMERS	0.5	:))	3	G1DMULT	IE-MoM	circ.cyl. or spher., periodical	yes	yes	Fortran90		
					G2DMULT	IE-MoM	cyl. multiregion	no	yes	Fortran		
					HARD HORN	modes	horns	no	no	Fortran	specific !!!	with TICRA
31	FOI	0.5	:))	1	TFDTD	FDTD	3D	yes	no	C	for t and for freq.	input format
35	EPFL	0.5	:))	1	POLARIS	IE-MoM, Macro-BF	planar and cavities in layers	yes	yes	C++, Fortran77	E,H+S/ESTEC	with UPC
39	UOB	0	:))	1	FDTD	FDTD	3D	yes	yes	Pascal	:), E,H+S/Bristol	difficult
40	LIVUNI	0	:)	1	*ANTRAY*	*FDTD, GO, UTD*	*large 3D*	*no*	*no*	*Matlab*	*very difficult*	

Table 1. Single sheet overview with most important characteristics of the relevant software tools of the ASI partners. This sheet is continuously being updated.

The columns contain the following:
Column 1: number of the partner
Column 2: name of the partner
Column 3: person months invested in inventory action
Column 4: version of the description
Column 5: number of software tools reported
Column 6: name of the software
Column 7: basic numerical technique used
Column 8: basic antenna topology targeted
Column 9: is there a Graphical User Interface
Column 10: is there a User Manual
Column 11: which programming languages were used
Column 12: brief info about suggestions given for the data file format
Column 13: brief info about suggestions given for the Integrated Activity Selection (WP1.1-3)

The sheet was an essential tool in the classification process that followed. The goal of the classification procedure was to detect software tools, related to each other, based on the topology that they are solving, and the fundamental computational technique used in the tool. The classification process resulted in categories of software. The result of the classification process is given in Table 2 on the next page.

Classification of software tools								
	No.	Partner	name	basic techniques	structures targeted	Language	suggestions for integration	pm
frame	1	IDS	*ADF*	*framework*	*antennas in general*	*various*	*integration of engines*	5
IE-MoM	2	KUL	MAGMAS	IE-MoM, EWC	planar and quasi-3D in multilayers	Fortran77,90	GF, mesh, comp., M-level, asympt., opt.	12
layered	13	IETR	SAPHIR	IE-MoM	2.5D in 2 layers	C, Fortran	GF, wavelets, opt.	0-7
15-35.5 pm	19	SAPIENZA	Leaky_SDIA	IE-MoM	2D structure of period. spaced strips	Fortran90		0-4.5
			Current Anal.	IE-MoM	2D structure of period. spaced strips	Fortran90	with Ensemble	
			Disp. diag._LW	IE-MoM	2D structure of period. spaced strips	Fortran90		
	22	UNIFI	BMIA/AIM	IE-MoM, weak interaction	quasi-3D PEC in free space	Fortran90		0-3
	23	UNISI	TFWMOM	IE-MoM, periodicity	large arrays open-ended waveguides	Fortran77	done in ADF	0-4
			TFWTaper	spectral calc. GF	array of elem. dipoles in free space	Fortran77		
			Multilayer_GF	spectral calc. GF	arbit. oriented elem. dipole	Fortran90	MoM code in MPIE formulation	
	28	UPV	RLSA-CAD	IE-MoM	radial line slot arrays	Matlab		2
	29	CHALMERS	G1DMULT	IE-MoM	circ.cyl. or spher., periodical	Fortran90		0-2
	35	EPFL	POLARIS	IE-MoM, Macro-BF	planar and cavities in layers	C++, Fortran77	with UPC	1
IE-MoM	8	FT R&D	SR3D	IE-MoM, surface form.	3D	Fortran		0-1
3D	10	TAS	*AD*	*IE-MoM, surface form.*	*3D*	*C, Fortran77,90*	*done in ADF, MADS*	1
1-9 pm	20	POLITO	*AntSim*	*IE-MoM*	*3D PEC in free space*	*Fortran77, C*		0-5
	29	CHALMERS	G2DMULT	IE-MoM	cyl. multiregion	Fortran		0-2
IE-MoM	20	POLITO	*MR-MOM*	*IE-MoM, multi-resolution*		*Matlab, Fortran*	*with MoM engines*	0-5
fast			*SFX-MOM*	*IE-MoM, Ent. Dom. BF*		*Fortran77,90*	*with MoM engines*	
3-8 pm	26	UPC	FIESTA 3D	IE-MoM, matrix operat.	3D in free space, in layers ?	Matlab, C	with EPFL	3
?	8	FT R&D	SRSRD	IE-MoM	symmetry of revolution	Fortran		0-1
0-6 pm	18	ICCS/NTUA	MMAS_CYL	MAS	cylindrically conformal	Fortran90	done in MADS	0
	20	POLITO	*TOPICA*	*IE-MoM*	*plasma facing 3D antennas*	*Fortran77*		0-5
high f	4	TICRA	GRASP8	PO, PTD, GO, GTD	reflector antennas	Fortran90	not suited for integration	1
1-7 pm	26	UPC	GRECO	high f - asymptotic	3D in free space	C	not suited for integration	0
	23	UNISI	TFW Irreg.	Floq. W diffraction, UTD	array of elem. dipoles in free space	Fortran90	using output of MoM inf. array	0-4
			UTD_Wedge	GO, UTD	diffr. from wedge	Fortran90	in high-freq. codes	
			ITD_Wedge	GO, ITD	diffr. from wedge	Fortran90	in high-freq. codes	
	29	CHALMERS	HARD HORN	modes	horns	Fortran	with TICRA	0-2
FE	13	IETR	ANTEF	FE	3D in free space	Fortran90	with opimization, periodicity	0-7
1-11 pm	22	UNIFI	CPFEM3D	FEM-BE	axially periodic cylinder	Fortran90		0-3
	27	UPM	SFELP	FEM, modes	3D, in dielectric sphere	Fortran77,90,95	through modes in regions	1
FDTD	12	CNRS-LEAT	FP&EMMA-TLM	FDTD-TLM	3D	Fortran90	spectral analysis, GA optimization	1
4.5-12 pm	13	IETR	IMELSI	FDTD	3D	Fortran90	mesh, PML, hybrid., opt.	0-7
4 partners			MR/FDTD	FDTD-Multiregion	3D	C	equiv. currents, TD-MoM, opt.	
	16	IMST	*EMPIRE*	*FDTD*	*3D*	*C, C++, Python*		0.5
	31	FOI	TFDTD	FDTD	3D	C	input format	1
	39	UOB	FDTD	FDTD	3D	Pascal	difficult	1
	40	LIVUNI	*ANTRAY*	*FDTD, GO, UTD*	*large 3D*	*Matlab*		1

Table 2. Single sheet classification of the relevant software tools of the ASI partners. This sheet is continuously being updated.

Category 1: IEM-MoM, layered: This category concerns the set of software tools 1. that is coping with antenna structures in multilayered dielectrics, and 2. using the integral equation technique solved with the method of moments. This is clearly the most important category, both from the point of view of the number of partners involved as from the point of view of number of person months allocated.

Category 2: IEM-MoM, 3D: This category concerns the set of software tools 1. that is coping with arbitrary 3D antenna structures in homogeneous space, and 2. using the integral equation technique solved with the method of moments. These software packages are very general: they are able to cope with very general antenna geometries but for specific geometries, in many cases they are slower.

Category 3: IEM-MoM, fast. This category concerns the set of software tools 1. intended to be used in combination with one of the previous two categories, and 2. speeding up the solution process by using hierarchical techniques. This category is very promising in regard of WP1.1-3, the Integration Activity Selection. It has to be mentioned that some software tools in category 1 also have hierarchical techniques, already inherently implemented within the tool.

Category 4: This category concerns the set of software tools 1. that is coping with very specific geometries, and 2. using the integral equation technique solved with the method of moments. Due to the specificity of the geometry, and its implications in the modelling procedure, it is less obvious to integrate these software tools in more general frameworks.

Category 5: This category concerns the set of software tools using asymptotic high-frequency techniques. Since the number of person months allocated to this category is very low. This category will not be looked at for integration purposes.

Category 6: This category concerns the set of software tools using the Finite Elements (FE) technique. This technique discretises the space to be solved. Like the IEM-MoM techniques, it solves the structure frequency per frequency. The topology that can be solved is very general. The number of person months is reasonable. However, since 1. this technique is also in the frequency domain, 2. the number of partners involved is rather low, 3. all partners here are also involved in the IEM-MoM categories, it will merge with the IEM-MoM categories when considering general integration frameworks.

Category 7: This category concerns the set of software tools using the Finite Difference Time Domain (FDTD) technique. Not only space, but also time is discretised. The solution is thus found not frequency per frequency, but marching on in time. The topology that can be solved is very general.

Based on the classification of the software tools, the allocated effort to each category, the partners involved in the categories, the ASI group was split into two groups: one group involved in the ‘Frequency domain’, the other group involved in the ‘Time domain’. The first group covers the categories 1, 2, 3, and 6. The second group is smaller and covers the category 7. Categories 4 and 5 have a much less priority within the ASI.

3. The Electromagnetic Data Interface

1.3. Starting point

In the proposal it was said that 'antenna data file formats have to be agreed upon to allow easy exchange of information'. During the first discussions on the inventory and certainly from the results of the first phase of the inventory, it became very clear that this issue really is a key issue, and not an easy task. At this moment all the different software codes use their own data formats. This means that a necessary condition for cooperation between partners will always involve a phase where this difference in data formats is solved. The situation now is that for every cooperation, this is performed on an ad-hoc basis, which is, from a European investment point of view, very inefficient. Therefore, the ASI group decided to set up a Special Interest Group on Electromagnetic Data Interfaces (EDI). The partners involved are KUL, IETR, TICRA, IDS, TAS, CHALMERS, and FOI. Their task was to define the requirements of an EDI and to set out the procedure to be followed to establish this EDI.

1.4. Procedure targeted

At a first glance defining common file format may seam a simple task, but for many reasons the development of such formats leads to very complex problems when software tools for solving advanced problems in science and engineering are considered. The field covers a wide range of antenna types, which are modelled with a diversity of highly different software. The different software developers use proprietary formats specifically tailored for their own software and their view of the data will in most cases be influenced by the underlying method for solving a specific problem and often also by the software architecture. For the above reason, specifying a set of general requirements for one or several file formats that covers a majority of the data presently used in the field is deemed highly unrealistic. Rather, within the limits given by the available resources, important subsets of the overall general data domain must be considered and the work concentrated on data formats for the files with contents that are used by most if not all. The file formats should then be extended step-wise towards larger parts of the complete domain in sub-sequent projects.

From the IT point of view the development of a new format includes a number of specific steps. Initially, the file types to be covered by the format must be determined. The Special Interest Group has decided to prepare specifications for data files that is most frequently exchanged between antenna and electromagnetic software tools including files with near and far fields data, electrical currents data, S-matrices etc. The current list includes 7 file types. Recently, the group has also been asked to consider files containing Time Domain fields on rectangular surfaces.

Next, a data dictionary must be established to determine the exact contents of each file type. More precisely the data dictionary describes the physical entities to be stored in the file together with control data that explains how these physical data shall be interpreted. Near field data may e.g. be accompanied by specifications of a sampling grid and a coordinate system telling how the field sampling is positioned relative to some external coordinate system. Data about the underlying definition of the data is often required. As an example a field may be expressed in several forms depending on the application using discrete sampling in which case the file will contain a multidimensional array. The field may also be expressed as an expansion of basis functions in which case the file will contain expansion coefficients. The SIG is currently working on data dictionaries for the important files containing near fields, far fields and currents.

The organization of the data in the file is a key task i.e. what are the basic formats used and how and where do the different data blocks appear. It has been a specific requirement to base the new file format on the ASCII format such that files can be inspected with traditional editors. Further, a simple mark up language based on the eXtended Markup Language (XML, see e.g. E.Tittel, N.Pitts & F.Boumphrey, "XML for dummies", Hungry Minds, New York, 2002) is expected to be developed for the in file organization of data and a header with users information and metadata (i.e. data that describe the organization of other data) is also under consideration. Finally, it is expected that the software tools must be able to handle large data amounts in the future and in this case ASCII file will not be sufficient. Therefore the new file format must be prepared for extensions such that data can be stored using an advanced file format like the HDF5 (see e.g. http://hdf.ncsa.uiuc.edu/HDF5/).

When requirements covering the needs and questions have been specified, the application programmers could in principle start to modify their software to access the files in the traditional way using input and out statements. For several reasons, however, it is very important that the access to the files are made using a software library that stores and retrieves data in a controlled and uniform manner. The development of such library is as comprehensive as the specification of the format requirements themselves and includes the specification of the data model (i.e. how shall the data/data blocks be seen from the application programs point of view). The planned interface library, which has been denoted Electromagnetic Data Interface (EDI) must be specified in detail lying out the exact set of function, their interface and functionality. The library must be designed taking future extensions in account and then implemented and tested before it can be disseminated to the application programmers.

Present activities in the SIG covers the data dictionaries and the requirements for the EDI including data model and functions. In short, the requirements aim at a format that is simple to use, flexible, customizable and expandable. The data model will be based on named blocks denoted variables. Reserved names will be used for variables containing standard electromagnetic entities i.e. when such a name appears in a file, the form and meaning will be well defined. Members of ACE must administer the set of reserved names. A public page on the ACE VCE could contain information about decisions taken about the format.

4. The specific inventory action on software tools for conformal antennas (input from WP 2.4-3)

Conformal antennas are becoming more and more important. However, at the same time the number of dedicated software tools to model them is very low. Since it was judged that this type of antennas requires a special effort, a separatel section of this deliverable is devoted to them.

Conformal antennas can be analysed with general programs like FDTD or FEM. However, the antenna structures are usually large in terms of the wavelength, and consequently the needed computer time is very large. It is more convenient to use specialized programs for specific conformal geometries that are fast and in some cases more accurate, since they explicitly take into account the antenna geometry. Therefore, the usual procedure in designing conformal antennas is to use first a specialized program for a specific type of conformal antennas, and then some general program for designing fine details.

The basic objective of WP 2.4-3 is to structure better the ongoing research on conformal antennas, dispersed in several European universities or industrial Research centres. The description of several planned activities is:

- make an inventory of the ongoing research,

- contribute to activity 1.1 (modelling methods and software), for all aspects specific to conformal antennas: propose validation cases, launch benchmarking simulations, and compare results with measurements.

A summary of the developed programs for analysing conformal antennas is given in the table 3 below. All software packages are for a specific type of conformal antennas (mostly cylindrical structures) and for specific antenna elements (waveguide openings, patches or dipoles). All of the programs use the moment method as the numerical method for determining the unknown physical or equivalent currents (the exception is the CylFDTD program which is based on FDTD in cylindrical coordinate system). The main difference is in the type of structures they can analyse, and how the quantities needed for the moment method procedure are numerically calculated. The programs are sorted by the participant number. A detailed description of the developed software packages is given in deliverable 2.4-D6 and in a dedicated folder of the VCE.

Name of the program	*Developer*	*Type of structure*	*Type of radiating elements*
Cylindrical Magmas	K.U. Leuven	• Multilayer circular-cylindrical structures	• Patches
DMM	DLR	• Structures consisting of quasi-planar multilayer parts	• Patches
MCAT	DLR	• Multilayer circular-cylindrical structures	• Patches
G1DMULT	Chalmers	• Multilayer circular-cylindrical structures • Multilayer spherical structures	• Patches • Waveguide apertures
G2DMULT	Chalmers	• Multilayer cylindrical structures with arbitrary cross-section	• Patches • Dipoles • Waveguide apertures
CylFDTD	FOI	• Multilayer circular-cylindrical structures	• Waveguide apertures
Conformal Antenna Design	KTH	• Single-curved PEC surfaces • Doubly-curved PEC surfaces • Coated PEC circular-cylinders	• Waveguide apertures
MEN_MFSS	TNO	Multilayer circular-cylindrical structures including FSS	• Waveguide apertures

Table 3. Overview of existing conformal antenna software among the ACE partners.

Proposed actions for conformal antenna software within the second year of the project are:

- Propose validation cases suitable for most-interesting types of conformal antennas, launch benchmarking simulations, and compare results with measurements (in cooperation with WP 1.1-2).
- Join research activities of different groups: different software packages can be combined in order to take advantages of the different methods (in cooperation with WP 1.1-3).

5. Contribution from external partners

In this first phase of the inventory action, only partners within ACE have been considered. However, the procedure used to establish the inventory has been compiled in such a way that it is extremely easy to include additional info from external partners:

- A template is available and can be downloaded from the VCE. This template contains a detailed explanation on the different topics to be treated in the report.

- The info can be submitted directly to the VCE, even by external partners.

6. Comparison with commercial software

The question can be put why universities, research institutes, and even companies do even bother developing own software for antenna design. Why not just use available commercial software?

The answer is threefold.

1. Antenna modeling is a part of what we call “Computational Electromagnetics”, and this discipline is clearly a part of “engineering science”. In other words, the development of new theories, models, and their implementation into software codes is a scientific challenge. This issue is a driving force for all universities and research institutes.

2. Pure commercial codes are developed to serve a design community that is large enough to acquire a sufficient and sustainable income for the developing company. This means that new antenna developments in many cases are not covered by the codes available at that moment. In other words, the need for new antenna designs, tailored to new and emerging applications automatically creates a need for new modeling tools, not provided by the commercial vendors. This force is driving all players in the field.

3. The third driving force is efficiency and speed. The performance of commercial codes in most cases is much lower compared to many codes developed at universities, institutes, and companies, both concerning computer memory requirements and computation speed. A survey among the software codes reported in the inventory has made this very clear. Actually, the research work at these locations can be seen as the development phase for innovations in (new?) commercial software tools.

At this moment, most large commercial software companies in this field are non-European. One of the goals in the long run of the ASI is to short-circuit the existing gap between the excellent European antenna modeling capabilities and European industry, in order to make Europe "excellent" and more independent in this field.

In the second year of the project, this issue will be further taken up in WP1.1-2, the WP involving benchmarking.