Management Plan

ACA Correlator, ACA Correlator Software Subsystem, and ACA Backend Subsystem

ALMA-J-62.00.00.00-002-A-GEN

Version: A

Status: Draft A

2004-05-31

Prepared By:		
Name(s) and Signature(s)	**Organization**	**Date**
Satoru IGUCHI Sachiko K. OKUMURA	NAOJ NAOJ	2004-05-31
Approved By ALMA-J:		
Name and Signature	**Organization**	**Date**
Tetsuo HASEGAWA	NAOJ	yyyy-mm-dd
Released By NAOJ:		
Name and Signature	**Organization**	**Date**
Masato ISHIGURO	NAOJ	yyyy-mm-dd

Change Record

Version	Date	Affected Section(s)	Change Request #	Reason/Initiation/Remarks
A	2004-05-31	all	Draft A	First Draft

Table of Contents

1 Description

1.1 Purpose

The scientific requirement of ALMA Correlator Subsystem is high flexibility and high sensitivity. The ACA Correlator has an enhanced spectroscopic capability that enables a flexible allocation of frequency resolution and the widest bandwidth. The correlator supports both a simultaneous operation of the ACA interferometric observations (with twelve 7-m antennas) and single-dish observations (with four 12-m antennas), and a 16-element interferometric observations. One more important point is high sensitivity. The loss of sensitivity caused by quantization of the signal should be minimized. Thus the ACA Correlator supports more than 3-bit correlation, recovering 9 % in sensitivity relative to the Baseline Correlator (BLC), for which 2-bit correlation is standard. This is a great compensating advantage for the smaller collecting area of the ACA antennas to assure that the ACA system can provide the single-dish and short-baseline data for the ALMA science programs whenever necessary. The detailed specifications of the ACA Correlator and ACA Software Subsystem are summarized in RD 01 and RD 04, respectively.

The signal processing from the Intermediate Frequency (IF) outputs of the ACA Front End to the digital inputs of the ACA Correlator is proceeded in the ACA Backend (BE) Subsystem. The ACA BE Subsystem is exactly the same as ALMA-B BE Subsystem. The ACA BE Subsystem consists of the following four parts:

1. IF Downconverter
2. Digitizer and Sampler clock module
3. Data Transmission System (DTS)
4. Low frequency LO Reference System and Photonic LO Reference System

The detailed specifications of the ACA BE Subsystem are summarized in RD 02.

1.2 Scope

This management plan consists of the design, development, manufacturing and deliveries for ACA Correlator, ACA Correlator Software Subsystem, and ACA BE Subsystem (see Figure 1-1).

The ACA Correlator includes the DTS Receiver (DTS-R) part with FO receiver and DTS digital deformatter. This differs from those of ALMA-B, in which the design and development of FO receiver and DTS digital deformatter are included in ALMA Backend Subsystem. However, it will be expected that the man power is minimized by including them in the ACA Correlator (see RD 01).

The ACA Correlator Software Subsystem connects between the ACA Correlator and the ALMA Computing system (see RD 04).

The ACA BE Subsystem is the same as that of ALMA-B, excluding the FO receiver and DTS digital deformatter (see RD 02).

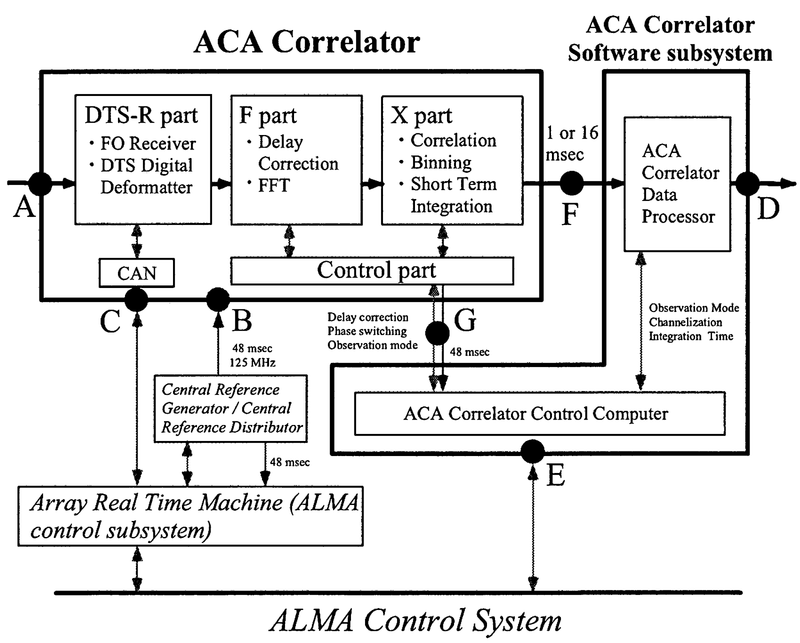

Figure 1-1. Relationship between the ACA Correlator, ACA Correlator Software Subsystem and ACA BE Subsystem.

2 Related Documents and Drawings

2.1 References

No	Document Title	Date	Reference
RD 01	ACA Correlator Technical Specifications and Requirements	2004-xx-xx	ALMA-J-62.00.00.00-001-A-SPE
RD 02	ACA Backend Subsystem Technical Specifications	2004-xx-xx	ALMA-J-59.00.00.00-001-A-SPE
RD 03	ACA Backend Subsystem Statement of Work	2004-xx-xx	ALMA-J-59.00.00.00-002-A-SOW
RD 04	ACA Correlator Software subsystem design documentations	2004-xx-xx	ALMA-J-75.00.00.00-001-A-SPE
RD 05	ACA Correlator Product Contract		ALMA-J-62.00.00.00-003-A-PLA
RD 06	ACA Correlator Product Assurance		ALMA-J-62.00.00.00-004-A-PLA
RD 07	ACA Correlator Manufacturing and verification Plan		CORL-62.00.00.00-005-A-PLA
RD 08	ACA Correlator Software Subsystem Manufacturing and verification Plan		COMP-75.00.00.00-002-A-PLA
RD 09	ACA Correlator Transportation Plan		CORL-62.00.00.00-006-A-PLA
RD 10	ACA Correlator (HW&SW) Acceptance Testing Plan		CORL-62.00.00.00-007-A-PLA
RD 11	ACA Correlator (HW&SW) Operational Education Plan and Procedures		CORL-62.00.00.00-008-A-PLA
RD 12	ALMA-J System Integration Plan		
RD 13	ACA Backend Subsystem Product Contract		ALMA-J-59.00.00.00-001-A-GEN
RD 14	ACA Backend Subsystem Product Assurance		ALMA-J-59.00.00.00-002-A-GEN

2.2 Abbreviations and Acronyms

RD	Reference Document
NAOJ	National Astronomical Observatory of Japan
ACA	Atacama Compact Array
ESO	European Southern Observatory
NRAO	National Radio Astronomy Observatory
JAO	Joint ALMA Office
ALMA	Atacama Large Millimeter Array
ALMA-B	ALMA Bilateral
ALMA-J	ALMA Japan
SE&I	System Engineering and Integration
IPT	Integration Product Team
BE	Back-End
DTS	Data Transmission System
DTS-R	DTS Receiver
FO	Fiber Optical
WDM	Wavelength Division Multiplexing

3 Organizational structure

The organizational structure of the ACA Correlator Hardware and Software, and ACA BE subsystem Group is presented in Figure 3-1. The Group is represented by NAOJ. The bulk of the group members working in NAOJ are employed by NAOJ. Prof. Tetsuo Hasegawa, the project manager of ALMA-J, is the principal point of contact for legal and administrative matters.

Dr. Sachiko K. Okumura, the project manager of the ACA Correlator Hardware and Software Team, has a management responsibility for the development and manufacturing of the ACA Correlator Hardware and Software.

Dr. Takeshi Kamazaki is the contact person for the ACA Correlator Software Subsystem with Computing IPT.

Dr. Satoru Iguchi, the project engineer of ALMA-J, is the point of contact for the ACA BE subsystem.

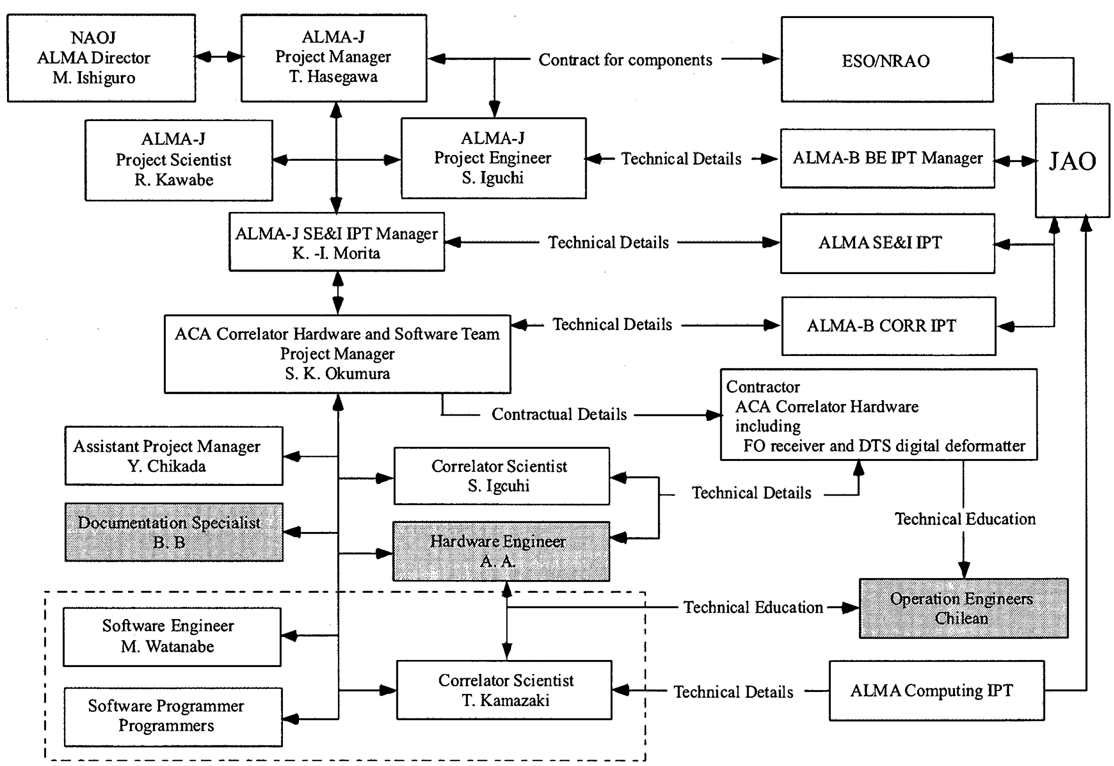

Figure 3-1. Organizational structure of the ACA Correlator Hardware and Software, and ACA BE subsystem Group

Principal contact

Tetsuo Hasegawa
National Astronomical Observatory
2-21-1 Osawa, Mitaka
Tokyo 181-8588, Japan
Phone: +81 (422) 34 3780
Fax: +81 (422) 34 3764
E-mail: tetsuo.hasegawa@nao.ac.jp

ACA Correlator Hardware contact person

Sachiko K. Okumura
National Astronomical Observatory
2-21-1 Osawa, Mitaka
Tokyo 181-8588, Japan
Phone: +81 (422) 34 3762
E-mail: sokumura@nro.nao.ac.jp

ACA Correlator Software contact person

Takeshi Kamazaki
University of Tokyo
2-21-1 Osawa, Mitaka
Tokyo 181-0015, Japan
Phone: +81 (422) 34 5094
E-mail: kamazaki@ioa.s.u-tokyo.ac.jp

ACA Backend Subsystem contact person

Satoru Iguchi
National Astronomical Observatory
2-21-1 Osawa, Mitaka
Tokyo 181-8588, Japan
Phone: +81 (422) 34 3762
E-mail: s.iguchi@nao.ac.jp

4 ACA Correlator Hardware and Software Team

ALMA-J has a responsibility to develop and deliver ACA Correlator and ACA Correlator Software Subsystem to ALMA. The ACA Correlator hardware and Software (NAOJ deliver items) Team is represented by ALMA-J. The contents of the team are summarized in follows:

- Management and manufacturing task descriptions;
- Group members and primary responsibilities;
- Level 2 and 3 milestones; and
- Schedule;

4.1 Management and Manufacturing task descriptions

Viewed functionally (as opposed to chronologically), the manufacturing tasks are allocated to three main summary tasks:

- project management;
- design, development and manufacturing; and
- deliveries;

The contents of these summary tasks are summarized in the following 3 sub-sub-sections, together with an identification of the individuals that are responsible for each task. Note that multiple individuals are identified in some cases. This is either because the tasks require input from several people, or because the time-critical nature of the schedule is expected to result in tasks overlapping, such that work may need to be reallocated within the team of ACA Correlator hardware and Software.

4.1.1 Project management

Project management task requires a significant allocation of resources. As seen in Figure 4-1, a number of tasks fall under the project management summary task, including:

- maintaining external contacts (including those with NAOJ and the ALMA-B project, and sub-contractors);
- general project management tasks (including tracking the schedule and budget, plus personnel-related issues);
- project-level system engineering (esp. issues related to the specifications and external ICDs);
- developing and maintaining a documentation system (including the Configured Items Data List: CIDL); and
- developing and maintaining a product assurance program.

This summary task falls under the overall responsibility of Sachiko K. Okumura, with significant inputs from Yoshihiro Chikada, B. B., Satoru Iguchi, and Takeshi Kamazaki.

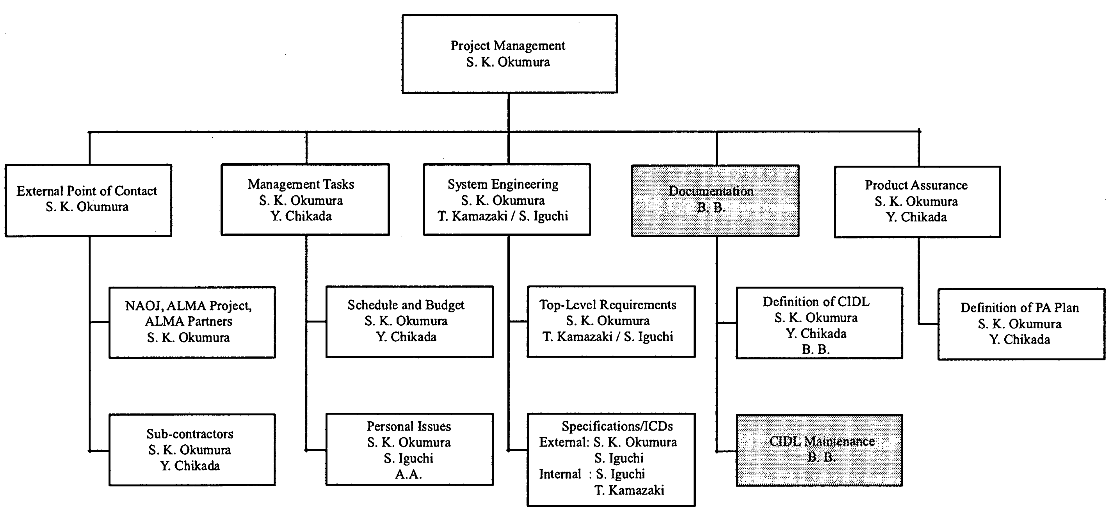

Figure 4-1. Project Management Tasks

4.1.2 Design, development and manufacturing

As seen in Figure 4-2, a number of tasks fall under the design, development and manufacturing summary task, including:

- correlatior design, development and manufacturing (including prototyping and testing; including the designs of interface protocol to FO receiver and DTS digital deformatter; defining the requirements to keep a compatibility with ALMA data transmission signal; and supporting detailed design work performed by a contractor, TBD);
- correlator software design, development and manufacturing [including developing ACA Correlator Control Computer (CCC) and ACA Correlator Data Processor (CDP); including keeping the compatibility with Array Real Time Machine (ARTM) for the monitor and control of FO receiver and DTS digital deformatter; developing the ACA Correlator software subsystem; and supporting detailed design work performed by programmers]; and
- education for Chilean engineers [educating the Chilean engineer to be able to integrate and operate the ACA Correlator and ACA Correlator Software (see RD 11)].

This summary task falls under the overall responsibility of Takeshi Kamazaki and Satoru Iguchi, with significant contributions from A. A. and contractor (TBD) engineers for ACA correlator, Manabu Watanabe and programmers for ACA correlator software among others.

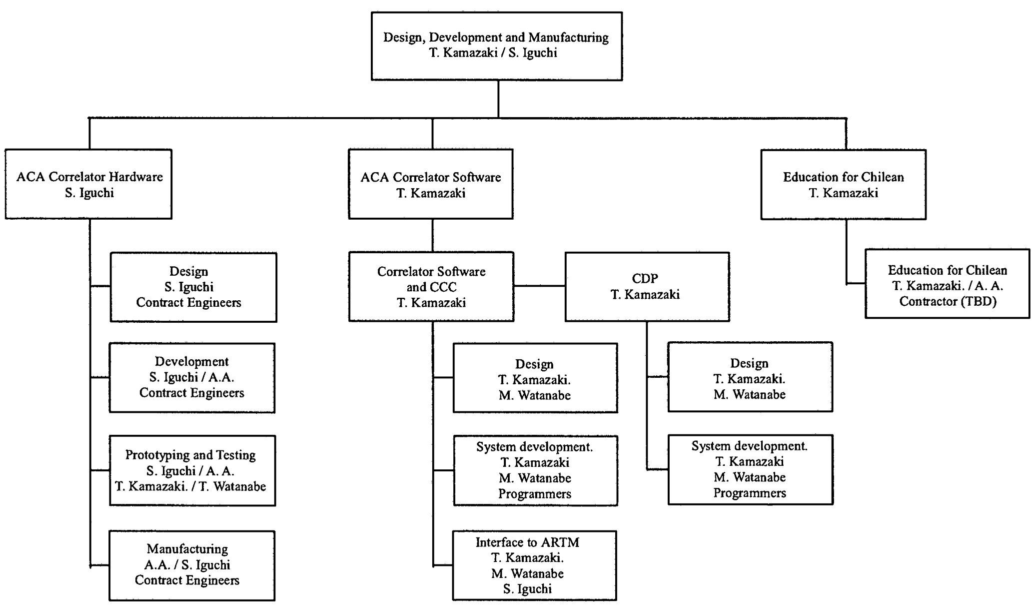

Figure 4-2. Design, Development and Manufacturing Tasks

4.1.3 Deliveries

Table 4-1 summarizes the hardware deliveries from ESO/NRAO/JAO to the ACA Correlator Hardware and Software Team, while Table 4-2 summarizes the deliveries from the team to ALMA.

A number of tasks fall under this summary task, including:

- definition of the verification plan, the requirements for test equipment, and test procedures (see RD 07);
- (pre-transporting) testing at NAOJ, and contractor racks, TBD;
- transporting from NAOJ and TBD to AOS (as written in the transportation plan, RD 09)
- (post-transporting) acceptance testing at AOS (as written in the acceptance testing plan, RD 10); and
- documentation (of operational procedures, in RD 11).

This summary task falls under the overall responsibility of Sachiko K. Okumura with significant contributions from Satoru Iguchi and Takeshi Kamazaki.

Table 4-1 – ESO/NRAO/JAO Hardware Deliveries to the ACA Correlator Hardware and Software Team (via ALMA-J)

Date	Description	Supplier	Comments
2005-10-xx	Array Real-Time Machine	ESO/NRAO/JAO	Yet required. We need to confirm the control & monitor for FO receiver and DTS digital deformatter in ACA Correlator

Table 4-2 – The ACA Correlator Hardware and Software Team Deliveries to ALMA (via ALMA-J)

Description	Delivered to	Comments
ACA Correlator Hardware	ALMA	
ACA Correlator Software	ALMA	ACA Correlator Control Computer (CCC) ACA Correlator Data Processors (CDP) ACA Correlator Software source code
Documentation	ALMA	
Spare Parts List	ALMA	
Tools and Support Equipment	ALMA	

4.2 Team members and primary responsibilities

As a supplement to the more detailed information in the previous section, the following table summarizes the primary responsibilities of the individuals within the Team.

Table 4-3 – Responsibilities within the ACA Correlator Hardware and Software Team

Name	Position	Main Responsibilities
Sachiko K. Okumura	Project Manager	• Project management • External point-of-contact for ACA Correlator hardware • Oversight of design, development and manufacturing
Yoshihiro Chikada	Assistant Project Manager	• Project management • Procurement • Management of external contracts
Takeshi Kamazaki	Correlator Scientist	• Oversight of correlator software design and system development • External point-of-contact for ACA Correlator Software subsystem • Prototype development and testing • Interface • Education of Chilean engineer
Satoru Iguchi	Correlator Scientist	• Oversight of correlator hardware design, development and manufacturing • Prototype development and testing • Interface
Manabu Watanabe	Software Engineer	• Correlator software system development • Prototype development and testing • Interface
A. A.	Hardware Engineer	• Manufacturing correlator hardware • Prototype development and testing
Programmers	Software Programmer	• Correlator software system development
B. B.	Documentation Specialist	• Documentation • Development and maintenance of CIDL

4.3 Level 2 and 3 milestones

4.3.1 ACA Correlator

A preliminary project schedule, produced at the beginning of 2004, was compliant with the original milestones defined in Table 4-4. This schedule was based upon a number of critical assumptions, several of which were not realized in practice. These assumptions were:

- Specifications are being available on July 2004.
- All interface definitions external to the ACA Correlator are defined before Production Contract, October 2004 (see RD 05).
- Production Contract is being done on October 2004 before the Critical Design Review (CDR), July 2005 (see RD 05).
- Array Real-Time Machine is delivered by the ESO/NRAO until October 2005.

Table 4-4 – Level 2 and 3 Milestones for ACA Correlator

Milestones	Date (Start)	Date (Finish)	Level 2	Level 3	Level 4
Detailed Design and Development Phase					
Technical Kick-off (**KO**)	2004-01-01	2004-01-01		x	
Specifications Review (SR)	2004-07-12	2004-07-13		x	
Production Contract (PC)	2004-09-30	2004-09-30		x	
Internal Progress Review (IPR)	2005-02-02	2005-02-03		x	
Critical Design Review (CDR)	2005-07-04	2005-07-06	x		
Final Design Decision	2005-07-29	2005-07-29		x	
Manufacturing and Deliverable Phase					
Start Manufacturing	2005-08-01	2005-08-01		x	
Arrival at Chile	2007-03-30	2007-03-30		x	
Delivered to ALMA	2007-05-31	2007-05-31	x		
ACA Correlator Integration	2007-06-01	2007-07-16		x	
Science Commissioning Phase					
Start Science Commissioning	2007-12-31	2007-12-31	x		

4.3.2 ACA Correlator Software Subsystem

A preliminary project schedule, produced at the middle of 2004, was compliant with the original milestones defined in Table 4-5. This schedule was based upon a number of critical assumptions, several of which were not realized in practice. These assumptions were:

- Specifications and development plan are being available on 14th December 2004.
- All interface definitions external to the ACA Correlator Software Subsystem are defined by March 2005.

Table 4-5 – Level 2 and 3 Milestones for ACA Correlator Software Subsystem

Milestones	Date (Start)	Date (Finish)	Level		
			2	3	4
System Design and Development Phase					
Technical Kick-off (**KO**)	2004-06-01	2004-06-01		x	
Specifications and Development Plan Review (SDPR)	2004-12-14	2004-12-15		x	
Critical Design Review 3 (CDR 3)	2005-05-01	2005-05-xx		x	
Release 3.0		2005-10-01	x		
Readiness Review (RR)	2006-06-01	2006-06-xx		x	
Release 4.0		2006-10-01	x		
Preliminary Acceptance Review (PAR)	2007-03-01	2007-07-16	x		
Release 4.1		2007-07-16	x		
Science Commissioning Phase					
Start Science Commissioning	2007-12-31	2007-12-31	x		

4.4 Schedule

ID	Task Name	Duration	Start	Finish
1	**Detailed Design and Development Phase**	412 days	04/01/01	05/07/29
2	**Technical Kick-off**	0 days	04/01/01	04/01/01
3	**Conceptual design**	128 days	04/01/05	04/06/30
4	DTS backend	63 days	04/01/05	04/03/31
5	ACA Correlation (F part and X part)	128 days	04/01/05	04/06/30
6	**Production Contract (PC) preparations**	153 days	04/01/02	04/08/03
7	**Specifications Review (SR) preparations**	30 days	04/06/01	04/07/12
8	**SR**	0 days	04/07/12	04/07/12
9	SR reports	10 days	04/07/12	04/07/23
10	**PC**	0 days	04/09/30	04/09/30
11	**Detailed Design**	129 days	04/07/01	04/12/28
12	FFT logic for FPGA	112 days	04/07/26	04/12/28
13	Cross Correlation logic for FPGA	112 days	04/07/26	04/12/28
14	Transmission from F parts to X parts	129 days	04/07/01	04/12/28
15	Data Output from X parts	87 days	04/07/01	04/10/29
16	FO receiver and DTS digital deformatter	107 days	04/08/02	04/12/28
17	**Prototyping and Testing**	303 days	04/04/01	05/05/30
18	DTS transmission	87 days	04/04/01	04/07/30
19	One station board in F parts	89 days	04/09/30	05/02/01
20	F parts to X parts Connection	145 days	04/09/30	05/04/20
21	One station board in X parts	89 days	04/09/30	05/02/01
22	Integrative Testing	28 days	05/04/21	05/05/30
23	**Internal Progress Review (IPR) preparations**	67 days	04/11/01	05/02/01
24	**IPR**	0 days	05/02/02	05/02/02
25	IPR reports	10 days	05/02/02	05/02/15
26	**Critical Design Review (CDR) preparations**	99 days	05/02/16	05/07/04
27	**CDR**	0 days	05/07/04	05/07/04
28	CDR reports	19 days	05/07/05	05/07/29
29	**Final Design Modifications**	118 days	05/02/16	05/07/29
30	Interfaces and Spec. of Critical Items	99 days	05/02/16	05/07/04
31	Review of Prototyping and Testing	25 days	05/05/31	05/07/04
32	Redesign	19 days	05/07/05	05/07/29
33	**Final Design Decision**	0 days	05/07/29	05/07/29
34				
35	**Manufacturing and Deliverable Phase**	511 days	05/08/01	07/07/16
36	**Manufacturing and Verification**	413 days	05/08/01	07/02/28
37	Manufacturing Hardware Step 1	177 days	05/08/01	06/04/04
38	Manufacturing Hardware Step 2	176 days	06/04/05	06/12/06
39	Verification 1 with ACA Correlator Software	30 days	06/04/05	06/05/16
40	Verification 2 with ACA Correlator Software	60 days	06/12/07	07/02/28
41	**Transportation to AOS**	34 days	07/03/01	07/04/17
42	Shipping	10 days	07/03/01	07/03/14
43	Transport from contract company to Chile	12 days	07/03/15	07/03/30
44	**Arrival at Chile**	0 days	07/03/30	07/03/30
45	Transport from Santiago to AOS	2 days	07/04/16	07/04/17
46	**Acceptance Testing at AOS for deliveries**	32 days	07/04/18	07/05/31
47	Acceptance testing	32 days	07/04/18	07/05/31
48	**Delivered to ALMA**	0 days	07/05/31	07/05/31
49	**ACA Correlator Integration**	32 days	07/06/01	07/07/16
50	ACA Correlator Integration with software	32 days	07/06/01	07/07/16
51				
52	**EARLY SCIENCE STARTS**	0 days	07/12/31	07/12/31

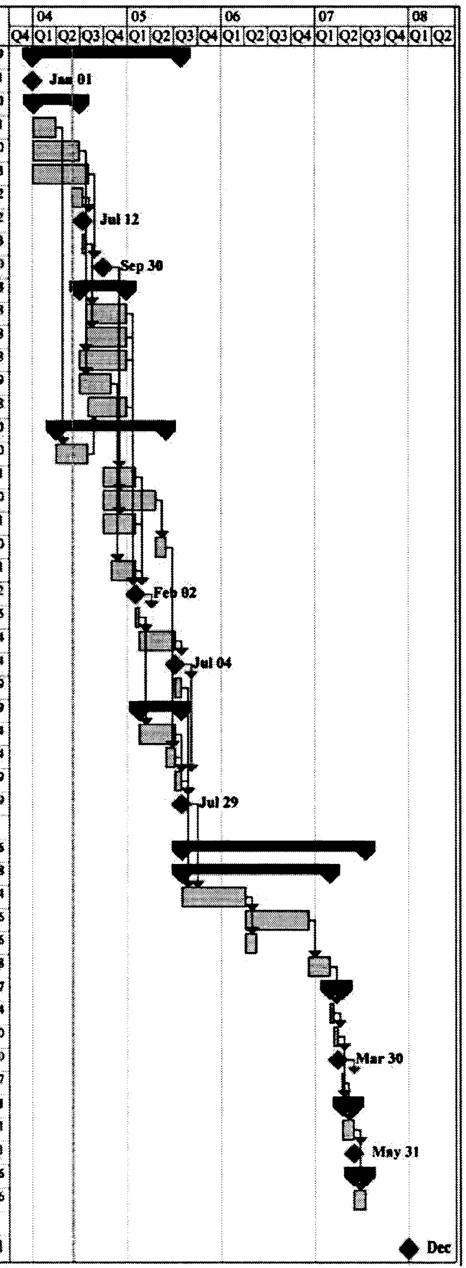

Figure 4-3. Schedule of ACA Correlator

ID	Task Name	Duration	Start	Finish
1	**System Design and Development Phase**	816 days	04/06/01	07/07/16
2	Technical Kick-off	0 days	04/06/01	04/06/01
3	Conceptual design	109 days	04/06/01	04/10/29
4	ACA Correlator Data Processor (CDP)	109 days	04/06/01	04/10/29
5	ACA Correlator Control Computer (CCC)	109 days	04/06/01	04/10/29
6	ACA Correlator Software	109 days	04/06/01	04/10/29
7	Spec. & Develop. Plan Rev. (SDPR) prep.	30 days	04/11/01	04/12/10
8	SDPR	0 days	04/12/14	04/12/14
9	SDPR reports	14 days	04/12/14	04/12/31
10	Detailed Design	85 days	05/01/03	05/04/29
11	CDP	85 days	05/01/03	05/04/29
12	CCC	85 days	05/01/03	05/04/29
13	ACA Correlator Software	85 days	05/01/03	05/04/29
14	Critical Design Review 3 (CDR) preparations	64 days	05/02/01	05/04/29
15	CDR 3	0 days	05/05/02	05/05/02
16	Software System Integration 3	111 days	05/05/02	05/10/03
17	Release 3.0	0 days	05/10/03	05/10/03
18	System Development Version 1	229 days	05/07/01	06/05/16
19	ACA Correlator Software Subsystem Ver 1	199 days	05/07/01	06/04/04
20	Verification Round 1 with ACA Correlator	30 days	06/04/05	06/05/16
21	Readiness Review (RR) preparations	68 days	06/03/01	06/06/01
22	RR	0 days	06/06/01	06/06/01
23	Software System Integration 4	87 days	06/06/02	06/10/02
24	Release 4	0 days	06/10/02	06/10/02
25	System Development Version 2	236 days	06/04/05	07/02/28
26	ACA Correlator Software Subsystem Ver 2	176 days	06/04/05	06/12/06
27	Verification Round 2 with ACA Correlator	60 days	06/12/07	07/02/28
28	Preliminary Acceptance Review (PAR)	98 days	07/03/01	07/07/16
29	Acceptance Testing in Chile	66 days	07/03/01	07/05/31
30	Acceptance Testing with ACA Correlator	32 days	07/06/01	07/07/16
31	Release 4.1	0 days	07/07/16	07/07/16
32				
33	**EARLY SCIENCE STARTS**	0 days	07/12/31	07/12/31

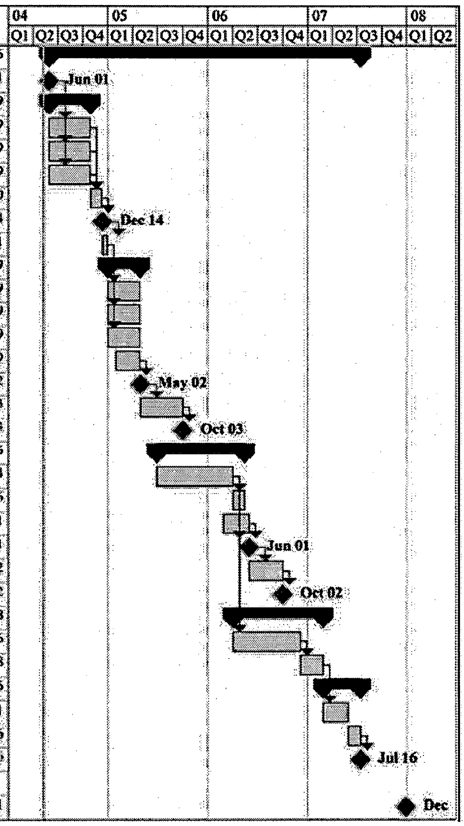

Figure 4-4. Schedule of ACA Correlator Software Subsystem

5 ACA Correlator

5.1 Design, development and manufacturing workpackages

In defining the development schedule, the tasks discussed in the previous section are broken up chronologically. This results in one continuing tasks (project management), three design stages, one prototyping and testing stage, one manufacturing and verification stage, one transportation stage, two delivery stages, and tasks of preparations for one large contract and three reviews. Thus, the top-level workpackages are:

- project management;
- conceptual design;
- Production Contract (PC) preparations;
- Specifications Review (SR) preparations;
- detailed design;
- prototyping and testing;
- Internal Progress Review (IPR) preparations;
- Critical Design Review (CDR) preparations;
- final design modifications;
- manufacturing and verification;
- transportation to AOS;
- acceptance testing at AOS and delivery; and
- ACA Correlator integration

5.1.1 Project management

Start Date: January 2004

End Date: July 2007

Overview: This workpackage combines the management tasks that are not specific to one of the design, hardware, or review preparation tasks. This includes the maintaining of external contacts (other than contract management), maintaining the project schedule and budget, personnel issues, defining the documentation system and PA plans. Note that the overall project management workload is much higher than the numbers stated here, due to the management workload that is incorporated in the other tasks.

Resources: Sachiko K. Okumura (40%)

Yoshihiro Chikada (20% from April 2004)

Satoru Iguchi (10%)

B.B. (20% from June 2004)

Total: 0.77 FTEs in 2004, 0.90 FTEs in 2005, 0.90 FTEs in 2006, and 0.53 FTEs in 2007

5.1.2 Conceptual design

Start Date: project start (Jan. 2004)

End Date: June 2004

Overview: This workpackage consisted of the conceptual design, feedback to the preliminary definitions of external ICDs and specifications, and the development of test equipment.

Inputs: requirements and interfaces (still incomplete)

Outputs: conceptual design, inc. critical items definition

Resources: Sachiko K. Okumura (20%)
Yoshihiro Chikada (20%)
Satoru Iguchi (40%)
Total: 0.40 FTEs in 2004

5.1.3 Production Contract (PC) preparations

Start Date: January 2004

End Date: August 2004

Overview: This workpackage consisted of the specifications to establish a contract with manufacturing company, held in October 2004.

Inputs: external ICDs, and conceptual design (via requirements and interfaces)

Outputs: specifications for contract

Resources: Sachiko K. Okumura (30%)
Yoshihiro Chikada (20%)
Satoru Iguchi (10%)
B. B. (30% from June 2004)
Total: 0.40 FTEs in 2004

5.1.4 Specifications Review (SR) preparations

Start Date: June 2004

End Date: July 2004

Overview: This workpackage consists of the production of the datapackage and presentations for the Specifications Review, held in July 2004.

Inputs: external ICDs, and conceptual design (via requirements and interfaces)

Outputs: specifications for contract

Resources: Sachiko K. Okumura (25%)
Yoshihiro Chikada (10%)
Satoru Iguchi (10%)
B. B. (20% from June 2004)
Total: 0.11 FTEs in 2004

5.1.5 Detailed design

Start Date: July 2004

End Date: December 2004 (predicted)

Overview: This workpackage consists of the detailed design, including finalizing the external ICDs and specifications, identification of supplies, and the design and production of test equipment.

Inputs: conceptual design, and specifications for contract
finalized requirements and interfaces

Outputs: detailed specifications of procured development items
manufacturing and verification plans
preliminary manufacturing and verification procedures
test equipment

Resources: Sachiko K. Okumura (20%)
Yoshihiro Chikada (20%)
Satoru Iguchi (40%)
A.A. (from October 40%)
Total: 0.50 FTEs in 2004 + TBD engineers (from November 2004)

5.1.6 Prototyping and Testing

Start Date: April 2004

End Date: May 2005 (predicted)

Overview: This workpackage contains the prototyping and testing tasks described in Section 4.1.2.

Inputs: prototyping and testing drawings
prototyping and testing procedures
test and evaluation equipments

Outputs: acceptance data package

Resources: Sachiko K. Okumura (20%)

Satoru Iguchi (40%)

A.A. (48% from October 2004)

Total: 0.57 FTEs in 2004, and 0.45 FTEs in 2005 + TBD engineers (from November 2004)

5.1.7 Internal Progress Review (IPR) preparations

Start Date: November 2004

End Date: February 2005

Overview: This workpackage consists of the production of the datapackage and presentations for the Internal Progress Review, held in February 2005.

Inputs: review requirements

Outputs: review datapackage and presentations

Resources: Sachiko K. Okumura (20%)

Yoshihiro Chikada (10%)

Satoru Iguchi (10%)

A.A. (20%)

B.B. (20%)

Total: 0.13 FTEs in 2004, and 0.13 FTEs in 2005

5.1.8 Critical Design Review (CDR) preparations

Start Date: February 2005 (predicted)

End Date: July 2005 (predicted)

Overview: This workpackage consists of the preparation of documentation and presentations for the Critical Design Review expected in July 2005.

Inputs: review requirements

Outputs: review datapackage and presentations (including updated engineering documentation file system)

Resources: Sachiko K. Okumura (30%)

Yoshihiro Chikada (10%)

Satoru Iguchi (10%)

A.A. (20%)

B.B. (20%)

Total: 0.45 FTEs in 2005 + TBD engineers

5.1.9 Final Design modifications

Start Date: February 2005 (predicted)

End Date: July 2005 (predicted)

Overview: This workpackage consists of a review of the experiences gained with the prototyping and testing, and CDR, any redesign that is necessary, upgrades to test equipment, further detailing of manufacturing and test procedures, and updates to external ICDs and specifications.

Inputs: requirements
Feedback from prototyping and testing, and CDR
lessons-learned and performance

Outputs: updated design, including manufacturing drawings and specifications
updated manufacturing and verification plan and procedures
upgraded test equipment

Resources: Sachiko K. Okumura (20%)
Yoshihiro Chikada (20%)
Satoru Iguchi (40%)
A.A. (60%)
B.B. (20%)
Total: 0.67 FTEs in 2005 + TBD engineers

5.1.10 Manufacturing and verification

Start Date: August 2005

End Date: February 2007 (predicted)

Overview: This workpackage contains the manufacturing and verification tasks described in Sections 4.1.1 and 4.1.2.

Inputs: manufacturing and verification drawings
manufacturing and verification procedures
test and evaluation equipments

Outputs: acceptance data package

Resources: Sachiko K. Okumura (60%)
Yoshihiro Chikada (10%)
Satoru Iguchi (10%)

A.A. (100%)
B.B. (20%)
Total: 0.82 FTEs in 2005, 2.00 FTEs in 2006 and 0.33 FTEs in 2007 + TBD engineers

5.1.11 Transportation to AOS

Start Date: March 2007
End Date: April 2007 (predicted)
Overview: This workpackage contains the transportation tasks described in Section 4.1.3.
Inputs: transportation plan (see RD 09) drawings
Outputs: acceptance confirmation package
Resources: Sachiko K. Okumura (30%)
Yoshihiro Chikada (20%)
B.B. (20%)
Total: 0.12 FTE in 2007 + TBD engineers

5.1.12 Acceptance testing at AOS and delivery

Start Date: April 2007
End Date: May 2007 (predicted)
Overview: This workpackage contains the acceptance testing tasks described in Section 4.1.3.
Inputs: acceptance testing plan (see RD 10) drawings
Outputs: delivery package
Resources: Sachiko K. Okumura (60%)
A. A. (100%)
Total: 0.27 FTE in 2007 + TBD engineers

5.1.13 ACA Correlator Integration

Start Date: June 2007
End Date: July 2007 (predicted)
Overview: This workpackage contains the ACA Correlator implementation to ACA system with ACA Correlator Software Subsystem.
Inputs: ACA Correlator delivery package and ACA Correlator Software Subsystem
Outputs: ACA Correlator integration in ALMA

Resources: Sachiko K. Okumura (60%)
A. A. (100%)
Total: 0.27 FTE in 2007 + TBD engineers

5.2 Total resources in workpackages

Totaling the previously discussed workpackages yields the following estimate of the total resources for these workpackages:

2004: 2.88 FTEs + [TBD engineers (from November 2004)]

2005: 3.43 FTEs + [TBD engineers]

2006: 2.90 FTEs + [TBD engineers]

2007: 1.51 FTEs + [TBD engineers]

The availability of these resources will be crucial to meeting the desired delivery schedule. Furthermore, the resource requirement for the manufacturing and verification needs to be reviewed.

Table 5-1 – Resources in workpackages

	2004	2005	2006	2007
Project management	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7
FTEs	0.77	0.90	0.90	0.53
Conceptual design	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7
FTEs	0.40	0.00	0.00	0.00
PC preparations	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7
FTEs	0.40	0.00	0.00	0.00
SR preparations	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7
FTEs	0.11	0.00	0.00	0.00
Detailed design	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7
FTEs	0.50	0.00	0.00	0.00
Prototyping and testing	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7
FTEs	0.57	0.45	0.00	0.00
IPR preparations	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7
FTEs	0.13	0.13	0.00	0.00
CDR preparations	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7
FTEs	0.00	0.45	0.00	0.00
Final Design modifications	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7
FTEs	0.00	0.67	0.00	0.00
Manufacturing and verification	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7
FTEs	0.00	0.83	2.00	0.33
Transportation to AOS	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7
FTEs	0.00	0.00	0.00	0.12
Acceptance testing at AOS and delivery	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7
FTEs	0.00	0.00	0.00	0.27
ACA Correlator Integration	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7
FTEs	0.00	0.00	0.00	0.27

Total FTEs	2.88	3.43	2.90	1.51
S. K. Okumura	1.00	1.00	1.00	0.59
Y. Chikada	0.50	0.39	0.30	0.17
S. Iguchi	0.89	0.54	0.20	0.08
A.A.	0.25	1.00	1.00	0.50
B.B.	0.23	0.50	0.40	0.18

6 ACA Correlator Software Subsystem

6.1 Design, development and manufacturing workpackages

In defining the development schedule, the tasks discussed in the previous section are broken up chronologically. This results in one continuing tasks (project management), two design stages, two development and verification stages, three software system integration stages, and tasks of preparations for four reviews. Thus, the top-level workpackages are:

- project management;
- conceptual design;
- Specifications and Development Plan Review (SR) preparations;
- detailed design;
- Critical Design Review 3 (CDR 3) preparations;
- software system integration 3;
- system development version 1;
- Readiness Review (RR) preparations;
- software system integration 4;
- system development version 2; and
- Preliminary Acceptance Review (PAR)

6.1.1 Project management

Start Date: June 2004

End Date: July 2007

Overview: This workpackage only combines the management tasks that are different from those in Section 5.1.1. This includes the maintaining of external contacts, maintaining personnel issues, defining the documentation system, and controlling the system engineering in developing the ACA Correlator Software Subsystem. The others are included in Section 5.1.1.

Resources: Takeshi Kamazaki (20%)

Total: 0.12 FTEs in 2004, 0.20 FTEs in 2005, 0.20 FTEs in 2006, and 0.12 FTEs in 2007

6.1.2 Conceptual design

Start Date: project start (June 2004)

End Date: October 2004

Overview: This workpackage consisted of the conceptual design, feedback to the preliminary definitions of external ICDs and specifications, and the development of test equipment.

Inputs: requirements and interfaces (still incomplete)

Outputs: conceptual design, inc. critical items definition

Resources: Takeshi Kamazaki (30%)
Manabu Watanabe (100%)
Total: 0.54 FTEs in 2004

6.1.3 Specifications and Development Plan Review (SDPR) preparations

Start Date: November 2004

End Date: December 2004

Overview: This workpackage consists of the production of the datapackage and presentations for the Specifications and Development Plan Review, held in December 2004.

Inputs: external ICDs, and conceptual design (via requirements and interfaces)

Outputs: specifications for contract

Resources: Takeshi Kamazaki (30%)
Manabu Watanabe (100%)
Total: 0.22 FTEs in 2004

6.1.4 Detailed design

Start Date: January 2005

End Date: April 2005 (predicted)

Overview: This workpackage consists of the detailed design, including finalizing the external ICDs and specifications, identification of supplies, and the design and production of test equipment.

Inputs: conceptual design, and specifications for contract
finalized requirements and interfaces

Outputs: detailed specifications of procured development items
manufacturing and verification plans
preliminary manufacturing and verification procedures
test equipment

Resources: Takeshi Kamazaki (80%)
Manabu Watanabe (95%)
Total: 0.58 FTEs in 2005

6.1.5 Critical Design Review 3 (CDR 3) preparations

Start Date: February 2005 (predicted)

End Date: April 2005 (predicted)

Overview: This workpackage consists of the preparation of documentation and presentations for the Critical Design Review 3 expected in May 2005.

Inputs: review requirements

Outputs: review datapackage and presentations (including updated engineering documentation file system)

Resources: Takeshi Kamazaki (30%)
Manabu Watanabe (50%)
Total: 0.20 FTEs in 2005 + programmers

6.1.6 Software System Integration 3

Start Date: May 2005 (predicted)

End Date: September 2005 (predicted)

Overview: This workpackage aims the realization for Release 3.0. This also consists of a review of the experiences gained with the CDR, any redesign that is necessary, upgrades to test equipment, further detailing of manufacturing and test procedures, and updates to external ICDs and specifications.

Inputs: Feedback from CDR
lessons-learned and performance

Outputs: updated design, including manufacturing drawings and specifications
updated manufacturing and verification plan and procedures
upgraded test equipment

Resources: Takeshi Kamazaki (50%)
Manabu Watanabe (50%)
Total: 0.42 FTEs in 2005

6.1.7 System Development Version 1

Start Date: July 2005

End Date: May 2006 (predicted)

Overview: This workpackage contains the manufacturing and verification tasks described in Sections 4.1.1 and 4.1.2.

Inputs: manufacturing and verification drawings
manufacturing and verification procedures

test and evaluation equipments

Outputs: acceptance data package

Resources: Takeshi Kamazaki (50%)
Manabu Watanabe (70%)
Total: 0.60 FTEs in 2005 and 0.50 FTEs in 2006 + programmers

6.1.8 Readiness Review (RR) preparations

Start Date: March 2006 (predicted)

End Date: May 2006 (predicted)

Overview: This workpackage consists of the preparation of documentation and presentations for the Readiness Review expected in June 2006.

Inputs: review requirements

Outputs: review datapackage and presentations (including updated engineering documentation file system)

Resources: Takeshi Kamazaki (20%)
Manabu Watanabe (20%)
Total: 0.10 FTEs in 2006 + programmers

6.1.9 Software System Integration 4

Start Date: June 2006 (predicted)

End Date: September 2006 (predicted)

Overview: This workpackage aims the realization for Release 4.0. This also consists of a review of the experiences gained with the RR, any redesign that is necessary, upgrades to test equipment, further detailing of manufacturing and test procedures, and updates to external ICDs and specifications.

Inputs: Feedback from RR
lessons-learned and performance

Outputs: updated design, including manufacturing drawings and specifications
updated manufacturing and verification plan and procedures
upgraded test equipment

Resources: Takeshi Kamazaki (50%)
Manabu Watanabe (40%)
Total: 0.30 FTEs in 2006

6.1.10 System Development Version 2

Start Date: April 2006

End Date: February 2007 (predicted)

Overview: This workpackage contains the manufacturing and verification tasks described in Sections 4.1.1 and 4.1.2.

Inputs: manufacturing and verification drawings
manufacturing and verification procedures
test and evaluation equipments

Outputs: acceptance data package

Resources: Takeshi Kamazaki (50%; 80% after Jan. 2007)
Manabu Watanabe (70%; 100% after Jan. 2007)
Total: 0.90 FTEs in 2006 and 0.30 FTEs in 2007 + programmers

6.1.11 Preliminary Acceptance Review (PAR)

Start Date: March 2007

End Date: July 2007 (predicted)

Overview: This workpackage contains the acceptance testing tasks described in Section 4.1.3.

Inputs: acceptance testing plan (see RD 10) drawings

Outputs: delivery package

Resources: Takeshi Kamazaki (80%)
Manabu Watanabe (100%)
Total: 0.75 FTE in 2007 + programmers

6.2 Total resources in workpackages

Totaling the previously discussed workpackages yields the following estimate of the total resources for these workpackages:

2004: 0.88 FTEs

2005: 2.00 FTEs + [programmers from April 2005]

2006: 2.00 FTEs + [programmers]

2007: 1.17 FTEs + [programmers]

The availability of these resources will be crucial to meeting the desired delivery schedule. Furthermore, the resource requirement for the manufacturing and verification needs to be reviewed.

Table 6-1 – Resources in workpackages

	2004	2005	2006	2007
Project management	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7
FTEs	0.12	0.20	0.20	0.12
Conceptual design	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7
FTEs	0.54	0.00	0.00	0.00
SDPR preparations	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7
FTEs	0.22	0.00	0.00	0.00
Detailed design	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7
FTEs	0.00	0.58	0.00	0.00
CDR 3 preparations	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7
FTEs	0.00	0.20	0.00	0.00
Software System Integration 3	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7
FTEs	0.00	0.42	0.00	0.00
System Development Version 1	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7
FTEs	0.00	0.60	0.50	0.00
RR preparations	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7
FTEs	0.00	0.00	0.10	0.00
Software System Integration 4	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7
FTEs	0.00	0.00	0.30	0.00
System Development Version 2	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7
FTEs	0.00	0.00	0.90	0.30
PAR preparations	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7
FTEs	0.00	0.00	0.00	0.75

Total FTEs	0.88	2.00	2.00	1.17
T. Kamazaki	0.29	1.00	1.00	0.58
M. Watanabe	0.58	1.00	1.00	0.58

7 ACA Backend Subsystem

Satoru Iguchi has a management responsibility for ACA Backend Subsystem, and is the contact person with the ALMA-B BE IPT.

The ACA Backend subsystem production contract and assurance plan are written in RD 13 and RD 14, respectively, under the overall responsibility of Tetsuo Hasegawa, with significant contributions from Satoru Iguchi and Yoshihiro Chikada.

The delivery schedule of ACA Backend Subsystem are required from ACA IPT (see RD 12 and Table 5-1).

Table 5-1 – Delivery Schedule to OSF from ALMA-B to ALMA/ACA via ALMA-J

TBD

8 Risk assessment

There are a number of significant risk items that could affect the planned project schedule and costs (including the manpower requirements). The most significant of these issues are discussed below under the following major headings:

- incomplete or unclear project requirements; and
- late delivery of components;

8.1 Incomplete or unclear project requirements

The estimated schedule and costs are based upon the current understanding of the project requirements, including the technical specifications (including the external ICDs and the environmental and EMC requirements), and product assurance and documentation requirements (see RD 06). Missing or misunderstood requirements in any or all of these areas could lead to significant delays and/or additional costs in the project. On top of this, it is noted that a number of requirements (including the EMC and environmental requirements) were defined with the overall ALMA system in mind, but are either not fully applicable to the ACA Correlator Units (because they do not describe the environments of the AOS building; Air Conditioning or cooling capability, etc.), are not complete, or do not take into account the sensitive and developmental nature of all of the ACA Correlator Units (especially with respect to the EMC environment and Cosmic Ray).

Uncertainties with respect to the level of documentation that will be required are partially reflected in the previous statements about the product assurance requirements. In particular, the level of documentation that is required, both for design reviews and to accompany the delivered materials, could overload the group and delay progress on the hardware side of the project.

8.2 Late delivery of components

FO Receiver and DTS digital deformatter also depend upon the timely delivery of components (Array Real-Time Machine) by ALMA-B partners in the ALMA project. In principle, the delivery times stated in the Statement of Work (RD 03) are not on the critical path for the manufacturing and verification. However, given the development aspect of the design and development, there is a risk that manufacturing and verification will highlight one or more problem areas. If this is the case, the delivery schedules of the ESO/NRAO/JAO deliveries could become critical.

9 Financial accounting

Note that the budget ACA Correlator will be estimated in October of 2004, while the budget ACA Correlator Software will be estimated in March of 2005.