



**Atacama
Large
Millimeter
Array**

ALMA Software Project Management Lessons Learned

G. Raffi¹, B.E. Glendenning²

*¹European Southern Observatory, Garching,
Germany*

*²National Radio Astronomy Observatory,
Socorro, New Mexico, USA*

ALMA Software Project management,
Lessons learned - G. Raffi, B.E.
Glendenning



ALMA Project in Summary

- 54 x 12m + 12 x 7m antennas, 30-950 GHz
- Array configurations: 150 m-14 Km
- Near S. Pedro de Atacama, Chile at 5000 m
- EU and North America as equal partners, East Asia at 25%
- Construction phase 2003-2012
- Early Science foreseen for mid 2011

- ALMA is the largest ground based astronomical project under construction.
- Upcoming astronomy projects include 30-42 m optical telescopes but also radio projects (e.g. SKA)



end-to-end
(e2e)
software
system

Software Scope

- From the cradle...
 - Proposal Preparation
 - Proposal Review
 - Program Preparation
 - Dynamic Scheduling of Programs
 - Observation
 - Calibration & Imaging
 - Data Delivery & Archiving
- Afterlife:
 - Archival Research & Virtual Observatory (VO) Compliance





ALMA Computing

Observation Preparation: Spatial Editor

Editors

Spectral Spatial Forms Catalog

Frequency used: 95.00000 GHz Refresh

(source)

Antenna Diameter: 12m 7m

Show Fov(circle)

Image Query

Image Server: Digitized Sky (Version II) at ESO

Image Size(arcmin): 10 Query

Field Source Editor

This FieldSource is used by 1 target.

Field Source

Field Source Name: Primary

Source Name: NGC1390 Resolve

Source Coordinates

System: J2000 Sexagesimal display?

RA: 03:37:52.180

Dec: -19:00:27.612

Reference Position (Offset)

Field Pattern

Type: point

Point

PointingPattern: Offset

Offset Unit: arcmin

RA [arcmin]	Dec [arcmin]
-0.59801	-0.47470
-0.23712	-0.74739
0.12378	-1.02008
-0.18141	-0.29850
0.17949	-0.57119

2x | 207.5, 353 | 4496.0

03:37:58.569, -18:59:31.75 J2000

image filename: /home/ab/.jsky/cache/jsky21048.fits



Project Management Aspects

- Large but extremely distributed team. About 80 Full Time Equivalent including the support group in Chile.
- Staff in 15 locations in 4 continents
- Geographical distribution with this size & pace is difficult
... *but we believe to be a very good example of a collaborative project*
 - Computing Subsystems mixed across continents (sometimes)
 - Acceptance of common software (optimized for system, not for everybody's taste & mandatory) => *Requires team spirit.*
 - Some inefficiency is inevitable (but better checked design)
- ✓ Most important: *Wiki*, CVS, regular telecons, *face to face* meetings



Project Management Approach

Requirements (and Use Cases):

- ❖ Requirements working group to be recommended
- ❖ There will be still missing or late requirements, but **design is done upfront**
- ❖ **Tracking requirements** completion to show progress (planned vs. actual) (we use Telelogic's DOORS)



Project Management Approach (cont.)

Using a software framework is essential (ALMA Common Software - ACS #)

(but most of this would apply also to EPICS, TANGO etc):

- ❖ Allows collaborative work, results in an homogeneous system
- ❖ Provides a solid debugged base of software
- ❖ Enforces also hardware standards and operating system versions
- ❖ Makes large distributed projects manageable and maintainable
- .. But requires team discipline and managerial support
- And learning (yearly ACS courses)

(#) Based on the container-component paradigm and using CORBA. The system allows the use of C++, JAVA and Python on Linux operating systems.

Started with a collaboration with M. Plesko & Co (JSI, now Cosylab) based on ANKA ... around ICALEPCS'09 (10 years of ACS!) This is still on-going.

- *ACS is free under GNU LGPL license..*
 - *And has its own circulation, also outside ALMA.*
-



Project Management Approach (cont.)

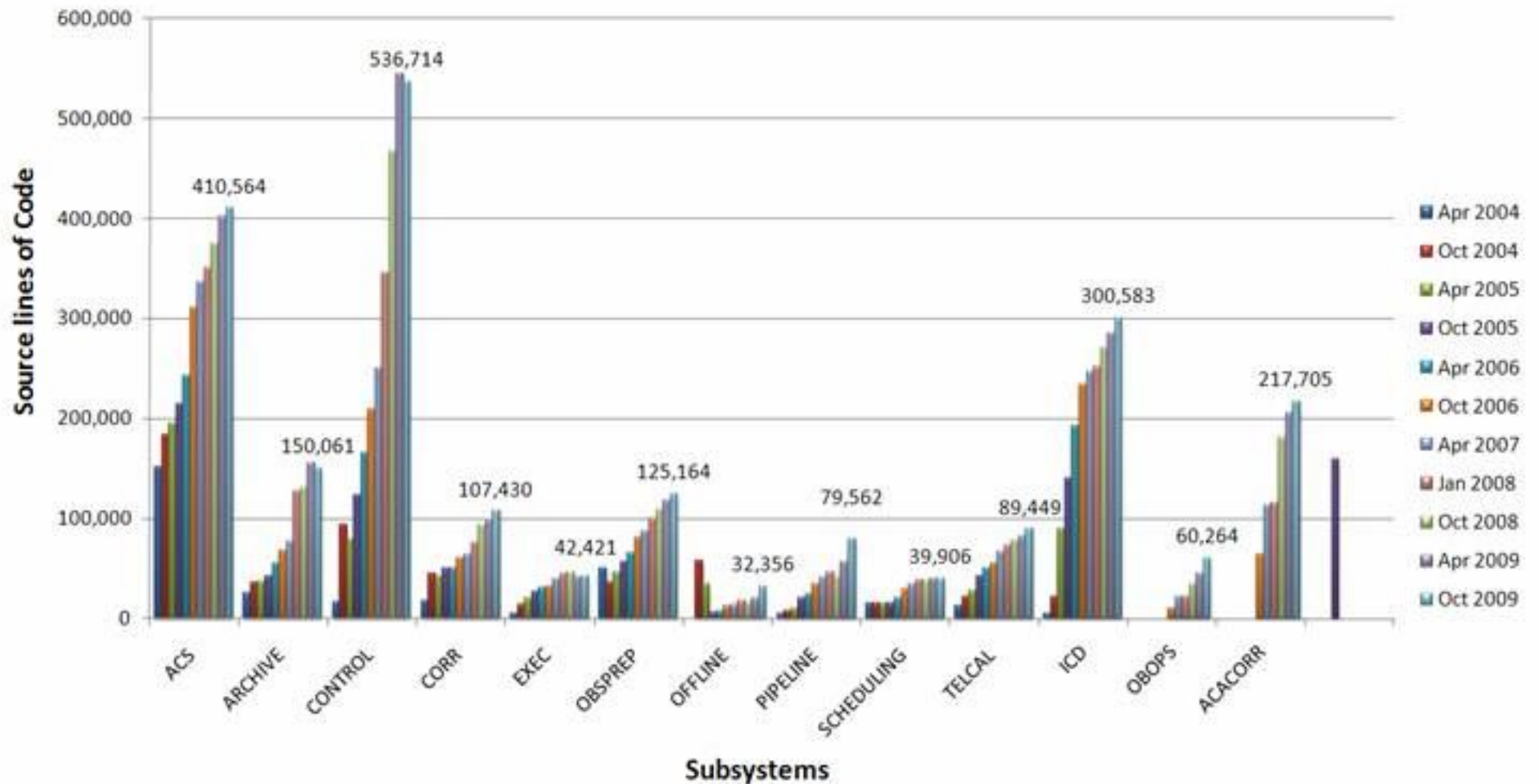
Incremental Releases at fixed dates (vs. fixed content) twice/year

- ❖ Software is developed incrementally in 6 monthly steps
- ❖ Easier integration, **predictable dates** for the rest of the project
- ❖ Releases are an integrated e2e system
- ❖ Patches (typically one per 6 month development cycle) allow to upgrade a few computing subsystems
- ❖ Planning work is for 6 months and can be tuned to **accommodate project priorities**
- Give priority to testing and making releases over development when deadlines approach



Lines of code by Computing subsystem at Release 7.0 (Oct.2009)

SLOC per Subsystem over Releases



Total ~2M SLOC (comments, doc., adopted/modified packages not included).



Project management Approach (cont.)

Integration tests (by independent team)

- ❖ In addition to subsystem tests (build-in test time up front)
- ❖ Regression tests, eventually mostly automatic
- ❖ Require good test models (several computers)
- ... but cannot replace tests with real hardware
- defend towards the rest of the project the **need for significant test time on the system**, to discover/fix issues before software gets used
- .. You will get anyway criticism later and it will be your problem if you did not **follow your procedures**

Cross-subsystem Function Based Teams (FBTs) (~3 months)

- ❖ Implement important functionality reducing impact of changing interfaces
- ❖ Make **integration easier**, as inter-subsystem issues get sorted out continuously.
- ❖ Integrations are more frequent, which is important with a geographically distributed team.



Lessons Learned

- Project management tools: risk analysis, earned value measures
 - ❖ Risk analysis helps project to assess software risks
 - Earned Value (apart from Requirements tracking) was difficult to apply in a meaningful way
 - Reviews to monitor progress:
 - ❖ Internal reviews, like Releases, are incremental. This allows incremental design and flexibility towards project priorities
 - ❖ External reviews are good.
They require preparation and thinking and result in obtaining comments that help in the remaining work.
-



Lessons Learned (cont.)

➤ Planning, Control

Plan coming year in detail according to priorities

➤ Verify (trace) feature completion via integration and user end tests before delivering software for real use.

❖ Problem reporting (JIRA in our case)

– Important to track bugs/improvement request

– JIRA is good. Whatever the system, follow up is important.

– Weekly meeting to discuss issues and flag blocking ones



Status

- Passed external PDR (03) and three external reviews- last one Oct.08
- Incremental internal Critical Design Reviews CDR1 ('04) – CDR6 ('09).
- Delivered R0-R6 release (+Rx.1 Releases & Patches).
- ✓ The ALMA software is regular use for commissioning the ALMA observatory



ALMA Observatory - Operation Site Facility (OSF) (2900 m)



Antennas under test



Project management, Lessons learned -
Planning

Operator Monitoring and Control

Session View Debug

Alma CONTROL/Array001 CONTROL/Array002

Mount Control Stop

AL	AL	XX03	XX04	XX05	XX06	XX07	XX08	XX09	XX10
XX11	XX12	XX13	XX14	XX15	XX16	XX17	XX18	XX19	XX20
XX21	XX22	XX23	XX24	XX25	XX26	XX27	XX28	XX29	XX30
XX31	XX32	XX33	XX34	XX35	XX36	XX37	XX38	XX39	XX40
XX41	XX42	XX43	XX44	XX45	XX46	XX47	XX48	XX49	XX50
YY01	YY02	YY03	YY04	YY05	YY06	YY07	YY08	YY09	YY10
YY11	YY12	ZZ01	ZZ02	ZZ03	ZZ04				

New Replace Clear

Dartboard DartboardALMA01 Stop

Scheduler Stop

Interactive Scheduling

Array Status = Active Destroy Array

Projects: SBs:

PI Name * SB Type All

Project Name* SB Mode All

Project Type All Search Clear

Projects Found	SBs Found
Project Name	SB Name
Holography Standard Mode	trcOP.scat.6.polar.stars.bright
OPT - 6 bright polar stars	
Holography Standard Mode	
Single Field Interferometry	
Holography Standard Mode - Lo	

Execute Stop Abort

Project Info

project s status = not complete

PI Name = Thomas Powers

Status = ready

Total SBs = 1

Total SBs complete = 0

Total SBs failed = 0

SB Details

SB Name: trcOP.scat.6.polar.sta

SB Status: not complete

Max. execution count : indefin

Priority: background

Shift Log Stop

ShiftLog ShiftLogReport

ID	Type	Timestamp	Comment
No entries			

DataFlow Stop

Start	SB	Array	ExBlk	ExBlk#	Scan#	Subscan#	Foc#	Pnt#	QL#	DC#
09-14 12:21:42	uid://X42/X3f9/X3	CONTROL/Array001	uid://X42/Xd6b/X1	1 - 1	6 - 6	6 - 6				

Operator User Interface



ALMA
antenna
moving up to
the high
plateau of
Chajnantor
(5000m).
ALMA base
camp –OSF
in the
background.







ICALEPCS'2009 - Kobe

**ALMA Software Project management, Lessons learned -
G. Raffi, B.E. Glendenning**



More information on ALMA at:
www.almaobservatory.org



There is a video on the Web about the transport of the first ALMA antenna to the site at 5000 m.



Acknowledgments

We are grateful to ALMA Computing staff, who are the real authors of the ALMA software and are located in:

- Europe (Munich, Bonn, Edinburgh, Grenoble, Madrid, Manchester, Paris, Trieste),
- North America (Charlottesville, Socorro, Calgary),
- East Asia (Tokyo, Taipeh),
- ALMA Observatory in Chile (OSF- San Pedro de Atacama).

For more on ALMA and ACS at this Conference:

–**TUP101 ALMA Common Software, status and development** by G. Chiozzi (ESO) et al.

–**WEA006 Data Distribution Service as an alternative to CORBA Notify Service for the ALMA Common Software** by G. Chiozzi (ESO) et al.

–**TU048** This paper