ALMA BOARD

ALMA EDM Document	AEDM 2011-023-O (Rev2)
Distribution	**Ordinary Session**

Subject: Principles for ALMA Development Program

AUTHOR(S): T. de Graauw, M. McKinnon, S. Iguchi, W. Wild and L. Ball

Purpose of Document: To provide the Board with the principles for the ALMA development program

Status: Approved at the July 28th 2011 telecon

Principles for the ALMA Development Program

1. Introduction

At the start of the project it was realized that continuing technical upgrades and development of new capabilities are essential to maintain ALMA as the state-of-the-art facility for millimeter/submillimeter astronomy over the course of its projected life of 30+ years. Rapid progress of relevant hardware technologies will enable new components and subsystems that can offer improved and extended performance and a higher reliability for ALMA. Equally, advances in software and computing can also offer improved performance that translate into more capabilities for scientific research and reduced costs of operation. Infrastructure upgrades may also result in qualitative and or quantitative increases in the scientific capability of ALMA.

The ALMA Board agreed to develop a science-driven long-range development plan. In 2008-2009 an international panel with members from all regions considered a wide range of possibilities to extend the baseline capabilities of ALMA, including small and large-scale projects. ASAC reviewed these and gave indications of scientific priorities. Since this ASAC listing, not much progress has been made. However, regional initiatives are already underway. A European process, soliciting community input to a set of science priorities for ALMA and associated developments, was successfully started. In July 2010 ESO requested proposals for funding to undertake studies which would lead to projects and after selection, a number of studies started in 2010. East Asia and North America are following a similar approach. In the US a straw-person development plan was included in AUI's proposal to NSF, but it is not binding. An ALMA Development Workshop hosted by NRAO took place early in 2011.

In order to move forward the Board has asked the Directors Council to develop the high level principles for the overall Development Program. The Directors Council brought the resulting draft to the Board's April 2011 meeting for discussion. This current draft (v1.8) updates the version discussed at the April 2011 Directors Council and Board meetings.

As the ALMA Development Program is part of the overall operations plan, the summary given in chapter 2 of AOP-D has been adopted as a starting point. Chapter 13 of AOP-D contains more detail.

It is important that the scope, governance and implementation of the ALMA Development Program are transparent. We give first a list of the main players, most of them described in AOP-D.

Executives: The Executives, in possible collaboration with other institutes they may choose, fund and carry out development of new ALMA capabilities, including hardware, software and infrastructure.

ALMA Director: The ALMA Director coordinates activities by which new projects to be funded out of the ALMA operations development budget are identified and proposed by the Executives in consultation with the relevant communities, via the ALMA Development Steering Committee. The ALMA Director will submit the program proposal with suggested prioritization to the Directors Council for concurrence and to the ALMA Board for approval.

ALMA Development Steering Committee (ADSC): It is essential that the three Executives and the JAO work together to ensure the delivery of a coordinated and effective ALMA Development Program. To assist this it is proposed to establish an ALMA Development Steering Committee consisting of the ALMA Deputy Director as chair and representatives of each of the Executives (nominated by the Directors or Directors General) and, during construction, the ALMA Project Scientist. The ADSC will steer the overall program and manage its delivery. The ADSC will advise the ALMA Director on the prioritization of projects and the implementation and execution of the overall program and projects within it. The ADSC will provide specific advice in three areas: Progress towards the delivery of development

projects already approved (short-range view – implementation); proposals for new development projects (mid-range view); and the status of identification of ideas for possible projects and related research and/or feasibility studies (long-range view).

The establishment of the ADSC will also help to achieve a balance across the entire program and will identify complementarity between individual proposals for ALMA development projects, and the set of projects undertaken by each of the Executives[1].

Directors Council: The commitment of the relevant Executive to proposed development projects will be determined by the relevant Director or Director General, and discussed by the Directors Council. Concurrence of the Directors Council with the proposed program will be required before submission to the ALMA Board.

ALMA Board: The ALMA Development Program with its projects and suggested prioritization, will require approval by the ALMA Board.

ASAC: The ASAC provides scientific advice to the ALMA Board and ALMA Director. It is proposed that ASAC's Terms of Reference will include the provision of scientific advice related to the ALMA Development Program, and that ASAC's membership will explicitly include scientists with expert knowledge of the engineering and technical areas of relevance to ALMA. The prospective projects and priorities for the ALMA Development Program from the regional science advisory committees (ESAC, ANASAC, EASAC) will be made available to the ASAC which will provide a synthesis of that input in its advice to the ALMA Board and ALMA Director.

Integrated Engineering Team (IET): The IPTs responsible for the hardware deliverables during construction will morph into the Integrated Engineering Team as ALMA moves into operation. The IET will function in a way analogous to the functioning of the IPTs in construction, with the details to be spelled out in the ALMA Operations Plan. The IET will coordinate the engineering effort in Chile with the offsite technical support and development provided or organized by each Executive. It will be led by the JAO Head of the Department of Engineering and include the ALMA Technical/Engineering Leads from each Executive. The IET will draw on other specific expertise from within the JAO and the Executives, and externally, as required. The IET will provide recommendations on technical aspects of the ALMA Development Program and as such will make "technology readiness assessments" for each of the hardware proposals and will be responsible for reviewing the submitted cost estimates.

Integrated Computing Team (ICT): The Computing IPT relevant during construction will morph into the Integrated Computing Team as ALMA moves into operation. The ICT will function in a way analogous to the functioning of the IPTs in construction, with the details to be spelled out in the ALMA Operations Plan. The ICT will coordinate the computing and software effort in Chile with the offsite computing and software support and development provided or organized by each Executive. It will be led by the JAO Head of Computing and will include the ALMA Computing leads from each Executive. The ICT will draw on other specific expertise from within the JAO and the Executives, and externally, as required. As the construction computing effort transitions to operations, ALMA software will still be a developing system. It is imperative that this effort remains well coordinated. A transparent process for the submission, discussion and approval of the program will be implemented for computing development, analogous to that for hardware development. One source of input to this process is expected to be requests by the Integrated SciOps Team for computing improvements. The ICT will coordinate upgrades in operating systems or software version so that the JAO and ARCs do not diverge. Funds have been

[1] Detailed Terms of Reference and Operating Principles for the ADSC will be developed, see Section 9.

identified within the ALMA operations budget for ongoing software maintenance and it is expected that computing and software development will be funded from this source before being considered for funding as part of the Development Program.

2. Defining the program: scope, contribution and share

The key principle is that the ALMA Development Program must be driven by science – its purpose is to enhance the scientific capability and or impact of ALMA, within the bounds imposed by the availability of resources both for the development projects and for the ongoing operation of the observatory. It is also important that there is a single, coherent Program comprising a set of projects that are agreed to by the JAO and by all three Executives (and not three independent regional ALMA Development Programs). It is imperative that the Program involves the scientific and technical communities, and industries, of the partner regions, and competitive proposals for development projects will be welcomed.

Scope of ALMA Development Program

The ALMA Development Program will focus on the delivery of tangible improvements to the Observatory, but may also be used to fund the ALMA-targeted enabling research and development that may lead to such improvements, consistent with the scientific priorities identified.

The current anticipated funding for the ALMA Development Program is $15M/year. This is likely to be the principal source of funds for all ALMA-related development, and for research aimed at enabling ALMA development projects.

It is expected that the timescale for completion of ALMA development projects will be 3-5 years (or less) and therefore that the typical cost of a development project undertaken by a single Executive will not exceed $15M. However, collaborations within each region and across the ALMA regions should be encouraged. Larger projects may be undertaken, especially if they involve contributions from more than one Executive.

Contributions to the Development Program from parties other than the Executives may be considered as a means of bringing further resources to the observatory.

Development projects could be:

- Complete new additions to the Array;
- Extension of existing capabilities with more sensitivity, wider bandwidth, improved image quality, better dynamic range, …
- Improvements to existing systems (in hard- or software) resulting in enhanced availability and ability to optimize the data handling and analysis tools for maximum extraction of scientific information from ALMA;
- Improved infrastructure that reduces risks, increases availability, makes operation easier/less expensive.

In order to ensure a transparent and well-controlled software development program, the process for defining and implementing software developments will be analogous to that for hardware development. In particular, software development projects will be overseen by the ADSC in the same way as hardware development projects.

Contributions and Shares

Each Executive will contribute to the ALMA Development Program according to its share in the funding of ALMA operations (baseline) with, in principle, no transfer of funds.

Contributions will be based on their cost, as agreed by the ADSC and approved by the Board. The relative expenditure over time by each Executive will be consistent with the agreed partner shares, but may depart from these shares on timescales shorter than 5 years. The enhancements to ALMA resulting from each development project will be part of the Joint ALMA Observatory and as such will become available to all ALMA users.

Budgets for development projects and expenditure on projects will be approved by the ALMA Board based on submissions from the ALMA Director, which in turn will be based upon recommendation from the ADSC. The budget shall correspond to the agreed expected cost at the time of approval of the project. Costs will be determined by competitive proposals where possible, detailed cost review, and/or analogy to previous experience such as ALMA construction.

The ADSC will coordinate development activities across the JAO and the Executives, but the development effort at each Executive will be led separately. Accordingly, each Executive will be free to spend money in their own region according to their own culture, to apply their own contract and procurement and oversight practices, and to manage expenditure as required by their own rules.

Regional shares may include contributions from participation by institutions within each region. In such instances the responsible Executive may consider offering "Guaranteed Time" to the institutions contributing to the project. Such Guaranteed Time will be counted as part of that region's share of observing time, i.e. within the relevant regional share of 33.75% : 33.75% : 22.5% : 10% for EU, NA, EA, and Chile, respectively. Any such arrangement would require concurrence of the ALMA Board.

Proposals for additional external development contributions, beyond what is required as a baseline from each Executive as determined by their partnership share, must comply with the same principles and procedures for the baseline Development Program and thus will require approval from the Board. Such extra contributions must be proposed by one or more of the Executives. It is not anticipated that such proposals will change the shares of the partners nor is there any expectation that such proposals would provide a mechanism for new partners to join ALMA.

In the event that such a proposal requests "Guaranteed Time" in return for the external contributions, that consideration will itself require explicit approval by the Board. Projects of this type must represent improvements to the overall capabilities of ALMA, beyond those funded by the Executives under existing agreements, to the benefit of all ALMA users. In such a circumstance it is expected that Guaranteed Time, if any, will be taken off the top of the total available ALMA observing time before the regional shares are calculated.

Observing proposals associated with the use of Guaranteed Time (if any) must comply with the principles of ALMA's proposal review process (APRP), and will only be scheduled if they meet the same scientific and technical thresholds required of all other ALMA proposals.

Implementation of Guaranteed Time observations, if any, will be the responsibility of the ALMA Director. It is expected that Guaranteed Time will not exceed 10% of the total array time available for science in any schedule cycle.

Timescale

The Development Program should follow a plan with a timescale of the order of five years, with an additional five-year forward look. Mid-term reviews of the program as a whole will be implemented to assess and recommend updates and adjustments to the Program. Open and transparent reviews will be called by the ALMA Director and conducted by a small external panel, appointed by the ADSC. The

ALMA Director will present conclusions from each mid-term review to ASAC, and then to the Board together with recommendations for actions.

Contributions from the ALMA Executives will be expected to match (or exceed) the agreed development expenditure when smoothed over a five-year timescale. In the event that it falls below this level by more than 20% the relevant Executive will be expected to take on additional development projects and make up the shortfall within 24 months. The implementation details will be described in the Operational Arrangements for the ADSC which will accompany the Terms of Reference, and this threshold and timescale may be revised based on experience by mutual agreement between the Executives and the JAO. The additional development projects will be decided following the same process as the overall development program.

Development Studies

The ALMA Operations Plan provides funding for targeted exploratory research or feasibility studies aimed at facilitating or assessing the viability of possible development projects, including assessments of opportunities for collaboration. This Hardware Small Projects and Upgrades (OFF-003) budget line is equivalent to approximately 10% of the fund available for the ALMA Development Program. The ADSC will coordinate calls for proposals for such studies to be issued every 2-3 years by the Executives.

3. Governance

The Development Program will be proposed by the ALMA Director to the Board based on recommendations from the ADSC resulting from input developed via regional discussions overseen by the Executives. Project proposals will be presented by the Executives to the ADSC. The ADSC's recommendations to the ALMA Director on the program will include the prioritization of projects, taking into account advice from ASAC. In making their proposals the Executives shall take into account recommendations for development projects from the JAO. The ALMA Director will submit the program proposal with suggested prioritization to the Directors Council for concurrence and to the ALMA Board for approval.

The Executives, in possible collaboration with other institutes they may choose, oversee or carry out development projects within their respective regions, for both hardware and software enhancement of ALMA.

The ALMA Director, acting on the recommendation of the chair of an Acceptance Review Committee, will be the acceptance authority for completed development projects.

To implement:

- Each Executive, having task and delivery responsibility, will assign a project manager who will report to that Executive regarding matters of cost, progress, schedule, and compliance with specifications;
- Management of development projects (or work packages) at each Executive will be paid for from that Executive's development funds;
- The cost of commissioning each development project (or workpackage) shall be met from within the relevant Executives' development funds.
- Cost and schedule control and corrective actions relating to individual projects (or work packages) will be the responsibility of the individual Executives;
- The ADSC will oversee the implementation of the overall program and the projects within it;
- The project managers responsible for the individual development projects within the Executives will report to the ADSC regarding technical scope, compliance with scientific requirements and status of budget and schedule;
- To carry out oversight on behalf of the partnership (technical scope and schedule) the ALMA Director will assign an ALMA Development Program Manager, who will work with the Executives'

project managers to ensure compliance with the ALMA construction and safety standards, interfaces and scientific objectives and also to coordinate implementation in the array (through the ALMA Departments of Engineering, Computing and Science Operations);
- The cost of management and coordination of the Development Program within the JAO will be met from within the JAO operations budget;
- The ALMA Development Program Manager will act as Executive Secretary to the ADSC;
- In the event of major cost overruns, schedule delays, or inability to meet specifications, the ALMA Director may propose termination of a development project to the Board on advice from the ADSC;
- In the event that the ALMA Director recommends that the Board should terminate a project, the Directors Council will provide a recommendation to the Board regarding the accounting of the expended funds against the regional shares of the development program funding;
- Multi-Executive Development projects will be led by a single Executive.

4. Consultation with the Community, Committees and Executives

In order to match the challenges and expectations of the global astronomical community over ALMA's lifetime it is important to have a straightforward and transparent consultation process with sufficient flexibility to react rapidly to discoveries and emerging new fields in astronomy and engineering.

An important starting point in the process comes from the scientific priorities set by the ASAC as requested by the Board. For this we expect the most challenging input of opportunities to be supported through the Development Program to come through the regional Science Advisory Committees for discussion and prioritization by the ASAC, which would provide the international overall prioritization from the scientific perspective.

The JAO will trigger a synchronized "call for development project proposals" by the Executives, on a cycle that is expected to repeat every 2-3 years. The JAO will host an ALMA Development Coordination Workshop including input from the Directors Council, other members of the Executives, and ASAC on this regular cycle, synchronised with a series of Regional ALMA Development Workshops hosted by the Executives and aimed at the regional scientific and technical communities.

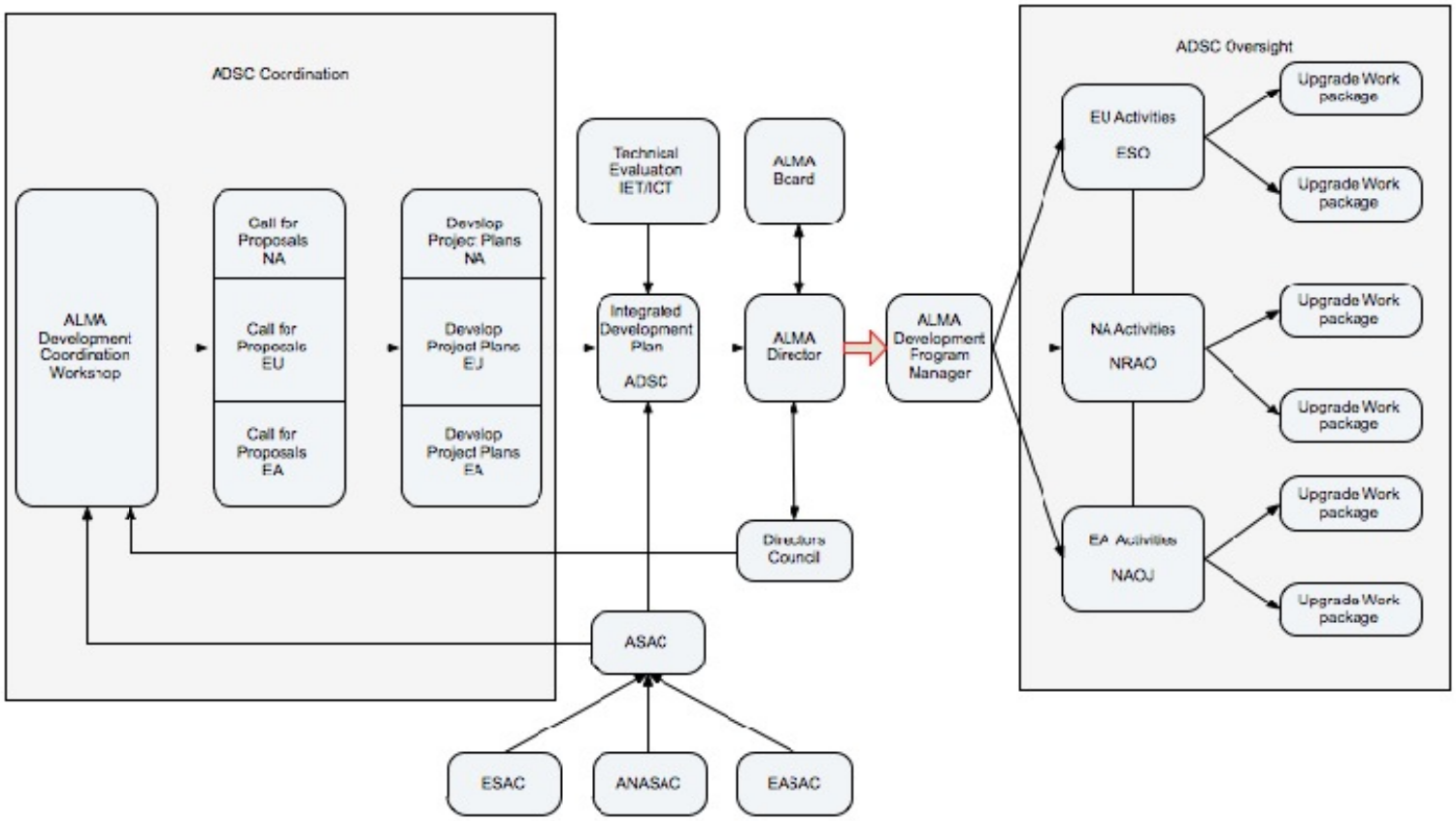
Coordinated regional calls aimed at identifying possible research and/or development studies to feed into the development program will also be issued by the Executives.

The ALMA Integrated Engineering Team and Integrated Computing Team will each take a special role in the Development Program. They will assess the technology readiness of all proposed projects, provide an independent review of the cost and resource requirements, and scope the effort required for integration of the proposed upgrade into the system and implications for ongoing operational resourcing. These teams may also provide suggestions of possible development projects to the Executives.

The involvement of the Executives and the regional communities in the definition of the program will occur through:
- Membership of the ADSC;
- Community-based discussions and proposals for new ALMA development items;
- The regional science advisory committees that feed into the ASAC;
- Proposals for development projects and design or feasibility studies;
- The IET and ICT that make the technology assessments and feasibility studies.

5. Workflow

An outline of the expected workflow of the ALMA Development Program is provided in the schematic below.


ADSC Coordination
ALMA Development Coordination Workshop
Call for Proposals NA
Call for Proposals EU
Call for Proposals EA
Develop Projec Plans NA
Develop Project Plans EU
Develop Project Plans EA
Technical Evaluaton IET/ICT
Integrated Development Plan ADSC
ALMA Board
ALMA Director
Directors Council
ASAC
ESAC
ANASAC
EASAC
ALMA Development Program Manager
ADSC Oversight
EU Activities ESO
NA Activities NRAO
EA Activities NAOJ
Upgrade Work package
Upgrade Work package
Upgrade Work package
Upgrade Work package
Upgrade Work package
Upgrade Work package

6. Ownership and maintenance

The same principles of ownership, warranty, and maintenance responsibility will apply to the deliverables resulting from the ALMA Development Program as apply to those resulting from the construction project. The deliverables shall remain the property of the delivering Executive.

7. Requirements on proposals for ALMA development projects

All proposals for possible development projects should comply with, and address, the following requirements:

1. In general, proposed projects should not increase the operations cost. However, each project will be evaluated on its own scientific merit, and operations costs will be considered in the prioritization of potential development projects.
2. Each proposed project must address the impact it will have on the scientific capability and or operational performance of the array.
3. Each project proposal must have a plan that addresses the following items, in addition to its science objectives:
    a. Cost (including AIV, commissioning and science verification)
    b. Schedule
    c. Safety plan
    d. PA/QA plan
    e. Software development plan
    f. Integration plan addressing also AIV, commissioning and science verification.
    g. Draft operation manual
    h. Maintenance plan

8. Chilean participation

At the time of writing the role of Chile in the ALMA Development Program, if any, is unclear. It is possible that the ALMA Conicyt Fund could support ALMA Development projects, and there may also be the possibility that funds from Chilean sources could be made available.

9. Next steps

At the ALMA Board face-to-face meeting in San Pedro de Atacama on 6-7 April 2011, the Board indicated that it hoped to be in a position to approve the ALMA Development Principles (this document) at its 23 June telecon, and the following next steps were approved.

1. The three Executives are asked to provide a status report to the ALMA Director for submission to the Board, on the initiatives being undertaken in their respective regions. (These reports are planned to go together with this principles document to the Board telecon on June 23.)
2. ASAC will be asked to:
    a. Comment on the ALMA Development Principles as input for a possible future revision – this is included in the ASAC charges for its face-to-face meeting in Charlottesville on October 5-6, 2011.
    b. Update its report from 2008‑09 on development priorities for ALMA.
3. The ALMA Deputy Director is asked to draft the Terms of Reference for the ADSC.
4. When established, the ADSC will be tasked with developing a straw-person plan for the implementation of an integrated ALMA Development Program, for consideration by the Executives and the Board.

Annex 1

Guaranteed Time Observations (GTO) @ ESO

This note briefly describes the concept of Guaranteed Time Observations (GTO) used at ESO's optical/infrared observatories. ESO uses two models of instrument procurements for the La Silla and Paranal telescopes: (1) Led by an external consortium, and (2) led by ESO. "External" in this context means "external institutes to ESO". This can be institutes/universities within or outside the ESO member states. Both models have proven very successful. Most of the instruments at La Silla/Paranal have been built following model 1 where ESO acts as a customer. In this model, ESO provides capital costs while the external consortium provides the staff effort from their own funding. This latter part – the provided staff effort – is compensated with GTO following established rules. The GTO return is assigned as nights of observing time at a particular telescope, and the amount of nights is calculated from the "agreed value per telescope night". As an example, the consortia of the following instruments received GTO at a single Paranal telescope (UT): KMOS (250 UT nights), SPHERE (260 UT nights), MUSE (225 UT nights). One night of UT time has been valued at 50 kEUR.

A few aspects of GTO return are worth mentioning:

- GTO return results in a strong motivation of the participating institutes
- The consortia develop strong science teams which push the instrument teams for performance
- GTO is used well and often results in high-impact papers
- The provided instruments are operated by ESO (they are not PI instruments) and are available to the whole ESO community. They are built according to strict interface specifications and engineering practices established by ESO.
- GTO can be seen as "return to an experimental physics model" where an instrument is built for a certain type of observation.

For the E-ELT, the number of nights compensating community effort will be calculated taking into account the capital value of the E-ELT amortised over 30 years, its annual operating cost, the statistical fraction of time expected to be lost due to technical and weather downtime, and the average cost of community FTEs. There will be a limit of 15% on the maximum number of scheduled GTO nights per year.

GTO may be interesting for ALMA since it could open additional funding channels for ALMA development and get the best consortia involved providing the staff effort in-kind (compensated by GTO).