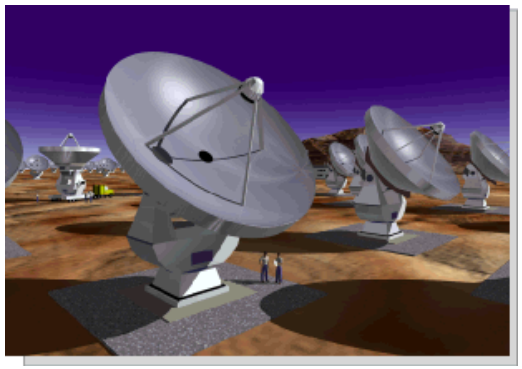


Atacama
Large
Millimeter
Array

System Engineering

Presented by: Christoph Haupt (SE & I IPT Deputy)
Jaap Baars (Antenna Evaluation Group)

ESO-Wide Review
13-17 February 2003

ALMA Project

ALMA: System Requirements

Requirement	Value
Observing Frequency Ranges	31.3 GHz and 950 GHz
Number of bands	10 Band 3, 6, 7, 9
Total collecting area	> 7000 m^2
Total number of antennas	64
Absolute pointing accuracy	< 2arcsec
IF Bandwidth (3dB)	> 8GHz
Number of simultaneously observed polarisation states	2
Phase stability	300 femtosec
Amplitude stability	10^{-4} for 1 sec, single dish
Number of antenna pads	250
Solar Observation shall be possible	
VLBI shall be possible	
Lifetime	30y

ALMA Project

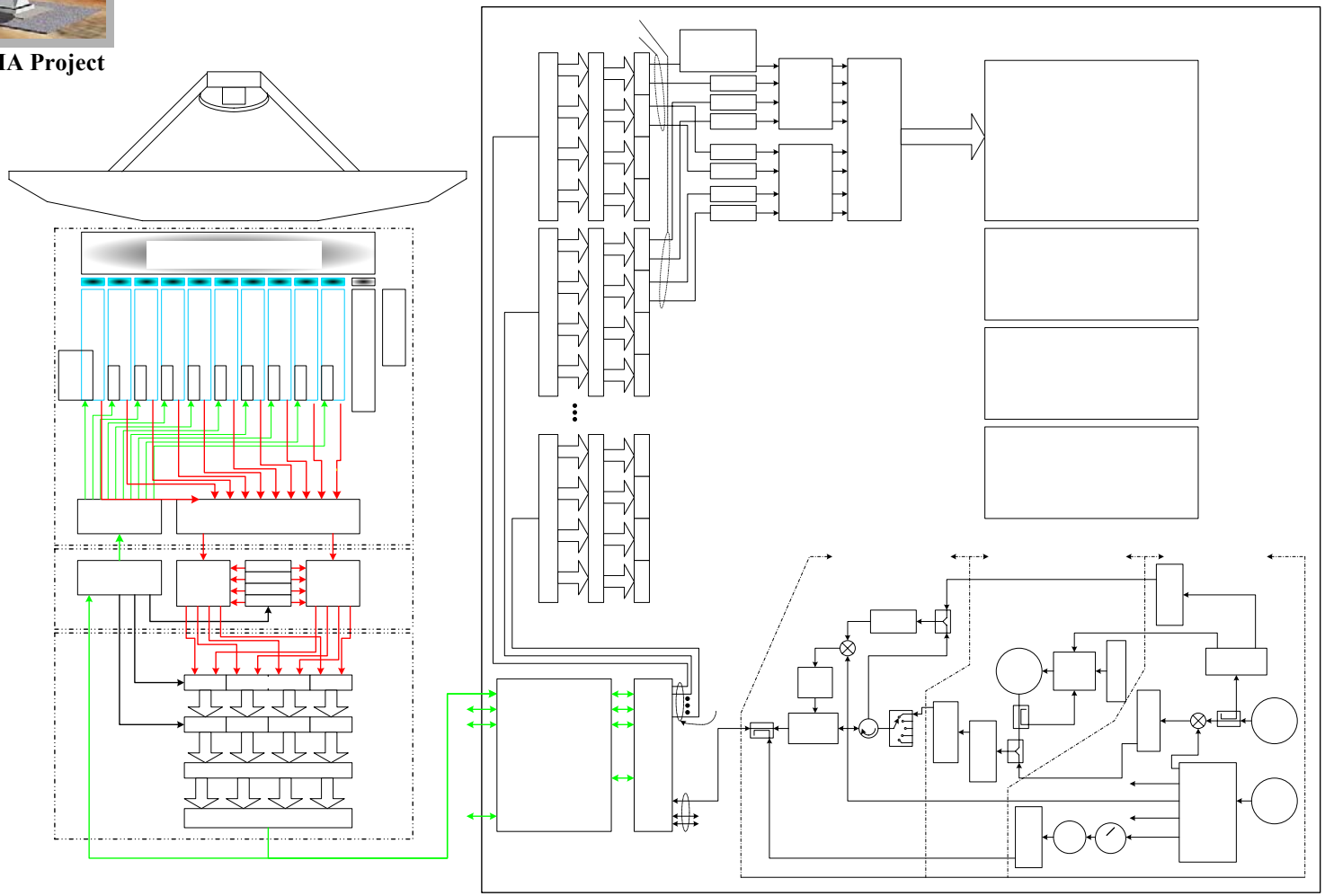
ALMA System Overview

Sub-Systems

- Site
- Antenna
- Front End
- Back End
- Correlator
- Computing

ALMA Project

System Block Diagram



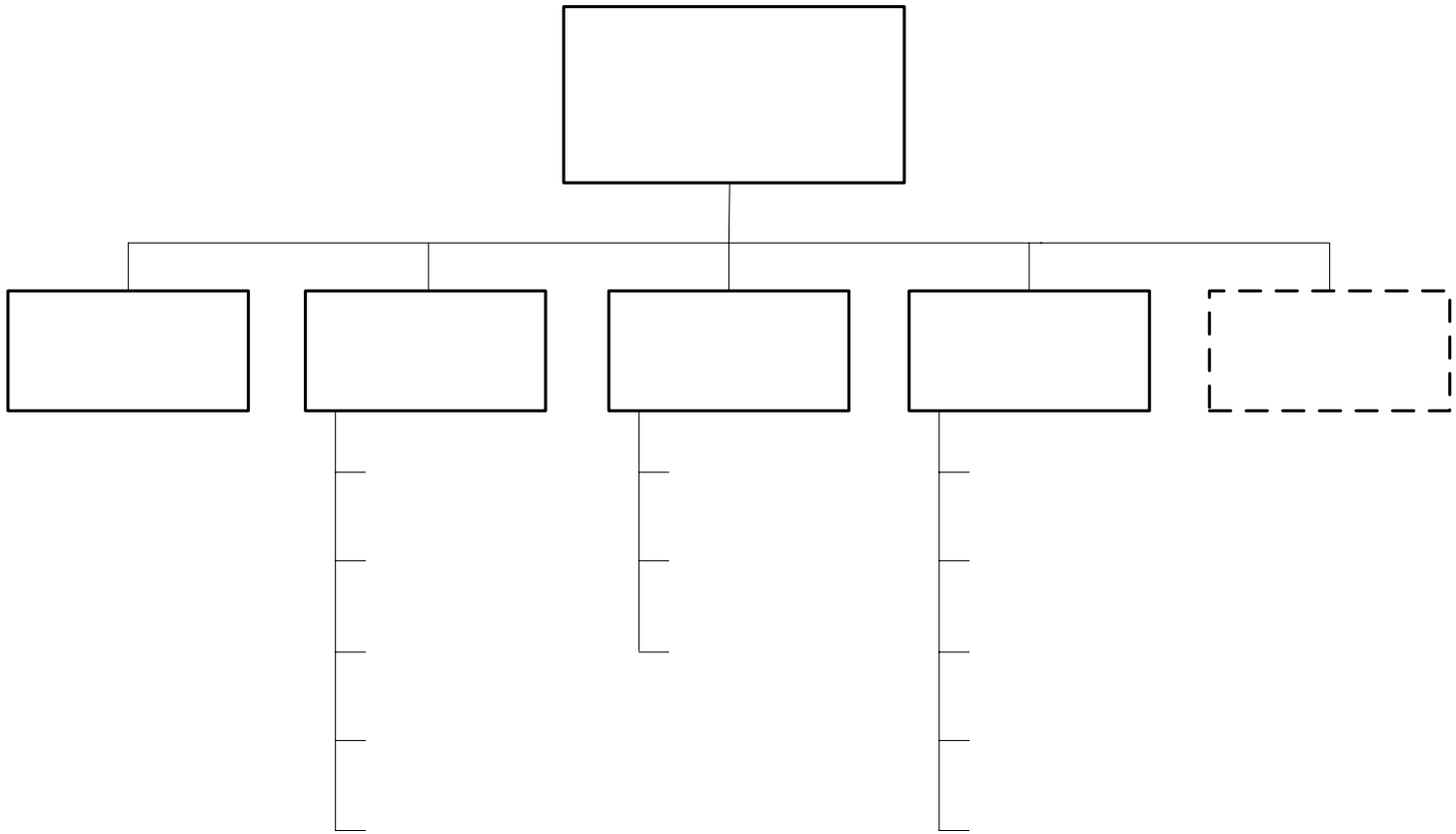
ALMA Project

System Engineering Challenges

- Project is distributed over three continents
- Harmonisation of the work approach
- Integration of 64 antennas in a hostile environment
- Ensure reliable operation for ALMA lifetime

ALMA Project

System Engineering Tasks



ALMA Project

Engineering: System Requirements and Standards

- System Requirement and Justification
- Engineering Specification
  - Electrical and Electronics Design
  - Mechanical and Thermal Design
  - Optical Design
  - Civil Engineering
- Environmental Specification

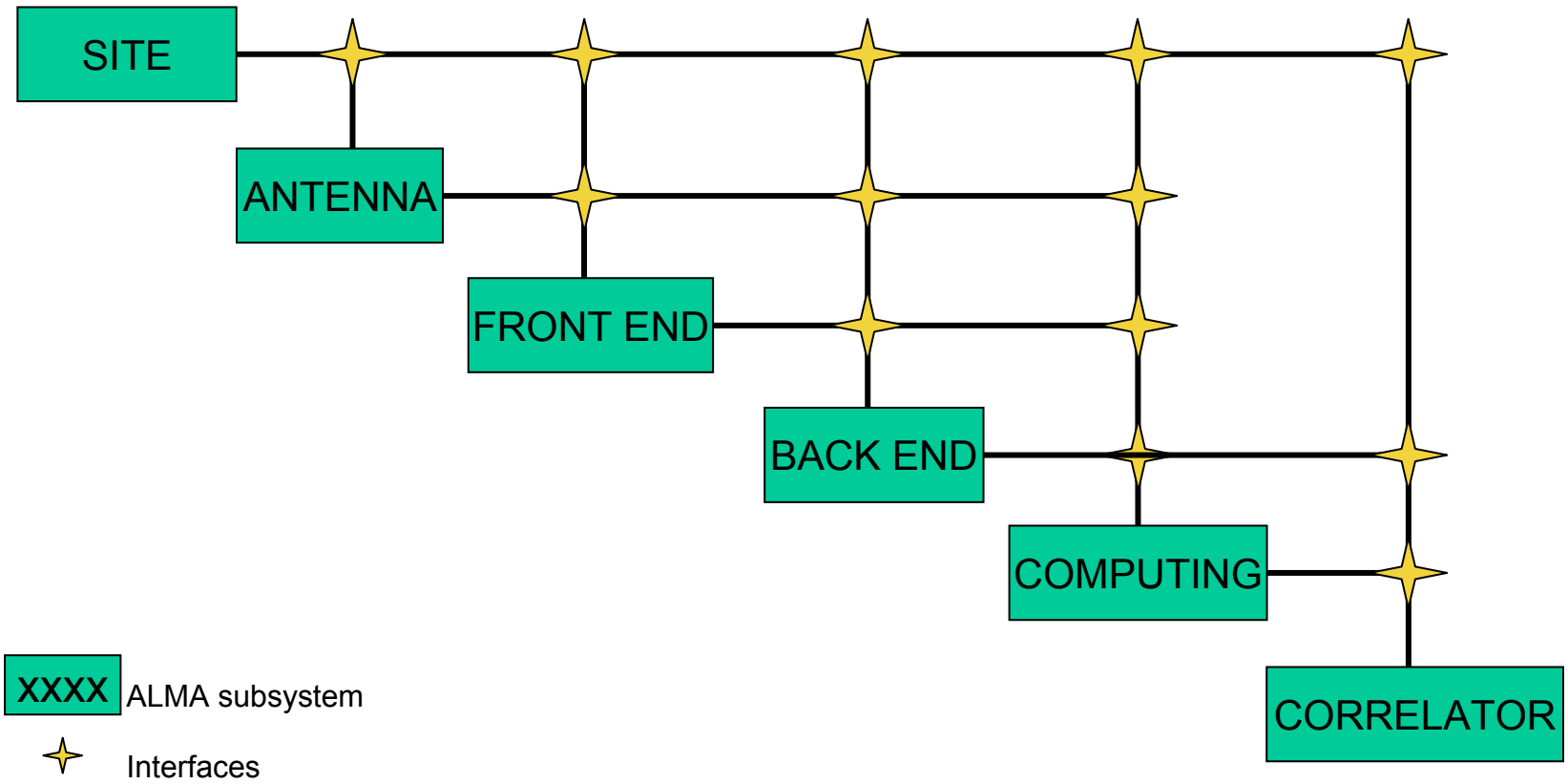

ALMA Project

Engineering: System Design and Analysis

- System Design
  (Preliminary System Design finalised, Detailed design ongoing)
- System Block Diagrams
  (System Block Diagrams available, continuous updates needed)
- Error Budget Allocation
  (Preliminary allocation available, final allocation ongoing)
- System Analysis
  (To be done)

ALMA Project

Interface Control



ALMA Project

System Integration and Test

- Prototype Antenna Evaluation
- ALMA System Integration planning
- ALMA System Maintenance planning
- Prototype System Integration and Test
- ALMA System Integration

ALMA Project

Product Assurance (PA)

- General Product Assurance
- Configuration Management
- Change Request Control, Request for Waiver

ALMA Project

Product Assurance

- Implementation and control the use of project wide requirements
- Reliability, Availability, Maintainability and product life time analysis and planning
- Establishment and maintenance of parts lists
- Participation in review meetings, AI lists, MoM
- Risk Analysis and planning

ALMA Project

PA Configuration Control

- Document management system established
- Product Tree
- Configuration Item Data List

ALMA Project

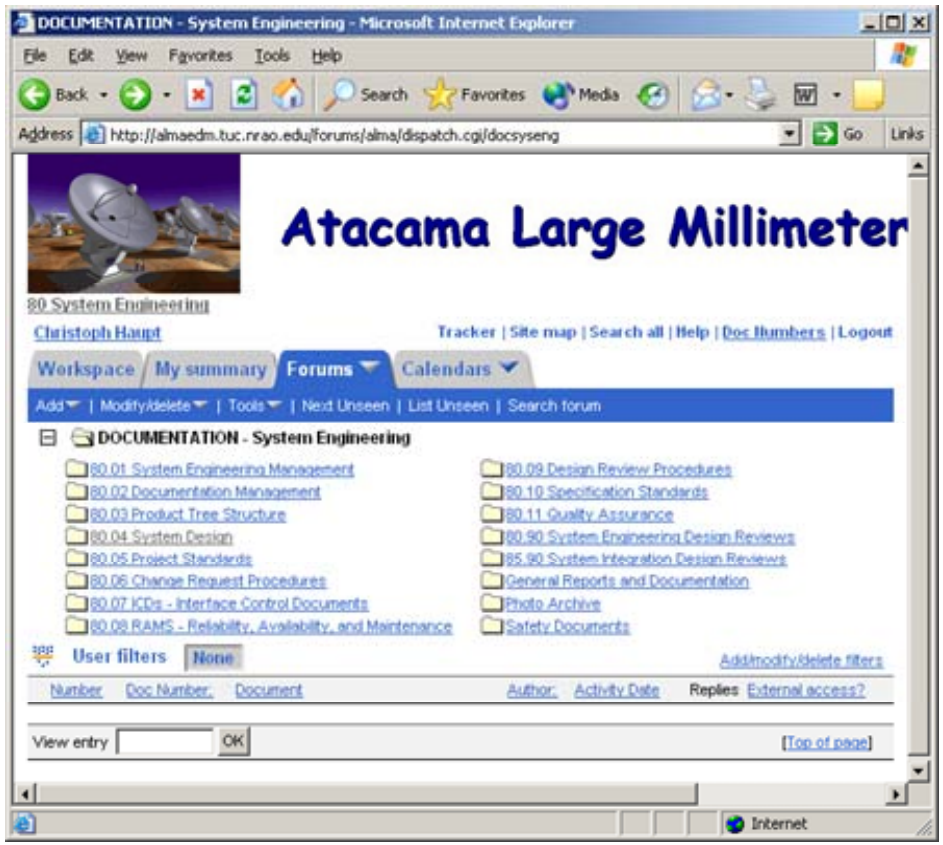
PA Document Management

Achieved

- Document management system established
- Product Tree

To be done

- Extend system from document to configura-tion management



ALMA Project

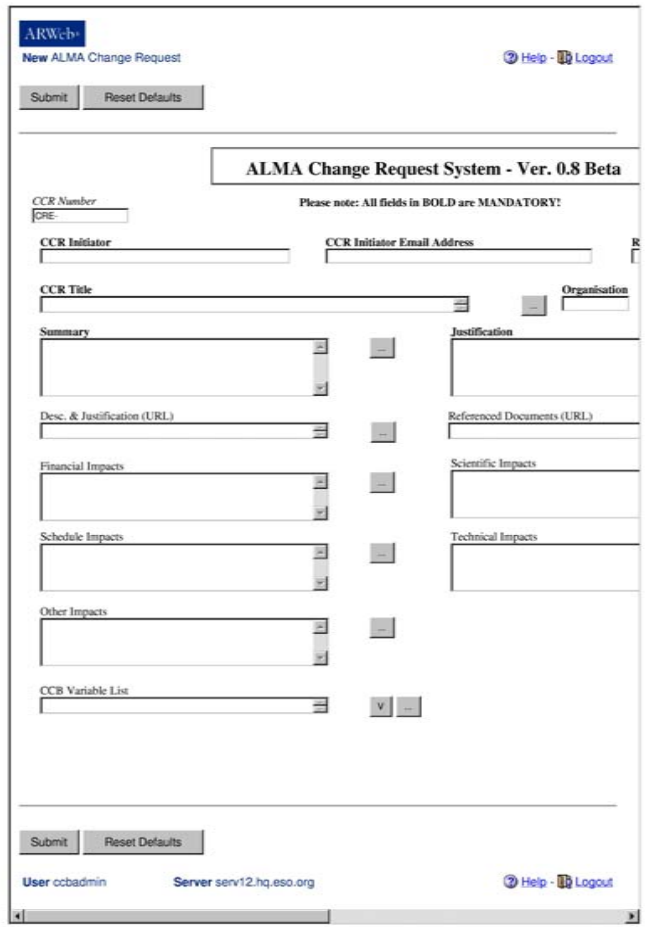
PA Change Request System

Achieved

- Change Request system established

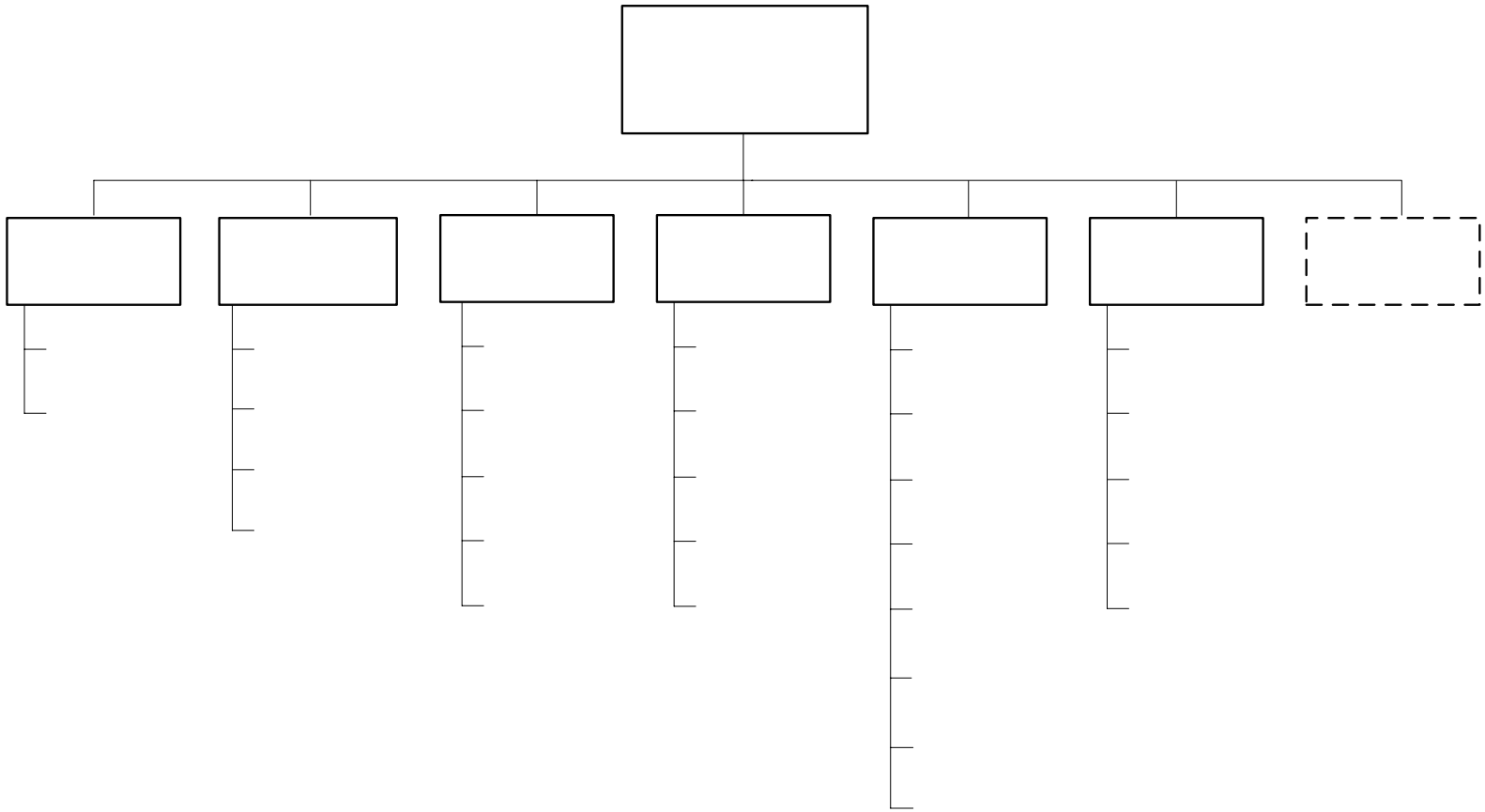
To be done

- Ensure that CR is implemented and used



ALMA Project

System Engineering Organisation



ALMA Project

System Engineering Achievements

- Establishment of web-based documentation system (ALMA EDM)
- SE organisation set-up started
- Antenna Evaluation Group set-up
- Preparation of Top Level SE Documentation started

ALMA Project

SE Major Milestones

Top level SE documentation submitted for approval, terminated by System Reviews: – Requirement specification – Engineering specifications (electrical, mechanical, EMC / RFI) – Environmental specifications – System design description – Product assurance plan – Product assurance requirements for sub-contractors – System engineering management plan – Reliability, Maintainability, Availability documents – Sub system ICDs available – System block diagrams	End of 2003

ALMA Project

SE Major Milestones 2003 and 2004

- Prototype system integration plan and test plan
- ALMA system integration plan
- All hardware for prototype system delivered and accepted
- Antenna Evaluation Group hands over prototype antenna to System Engineering
- ALMA prototype electronics and software installed on prototype system at antenna test facility ATF
- First Fringes at prototype system at ATF

ALMA Project

Antenna Evaluation

ALMA Project

Antenna Evaluation Group: Tasks

- Measurement devices installation
- Holography and surface setting
- Optical pointing / tracking
- Evaluation receiver installation & test
- Radiometric testing
- Monitoring and diagnostics

$\Rightarrow$ Antenna final joint evaluation end of 2003

ALMA Project

Vertex Antenna

QuickTime™ and a
Photo - JPEG decompressor
are needed to see this picture.

ALMA Project