Budget, Schedule, Contingency

Mark McKinnon
Project Manager
Outline

• Schedule
• Milestones
• Budget
• Contingency
• Project Risks
• Risk Analysis
• Descope Options
• Definitions of terms used in plots and tables
  – Percent Spent: comparison between the money actually spent on a task and the value assigned to it in the original project plan
  – Percent Complete: comparison between the value of the work completed on a task to its total value in the original project plan
Completion Status of Budget and Schedule - 2

Budget Plan vs Actual

- Original 11 Yr NSF Budget
- Current NSF budget
- % Spent
- % Compl
Milestone Completion

EVLA PROJECT MILESTONE SUMMARY

Milestone Completion

Mark McKinnon
NSF Mid-Project Review
May 11-12, 2006
WBS Level 2 Completion Status - 1

- Project Management: 52.1% spent, 45.8% complete
- Systems Integration: 76.1% spent, 70.1% complete
  - Overspent in parts for bins and modules
- Civil Construction: 87.8% spent, 80.5% complete
  - Advance purchase of materials
- Antennas: 69.1% spent, 59.2% complete
  - Advance purchase of materials
- Front End Systems: 55.1% spent, 43.4% complete
  - Delay in receiver production
WBS Level 2
Completion Status - 2

- LO Systems: 75.5% spent, 75.1% complete
- Fiber Optics Systems: 64.4% spent, 58.8% complete
- IF Systems: 61.5% spent, 52.7% complete
- M&C System: 57.6% spent, 51.1% complete
  - Contingency applied to address overrun in contributed effort
- Data Management & Computing: 51.2% spent, 40.0% complete
  - Contingency applied to address overrun in contributed effort and to provide additional e2e staff
  - Staff needed to make progress
### Completed Milestones

- **Examples (see list in information packet):**
  - Install prototype system on test antenna  
    Date: Q2 2003
  - Start production assembly of antenna fiber  
    Date: Q2 2004
  - Start production of LO/IF outfitting  
    Date: Q2 2004
  - Start production of module interface board (MIB)  
    Date: Q3 2004
  - Start production of L-band feed horns  
    Date: Q4 2004
  - Routine test observing software available  
    Date: Q1 2005
  - Install 4P converter (T301) in test antenna  
    Date: Q3 2005
  - Start production of K-band receiver upgrade  
    Date: Q3 2005
  - Deliver EVLA antenna 14 to operations  
    Date: Q4 2005
  - Start installation of shielded room  
    Date: Q4 2005
Remaining Milestones

- Examples:                          Date
  - DCAF software ready for testing  Q2 2006
  - Test prototype of S-band feed horn Q3 2006
  - Deliver 7 antennas to operations  Q4 2006
  - Complete installation of shielded room Q4 2006
  - Start production of L-band receiver Q4 2006
  - Complete delivery of UX converters (T303) Q4 2006
  - Start production of 3-bit, 4Gbps digitizer Q2 2007
  - Test prototype correlator on 4 EVLA antennas Q3 2007
  - Complete round trip phase module (L352) Q4 2007
  - M&C system ready for archive Q2 2009
Critical Path Tasks

- Examples:
  - TelCal software ready for testing  Q2 2006
  - Complete prototype of L-band receiver  Q3 2006
  - Conduct critical design review of M&C system  Q4 2006
Maintaining Schedule -1

- To maintain project schedule, we need to accelerate retrofits from the planned rate of 5 antennas per year to 5.5.
- Can we accelerate the antenna retrofit rate?
  - Retrofits are becoming an assembly line
    - Major components stockpiled (e.g. cryo compressors, HVAC units, L-band feed horns, antenna platforms)
    - Most electronics designs are mature
  - Staff continues to become more efficient in antenna retrofits
  - VLA antennas have been adequately maintained. Their reliability is excellent.
Antenna Retrofit
Sequence: Current

Up until now, we have been pursuing the mechanical and electrical outfitting of EVLA antennas serially, with testing proceeding in parallel.

<table>
<thead>
<tr>
<th>Mechanical, antenna 1</th>
<th>Electrical, antenna 1</th>
<th>Mechanical, antenna 2</th>
<th>Electrical, antenna 2</th>
<th>Mechanical, antenna 3</th>
<th>Electrical, antenna 3</th>
<th>Mechanical, antenna 4</th>
<th>Electrical, antenna 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Testing, antenna 1</td>
<td>Testing, antenna 2</td>
<td>Testing, antenna 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Antenna Retrofit Sequence: Future

In full production, mechanical outfitting of antennas can proceed in parallel with both electrical outfitting and testing.

<table>
<thead>
<tr>
<th>Mechanical, antenna 1</th>
<th>Mechanical, antenna 2</th>
<th>Mechanical, antenna 3</th>
<th>Mechanical, antenna 4</th>
<th>Mechanical, antenna 5</th>
<th>Mechanical, antenna 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical, antenna 1</td>
<td>Testing, antenna 1</td>
<td>Electrical, antenna 2</td>
<td>Testing, antenna 2</td>
<td>Electrical, antenna 3</td>
<td>Testing, antenna 3</td>
</tr>
<tr>
<td>Electrical, antenna 3</td>
<td>Testing, antenna 4</td>
<td>Electrical, antenna 5</td>
<td>Testing, antenna 5</td>
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<td></td>
</tr>
</tbody>
</table>

Project Plan
Retrofit Duration

Duration of Antenna Retrofit

<table>
<thead>
<tr>
<th>Antenna</th>
<th>Operating Antenna (2 IFs)</th>
<th>Mechanical Conversion</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>6.5</td>
<td>6.5</td>
</tr>
<tr>
<td>14</td>
<td>0.5</td>
<td>5.0</td>
</tr>
<tr>
<td>16</td>
<td>0.5</td>
<td>2.5</td>
</tr>
<tr>
<td>18</td>
<td>0.5</td>
<td>2.5</td>
</tr>
<tr>
<td>24</td>
<td>0.5</td>
<td>2.5</td>
</tr>
<tr>
<td>26</td>
<td>0.5</td>
<td>2.5</td>
</tr>
</tbody>
</table>

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Maintaining Schedule-2

- Antenna rate of up to 6 per year is possible if:
  - Duration of mechanical overhaul is 2 months.
  - Duration of parallel activities for electrical outfitting and testing is 1 month each.
- … but need to monitor impact on reliability of VLA antennas. Possible issue for VLA users.
- Expect progress in software areas of the project because of additional e2 staffing resources and finalization of M&C design.
- Shift front end production emphasis to Ka-band while solving design issues with wideband OMT.
Budget

• Funding = $93.8M (FY06)
  – NSF project funds $58.7M
  – NRAO contributed effort $16.3M
  – Canadian partner $17.0M (C$20M)
  – Mexican partner $1.8M
Contingency

Detailed calculation of percent contingency depends upon whether or not project contingency is used to cover the cost to complete the correlator (corr.).

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Contingency, $</td>
<td>$2.8M</td>
<td>$2.8M</td>
</tr>
<tr>
<td>Cost to Complete</td>
<td>$32.1M</td>
<td>$44.8M</td>
</tr>
<tr>
<td>Contingency, %</td>
<td>8.7%</td>
<td>6.2%</td>
</tr>
</tbody>
</table>

Correlator project carries its own contingency
External Risk Factors

- NRAO operating budget
  - Project dependence upon contributed effort.
  - Ability of operations budget to absorb personnel (e.g. e2e and CASA) moving from project to operations. Ability to support science staff. Plan developed.
- Strength of Canadian dollar
- Correlator funding profile
- Commodity prices
  - Aluminum, steel
  - Gold plating
Retirement of Risk

- Bulk purchase of half transponders
- Bulk purchase of module interface boards
- M&C software support of transition mode observing, including successful implementation of reference pointing
- Eliminated spurious correlation with redesign of digitizer in DTS
- Solved timing problem between EVLA and VLA antennas
- Solved image rejection problem in 4P downconverter (T301) with new filter design
- Solved aliasing problem in baseband downconverter (T304) that limited sensitivity with new filter design
- Selected appropriate fire protection system for new correlator shielded room
# Project Risks

<table>
<thead>
<tr>
<th>Risk Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Failure to stay on manpower curve</td>
<td>$1.2M</td>
</tr>
<tr>
<td>Correlator peripherals</td>
<td>$0.8M</td>
</tr>
<tr>
<td>Contribute to EPO program</td>
<td>$0.5M</td>
</tr>
<tr>
<td>Improve RFI protection</td>
<td>$0.3M</td>
</tr>
<tr>
<td>Additional module parts</td>
<td>$0.3M</td>
</tr>
<tr>
<td>Additional feed costs (S, X, Ku)</td>
<td>$0.3M</td>
</tr>
<tr>
<td>Spare correlator boards</td>
<td>$0.2M</td>
</tr>
<tr>
<td>Improve phase stability &amp; RTP</td>
<td>$0.2M</td>
</tr>
<tr>
<td>Improve wideband OMT</td>
<td>$0.2M</td>
</tr>
<tr>
<td>Improve synthesizer (L302)</td>
<td>$0.1M</td>
</tr>
<tr>
<td>Correlator installation manpower</td>
<td>$0.1M</td>
</tr>
<tr>
<td>Redesign 3-bit, 4Gsp s samplers</td>
<td>$0.1M</td>
</tr>
<tr>
<td>IF retrofits</td>
<td>$0.1M</td>
</tr>
<tr>
<td>Feed demoisture system</td>
<td>$0.1M</td>
</tr>
</tbody>
</table>
Risk Analysis

- Sum total risk = $4.5M
- Root sum square risk = $1.7M
- Contingency = $2.8M. Comparable to value of a year ago.
- Conclusion:
  - Still possible that project can be completed within budget and nearly on schedule.
  - Contingency coverage of risk is marginal, but no urgency now to implement descope options.
- Goal for FY06 is to refine contingency and risk analysis at finer level of detail (i.e. increase contingency and more accurately assess risk).
Value of Possible Descope Options

- Eliminate receiver bands:
  - X (8-12 GHz) $1.0M 2009 (date to decide on descope)
  - Ku (12-15 GHz) $1.3M 2009
  - S (2-4 GHz) $1.4M 2007
  - Ka (26-40 GHz) $1.2M 2006

- Purchase receiver components, but assemble/install as part of operations. Labor savings to project are:
  - X $0.2M
  - Ku $0.2M
  - S $0.4M
  - Ka $0.2M

- Eliminate solar observing mode $0.2M
- Transfer project-funded e2e effort (6 FTE years) to operations budget $0.7M
Other Possible Descope Options

- Reduce number of antenna retrofits
- Shut down the VLA part of the array for some time period
- Halve the observing bandwidth