

TCS3 Project

Replacement of the Telescope Control System for the IRTF

Conceptual Design Review

Aug 2003

Aug 21, 2003

Review Topics

- 1. Schedule, Tasks, and Budget
- 2. System Overview
- 3. Computers, Servo Controller, and Servo Simulator
- 4. T3 Electronics
- 5. Encoder
- 6. MCC Replacement
- 7. Facility IO
- 8. Software
- 9. TCS1-TCS3 Switching
- 10. RemoteGUI
- 11. TCS1 Removal

Schedule

TCS3 Project Schedule				200	03										20	04					I						20	05				· · · ·
	Jan Feb	Mar Ap	or May	Jun	July Au	ug Sej	pOct	Nov	Dec	Jan F	-eb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov Dec
Originial Schedule							· ·	Year 1	1											Yea	r 2						Yea	r 3 (5 mo	nths)		
Prelimiary Design (2 months)																																
Procurement (4 months)																																
Development and Testing (10 months)																																
Observatory Preparation (3 months)																																
Installation at observatory (3 months)																																
Testing and Engineering runs (3 months)																																
Operational shakedown (6 months)																																
Task Milestones																																
0. Project Overview - May 22, 2003																																
1. Conceptual Design - Aug, 2003																																
2. Build TCS3 Computer, controller, t3																																
electronics, servo simulator																																
3. Encoder Replacement																																
Install MCC replacement at summit.																																
5. Prototype & Build TO Panel																																
6. TCS1-TCS3 switch (Drive RA, Dec, and																																
Dome, and Shutter)																																
7. RemoteGUI																																
8. Daytime Test & Servo Tuning																																
9. Night Engineering (Pointing Run)																																
10. Remove TCS1												_																				

The original TCS3 Schedule given in the NASA proposal The New Task oriented T3 Schedule.

Tasks

- 2. Build TCS3 Computer, Servo Controller, and T3 Electronics, Servo Simulator
- 3. Encoder Replacement
- 4. Install MCC Replacement at Summit
- 5. Prototype and Build TO Panel
- 6. TCS1-TCS3 Switch (or Drive the RA, Dec, Dome and Shutter)
- 7. RemoteGUI
- 8. Daytime Test & Servo Tuning
- 9. Night Engineering (Pointing Run)
- 10. Remove TCS1

Task 2 – Build T3 Computer, Servo Controller, and Servo Simulator

TCS3 Project Schedule						20	03											20	04											20	05					
	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Originial Schedule										Y	'ear	1											Yea	r 2						Year	3 (5	5 moi	nths)			
0. Project Overview - May 22, 2003																																				
1. Conceptual Design - Aug, 2003																																				
2. Build TCS3 Computer, controller, t3																																				
electronics, servo simulator																																				
3. Encoder Replacement																																				
4. Install MCC replacement at summit.																																				
5. Prototype & Build TO Panel																																				
6. TCS1-TCS3 switch (Drive RA, Dec, and																																				
Dome, and Shutter)																																				
7. RemoteGUI																																				
8. Daytime Test & Servo Tuning																																				
9. Night Engineering (Pointing Run)																																				
10. Remove TCS1																																				

- Purchase computer, servo controller.
- Purchase T3 Equipment Rack
- Design and Build T3 Electronics
- Build servo simulator
- Develop TO Panel Prototype
- Control HA, Dec simulator using the computer, controller, and T3 Electronics.

Aug 21, 2003

Task3 – Encoder Replacement

TCS3 Project Schedule		0				200)3											20)04				• • •							20	05					
	Jan	Feb	Mar	\pr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Originial Schedule										١	/ear	1								-			Yea	ar 2						Yea	r 3 (!	5 mo	nths)		
0. Project Overview - May 22, 2003																																				
1. Conceptual Design - Aug, 2003																																				
2. Build TCS3 Computer, controller, t3																																				
electronics, servo simulator																																				
3. Encoder Replacement																																				
4. Install MCC replacement at summit.																																				
5. Prototype & Build TO Panel																																				
6. TCS1-TCS3 switch (Drive RA, Dec, and																																				
Dome, and Shutter)																																				
7. RemoteGUI																																				
8. Daytime Test & Servo Tuning																																				
9. Night Engineering (Pointing Run)																																				
10. Remove TCS1																																				

- Install new absolute Encoders
- Install new incremental Encoders
- Read current Dome Scanner
- Install T3 computer at the summit.
- Acquire encoder data into T3 computer.

Task 4 – Install MCC Replacement at Summit

TCS3 Project Schedule						200	03											20	04											20)5					
	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov [Dec	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Originial Schedule										Y	′ear [·]	1											Yea	r 2						Year	3 (5	mor	nths)			
0. Project Overview - May 22, 2003																																				
1. Conceptual Design - Aug, 2003																																				-
2. Build TCS3 Computer, controller, t3																																				1
electronics, servo simulator																																				1
3. Encoder Replacement																																				1
4. Install MCC replacement at summit.																																				1
5. Prototype & Build TO Panel																																				1
6. TCS1-TCS3 switch (Drive RA, Dec, and																																				1
Dome, and Shutter)																																				1
7. RemoteGUI																																				1
8. Daytime Test & Servo Tuning																																				1
9. Night Engineering (Pointing Run)																																				1
10. Remove TCS1																																				

- Prep TO area for new T3 Display and TO Panel
- Purchase Facility IO hardware
- Write Facility IO software.
- Install Facility IO at the summit.
- Develop MCC replacement GUI.
- Switch non-critical MCC function to TCS3

Task 5 – Prototype and Build TO Panel

TCS3 Project Schedule						20	003											20	004											20	005				
	Jan	Feb	Ма	r Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mai	r Apr	May	y Jun	July	Aug	Sep	Oct N	lov Dec
Originial Schedule											Year	1											Yea	ar 2						Yea	ır 3 (5 mo	nths)		
0. Project Overview - May 22, 2003																																			
1. Conceptual Design - Aug, 2003																																			
2. Build TCS3 Computer, controller, t3																																			
electronics, servo simulator																																			
3. Encoder Replacement																																			
4. Install MCC replacement at summit.																																			
5. Prototype & Build TO Panel																																			
6. TCS1-TCS3 switch (Drive RA, Dec, and																																			
Dome, and Shutter)																																			
7. RemoteGUI																																			
8. Daytime Test & Servo Tuning																																			
9. Night Engineering (Pointing Run)					1								1		1																				
10. Remove TCS1																																			

- Development of the TO Panel prototype is preliminary task.
- Construct 2 each TO Panels.
- Install TO Panel in lab and summit system.

Aug 21, 2003

Task 6 – TCS1/TCS3 switching

TCS3 Project Schedule				•		20	03											20	004											20	005				
	Jan	Feb	Ma	r Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov Dec
Originial Schedule										١	<i>rear</i>	1											Yea	ar 2						Yea	r 3 (5 mo	nths)	
0. Project Overview - May 22, 2003																																			
1. Conceptual Design - Aug, 2003																																			
2. Build TCS3 Computer, controller, t3																																			
electronics, servo simulator																																			
3. Encoder Replacement																																	\square		
4. Install MCC replacement at summit.																																	\square		
5. Prototype & Build TO Panel																																	\square		
6. TCS1-TCS3 switch (Drive RA, Dec, and																																	\square		
Dome, and Shutter)																																			
7. RemoteGUI																																	\square		
8. Daytime Test & Servo Tuning																																			
9. Night Engineering (Pointing Run)																																	\square		
10. Remove TCS1																																			

- Install tcs1/tcs3 switch over hardware.
- Develop switch over procedure
- Switch & Test Dome Control
- Switch & Test HA, Dec axis control.
- Install new Shutter JBOX and control using MCC replacements.

Aug 21, 2003

Task 7 – RemoteGUI

TCS3 Project Schedule						200	3		ò		•							20	04											200)5					
	Jan	Feb	Mar	Apr	May	Jun J	July A	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Originial Schedule										Y	ear	1											Yea	ar 2						Year	· 3 (5	mor	nths)			
0. Project Overview - May 22, 2003																																				
1. Conceptual Design - Aug, 2003																																				
2. Build TCS3 Computer, controller, t3																																				
electronics, servo simulator																																				
3. Encoder Replacement																																				
4. Install MCC replacement at summit.																																				
5. Prototype & Build TO Panel																																				
6. TCS1-TCS3 switch (Drive RA, Dec, and																																				
Dome, and Shutter)																																				
7. RemoteGUI																																				
8. Daytime Test & Servo Tuning																																				
9. Night Engineering (Pointing Run)																																				

- Purchase computers to run remoteGUI software
- Implement RemoteGUI software.

Task 8 – Daytime Tests

TCS3 Project Schedule						200)3											20	004											20	05					
	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Νον	Dec	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Νον	Dec	Jan	Feb	Mar	Apr	Ma	Jun	July	Aug	Sep	Oct	Nov	Dec
Originial Schedule										Ì	/ear	1											Yea	ar 2		-				Yea	ar 3 (5 mc	onths)		
0. Project Overview - May 22, 2003																																				
1. Conceptual Design - Aug, 2003																																				
2. Build TCS3 Computer, controller, t3 electronics, servo simulator																																				
3. Encoder Replacement																																		\square		
Install MCC replacement at summit.																																		\square		
5. Prototype & Build TO Panel																																		\square		
6. TCS1-TCS3 switch (Drive RA, Dec, and Dome, and Shutter)																																				
7. RemoteGUI																																				
8. Daytime Test & Servo Tuning																																		\square		
9. Night Engineering (Pointing Run)																																		\square		
10. Remove TCS1																																				

- Schedule Daytime Engineering Test.
- Switch from TCS1 to TCS3.
- Tune servo for HA, Dec, and Dome control.
- RA, Dec, and Dome performance is acceptable.

Aug 21, 2003

Task 9 – Night Engineering

TCS3 Project Schedule						20	03					•						20	004								•		•	20	05					
	Jan	Feb	Mai	r Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Originial Schedule										````	Year	1											Yea	ar 2						Yea	r 3 (5 mo	nths)		
0. Project Overview - May 22, 2003																																				
1. Conceptual Design - Aug, 2003																																				
2. Build TCS3 Computer, controller, t3																																				
electronics, servo simulator																																				
3. Encoder Replacement																																				
Install MCC replacement at summit.																																				
5. Prototype & Build TO Panel																																				
6. TCS1-TCS3 switch (Drive RA, Dec, and																																				
Dome, and Shutter)																																				
7. RemoteGUI																																				
8. Daytime Test & Servo Tuning																																				
9. Night Engineering (Pointing Run)																																				
10. Remove TCS1																																				

- Take pointing calibration data.
- Reduce and input correction to T3.
- Benchmark pointing performance.

Task 10 - Remove TCS1

TCS3 Project Schedule						20	03											20	04											20	05					
	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mai	r Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Originial Schedule										Y	/ear	1											Yea	ar 2						Yea	r 3 (5 mo	nths)		
0. Project Overview - May 22, 2003																																				
1. Conceptual Design - Aug, 2003																																				
2. Build TCS3 Computer, controller, t3																																				
electronics, servo simulator																																				
3. Encoder Replacement																																				
4. Install MCC replacement at summit.																																				
5. Prototype & Build TO Panel																																				
6. TCS1-TCS3 switch (Drive RA, Dec, and																																				
Dome, and Shutter)																																				
7. RemoteGUI																																				
8. Daytime Test & Servo Tuning																																				
9. Night Engineering (Pointing Run)																																	\square			
10. Remove TCS1																																				

- Decommission TCS1
- Remove TCS1 Equipment
- Remove TCS1-TCS3 switching equipment
- Remove TCS1 APE and Install T3 APE.
- Remove TCS1 Inc. Encoder and relocate T3 Inc. Encoders.



Identify Major TCS3 components

3. Computer System and Servo Controller, and Servo Simulator



- Computer, with DMC-18x0 PCI Controller
- Servo Simulator

Aug 21, 2003

4. T3 Electronics (1)

- T3 Electronic are in-house designed and build electronics providing these functions:
 - HA and Dec Axis Interface
 - Dome Interface
 - Safety Circuit
 - TO Panel Interface

4. T3 Electronics (2)



• HA and Dec Axis Interface

4. T3 Electronics (3)



• Dome Interface

4. T3 Electronics (4)



• Safety Circuit

4. T3 Electronics (5)



• TO Panel Electronics

5. Encoders

- Keep tcs1 encoders in place until tcs1 is decommissioned.
- Install new absolute encoders at bullgear. "Decrease" resolution to 1 arcsecond.
- Install new increment encoders at bullgear. Increase resolution to 0.01 arcseconds.
- After tcs1 is decommission, remove Inc. & Abs Encoders.
- Relocated T3 Incremental Encoder at bullgear.
- Install new APE encoders at old APE location.
- Redirect dome serial data from scanner to T3 computer.

5. Encoders – Our plan is still evolving

- Recently we discovered it may be possible to continue using the current APE in the new system. So APE plan may be modified to:
- Purchase a spare APE encoder (Mechanical hardware).
- Purchase new APE electronics.
- Switch encoder output at yoke from TCS1 to TCS3.
- TCS1 inductive and resolver data to MCC
- TCS3 APE Electronic interface to T3 computer.

6. MCC replacement

MCC1

MCC2

MCC3



T3 Display1



Old MCC vs. New T3 Displays

Coord. Type

Auto Manual

TCS3 Conceptual Design Review

Lockout

Standard

(A) ⊙Manual

Limit Override

On

• Off

Telescope

Brakes

On

Enable

M

Emergency

7. Facility IO

Requirements

- 10 Hz update
- Can be easily expanded.
- Good support widely used.
- Wide variety of IO options.
- Ethernet based interface.

- IO Estimate (as of 8/20/03):
 - Digital In 34
 - Digital Out 40
 - Analog In 22
 - Analog Out 0
 - Others serial(1)



We have selected the Opto22 SNAP line of devices.

8. Software

- Software Guideline:
- Development and deployment on a Linux OS/x86 system.
- All application written in C minimize the use of other computer languages.
- Astronomy calculations algorithms are done using slalib or TCSpk.
- Pointing correction to be based on the TPOINT software application.
- GUI is written using GTK+
- Use the POSIX API for system and clib calls, shared memory, message queues, scheduling and processing control.
- Berkeley Socket API and remote procedures call (RPC) are used for network libraries.

8. Software (2)

	CS	FK5		equinox	2000.000		Epoch	(current epoch)
		Ba	ise		Base Rat	tes (as/s)		
		19:49:34.39	20:28:19.20		0.00	0.00		
Name	OS.enable	OffSe	ts (as)					
User	off	0.00	0.00					
Beam	off	0.00	0.00		Scan Raj	tes (as/s)		
Scan	off	0.00	0.00		0.00	0.00		
	Target	19:49:34.39	20:28:19.20					

- Position Table
- Mean-To-Mount Calculations
- Pointing Correction based on TPOINT
- Software Modes
- Idle, Track, Slew, MP, and MV.
- Dome: Manual or Automatic
- Shutter: Same as current system
- Facility Communication: telnet interface (TCP/IP) or t3io (UDP)

8. Software (3)





Block diagram of T3 applications

9. TCS1-TCS3 Switching

- Develop hardware and procedure to switch between TCS1 and TCS3.
- No detail information at this time should a straight forward job.
- Shutter Control:
- New JBox connecting to Ethernet IO device.
- Communications over slip ring using existing X10 devices installed by the IQUP project.

10. RemoteGUI

- Remote GUI is a scaled down T3 GUI used by
- Summit Observers, Remote Observer, Day Crew.
- Replaces current hardware hand paddle and tcs1_status program. But should be similar in concept to the tcs1_status program.

r ⁴ <u>v</u>]	IRTF TO	S1 Status 01.02 (Apr 1	14 2003)
Quit			North(+Dec)
ForthTCS		- Next Update 01	
10:09:02.12 19:4	9:34.0 00:00:00.0	0.0 1 .000	
Disp_Offset 0.00 0.00	Beaw_Switch_Info 0.00 0.00 A-BEAH	HST 13:38:44.56	East(+RA) West(-RA)
 Application Calcy UTC Local 23:38:48 13:38 HJD 52865.98528 	ulations fime GHST :48 21:10:43 LAST 10:48:49	Heஜgʒx32i Focus (z) Not Enabled	Į
			South(-Dec)
Status Setup Feed	back		0.2 1.0 5.0
A_Beam	B_Beam	ZeroOffset	Offset Focus
Comman	d>		

11. Remove TCS1

- Decommission TCS1
- Remove TCS1 Equipment
- Remove TCS1-TCS3 switching equipment
- Remove TCS1 APE and Install T3 APE.
- Remove TCS1 Inc. Encoder and relocate T3 Inc. Encoders.

The End