



1  
00:00:25,429 --> 00:00:23,109  
over the past

2  
00:00:27,189 --> 00:00:25,439  
decades we've struggled to see beyond

3  
00:00:28,470 --> 00:00:27,199  
the atmosphere lying between earth and

4  
00:00:30,870 --> 00:00:28,480  
space

5  
00:00:32,870 --> 00:00:30,880  
even from mountaintop observatories the

6  
00:00:34,069 --> 00:00:32,880  
atmosphere has blurred our view of the

7  
00:00:35,990 --> 00:00:34,079  
universe

8  
00:00:37,670 --> 00:00:36,000  
and because the atmosphere absorbs

9  
00:00:39,670 --> 00:00:37,680  
certain forms of energy

10  
00:00:41,430 --> 00:00:39,680  
our knowledge of celestial phenomena has

11  
00:00:43,910 --> 00:00:41,440  
been limited

12  
00:00:45,270 --> 00:00:43,920  
one answer has been to go beyond the

13  
00:00:47,029 --> 00:00:45,280

atmosphere

14

00:00:49,830 --> 00:00:47,039

in fact between the late 60s and the

15

00:00:51,910 --> 00:00:49,840

late 70s nasa launched a series of

16

00:00:54,549 --> 00:00:51,920

special purpose observatories

17

00:00:56,830 --> 00:00:54,559

revealing ultraviolet sources such as

18

00:00:59,590 --> 00:00:56,840

very hot stars and very young

19

00:01:00,549 --> 00:00:59,600

stars these satellites made tremendous

20

00:01:02,790 --> 00:01:00,559

breakthroughs

21

00:01:04,710 --> 00:01:02,800

and encouraged astronomers to move on to

22

00:01:06,469 --> 00:01:04,720

larger observatories

23

00:01:09,190 --> 00:01:06,479

seeking answers about more distant

24

00:01:12,230 --> 00:01:09,200

galaxies mysterious pulsars

25

00:01:16,630 --> 00:01:12,240

and quasars and the universe

26  
00:01:17,109 --> 00:01:16,640  
itself astronomers envisioned the next

27  
00:01:20,230 --> 00:01:17,119  
step

28  
00:01:21,990 --> 00:01:20,240  
a multi-purpose observatory in space

29  
00:01:23,910 --> 00:01:22,000  
one that could image farther and more

30  
00:01:26,310 --> 00:01:23,920  
clearly than its predecessors

31  
00:01:28,469 --> 00:01:26,320  
uncovering phenomena in ultraviolet

32  
00:01:29,510 --> 00:01:28,479  
visible and near infrared regions of the

33  
00:01:31,429 --> 00:01:29,520  
spectrum

34  
00:01:33,910 --> 00:01:31,439  
an observatory that could expand our

35  
00:01:35,109 --> 00:01:33,920  
perception to the outer reaches of the

36  
00:01:39,030 --> 00:01:35,119  
universe

37  
00:01:40,390 --> 00:01:39,040  
that next step was hst nasa's hubble

38  
00:01:42,469 --> 00:01:40,400

space telescope

39

00:01:48,149 --> 00:01:42,479

with its precision optics and diverse

40

00:01:51,910 --> 00:01:50,389

nasa is responsible for developing

41

00:01:54,389 --> 00:01:51,920

operating and maintaining this

42

00:01:56,469 --> 00:01:54,399

ground-sized space observatory

43

00:01:57,590 --> 00:01:56,479

with its unparalleled goals the hubble

44

00:01:59,270 --> 00:01:57,600

space telescope

45

00:02:01,990 --> 00:01:59,280

poses a much greater challenge to

46

00:02:20,830 --> 00:02:02,000

operate than ground-based observatories

47

00:02:20,840 --> 00:02:35,910

so

48

00:02:40,470 --> 00:02:38,470

led by nasa engineers scientists and

49

00:02:43,350 --> 00:02:40,480

researchers from universities

50

00:02:44,150 --> 00:02:43,360

industries and the european space agency

51  
00:02:45,670 --> 00:02:44,160  
have combined

52  
00:02:48,229 --> 00:02:45,680  
efforts to meet the challenge of

53  
00:02:50,150 --> 00:02:48,239  
operating hubble space telescope

54  
00:02:51,830 --> 00:02:50,160  
the result is one of the most complex

55  
00:02:52,949 --> 00:02:51,840  
operations and maintenance systems in

56  
00:02:55,190 --> 00:02:52,959  
the world

57  
00:02:57,030 --> 00:02:55,200  
one that ensures quality observations

58  
00:03:01,910 --> 00:02:57,040  
and spacecraft performance

59  
00:03:06,149 --> 00:03:03,830  
to take a closer look we started the

60  
00:03:07,990 --> 00:03:06,159  
space telescope science institute in

61  
00:03:10,070 --> 00:03:08,000  
baltimore maryland

62  
00:03:12,309 --> 00:03:10,080  
aura a consortium of american

63  
00:03:13,910 --> 00:03:12,319

universities operates the institute for

64

00:03:16,229 --> 00:03:13,920

nasa

65

00:03:18,149 --> 00:03:16,239

the space telescope science institute is

66

00:03:20,070 --> 00:03:18,159

the international center for science

67

00:03:22,550 --> 00:03:20,080

activities with hst

68

00:03:23,910 --> 00:03:22,560

it plans the day-to-day observations and

69

00:03:26,949 --> 00:03:23,920

sets up the long-term

70

00:03:28,630 --> 00:03:26,959

science program astronomers first come

71

00:03:31,430 --> 00:03:28,640

in contact with the institute when they

72

00:03:33,750 --> 00:03:31,440

submit their proposed science program

73

00:03:34,710 --> 00:03:33,760

as with any major observatory the demand

74

00:03:37,270 --> 00:03:34,720

for the telescope

75

00:03:37,830 --> 00:03:37,280

exceeds the time available we expect to

76

00:03:40,149 --> 00:03:37,840

receive

77

00:03:42,550 --> 00:03:40,159

over a thousand proposals a year and

78

00:03:44,630 --> 00:03:42,560

only 200 can be conducted

79

00:03:46,470 --> 00:03:44,640

a committee of international astronomers

80

00:03:48,390 --> 00:03:46,480

selects the proposals based on their

81

00:03:51,350 --> 00:03:48,400

scientific merit

82

00:03:53,270 --> 00:03:51,360

because the hst offers several hundred

83

00:03:55,190 --> 00:03:53,280

instrument configurations

84

00:03:58,710 --> 00:03:55,200

our scientists work with the selected

85

00:04:01,270 --> 00:03:58,720

researchers to detail their observations

86

00:04:02,309 --> 00:04:01,280

next numerous proposals are incorporated

87

00:04:04,390 --> 00:04:02,319

into a week-long

88

00:04:07,350 --> 00:04:04,400

observing schedule that ensures the

89

00:04:09,110 --> 00:04:07,360

efficient use of every telescope minute

90

00:04:10,789 --> 00:04:09,120

there are many many factors involved in

91

00:04:11,990 --> 00:04:10,799

scheduling observations with the space

92

00:04:13,429 --> 00:04:12,000

telescope

93

00:04:15,589 --> 00:04:13,439

there are many instruments onboard a

94

00:04:16,150 --> 00:04:15,599

space telescope within the same

95

00:04:18,710 --> 00:04:16,160

instrument

96

00:04:19,749 --> 00:04:18,720

there are several observing modes even

97

00:04:22,550 --> 00:04:19,759

the simplest

98

00:04:24,310 --> 00:04:22,560

observation requires using different

99

00:04:26,790 --> 00:04:24,320

filters

100

00:04:29,110 --> 00:04:26,800

we may also have to revisit the same

101

00:04:31,430 --> 00:04:29,120

target at different times of the year

102

00:04:34,070 --> 00:04:31,440

we want to maximize the time spent

103

00:04:35,990 --> 00:04:34,080

observing with the space telescope

104

00:04:37,430 --> 00:04:36,000

and minimize the time wasted moving the

105

00:04:39,749 --> 00:04:37,440

telescope around

106

00:04:42,710 --> 00:04:39,759

therefore we will group the observations

107

00:04:45,350 --> 00:04:42,720

to happen in the same area of the sky

108

00:04:45,909 --> 00:04:45,360

we also want to use the same instrument

109

00:04:47,749 --> 00:04:45,919

for

110

00:04:49,430 --> 00:04:47,759

long periods of time even weeks at a

111

00:04:50,870 --> 00:04:49,440

time to minimize

112

00:04:54,550 --> 00:04:50,880

switching instruments on and off

113

00:04:58,629 --> 00:04:56,469

before the telescope schedule can be

114

00:04:59,430 --> 00:04:58,639

completed another essential factor is

115

00:05:03,110 --> 00:04:59,440

entered

116

00:05:04,310 --> 00:05:03,120

the guide stars to establish guide stars

117

00:05:06,710 --> 00:05:04,320

for operations

118

00:05:08,870 --> 00:05:06,720

the institute has converted 1500

119

00:05:12,710 --> 00:05:08,880

photographic plates of the sky

120

00:05:14,550 --> 00:05:12,720

into a catalog of 15 million stars

121

00:05:15,909 --> 00:05:14,560

using the catalog the institute's

122

00:05:19,270 --> 00:05:15,919

computer selects

123

00:05:21,510 --> 00:05:19,280

guide stars for each target hst

124

00:05:22,710 --> 00:05:21,520

stabilizes on a target by finding and

125

00:05:24,950 --> 00:05:22,720

locking onto

126  
00:05:26,790 --> 00:05:24,960  
two guide stars with its precision

127  
00:05:29,110 --> 00:05:26,800  
guidance sensors

128  
00:05:30,390 --> 00:05:29,120  
the sensors detect any minor drift from

129  
00:05:32,550 --> 00:05:30,400  
the guide stars

130  
00:05:34,469 --> 00:05:32,560  
and correct the spacecraft's position

131  
00:05:36,550 --> 00:05:34,479  
through the onboard computers

132  
00:05:38,070 --> 00:05:36,560  
with the guide stars and other system

133  
00:05:40,230 --> 00:05:38,080  
factors incorporated

134  
00:05:42,390 --> 00:05:40,240  
the institute produces a week-long

135  
00:05:45,270 --> 00:05:42,400  
schedule which specifies

136  
00:05:52,629 --> 00:05:45,280  
when where and how hst science

137  
00:05:54,550 --> 00:05:52,639  
instruments will be used

138  
00:05:56,070 --> 00:05:54,560

from the institute the science schedule

139

00:05:59,270 --> 00:05:56,080

is transmitted to the space

140

00:06:01,350 --> 00:05:59,280

telescope operations control center

141

00:06:03,110 --> 00:06:01,360

located at goddard space flight center

142

00:06:05,749 --> 00:06:03,120

in greenbelt maryland

143

00:06:07,029 --> 00:06:05,759

this is the nerve center of hst's ground

144

00:06:09,189 --> 00:06:07,039

system

145

00:06:11,029 --> 00:06:09,199

the science schedule automatically goes

146

00:06:11,830 --> 00:06:11,039

into one of the control center computer

147

00:06:13,909 --> 00:06:11,840

systems

148

00:06:16,710 --> 00:06:13,919

which adds commands for operating and

149

00:06:18,950 --> 00:06:16,720

maintaining the observatory

150

00:06:20,710 --> 00:06:18,960

these new commands cover such operations

151  
00:06:24,309 --> 00:06:20,720  
as moving the telescope

152  
00:06:26,550 --> 00:06:24,319  
or pointing its communications antennas

153  
00:06:29,830 --> 00:06:26,560  
the system also schedules links to

154  
00:06:32,230 --> 00:06:29,840  
nasa's communications satellites

155  
00:06:32,950 --> 00:06:32,240  
merging both the science and spacecraft

156  
00:06:35,270 --> 00:06:32,960  
commands

157  
00:06:36,390 --> 00:06:35,280  
the computer generates a master schedule

158  
00:06:38,070 --> 00:06:36,400  
for the week

159  
00:06:39,990 --> 00:06:38,080  
if this second by second schedule

160  
00:06:41,990 --> 00:06:40,000  
printed out the stack would be one to

161  
00:06:44,790 --> 00:06:42,000  
two feet high

162  
00:06:45,749 --> 00:06:44,800  
commands are sent to hst's two on-board

163  
00:06:47,909 --> 00:06:45,759

computers

164

00:06:50,790 --> 00:06:47,919

which on an average day carry out over

165

00:06:52,790 --> 00:06:50,800

12 000 commands

166

00:06:57,510 --> 00:06:52,800

the spacecraft's safety is also

167

00:07:02,870 --> 00:07:00,070

a typical satellite has about a thousand

168

00:07:06,230 --> 00:07:02,880

parameters that must be monitored

169

00:07:08,150 --> 00:07:06,240

hst has about six thousand

170

00:07:09,589 --> 00:07:08,160

these parameters include specific

171

00:07:12,150 --> 00:07:09,599

spacecraft temperatures

172

00:07:14,629 --> 00:07:12,160

voltages electrical currents and the

173

00:07:17,029 --> 00:07:14,639

condition of its computers

174

00:07:18,790 --> 00:07:17,039

our engineers must instantly recognize

175

00:07:20,309 --> 00:07:18,800

the codes for each function

176  
00:07:23,430 --> 00:07:20,319  
interpret their measurements and take

177  
00:07:25,430 --> 00:07:23,440  
immediate action if something is unusual

178  
00:07:27,350 --> 00:07:25,440  
because the engineers are overrun with

179  
00:07:29,270 --> 00:07:27,360  
data we became concerned about the

180  
00:07:31,110 --> 00:07:29,280  
potential for human error

181  
00:07:32,790 --> 00:07:31,120  
to minimize this possibility we are

182  
00:07:33,430 --> 00:07:32,800  
developing an artificial intelligence

183  
00:07:37,029 --> 00:07:33,440  
system

184  
00:07:39,350 --> 00:07:37,039  
that automates much of the analysis

185  
00:07:40,870 --> 00:07:39,360  
if the system finds something amiss it

186  
00:07:43,350 --> 00:07:40,880  
tells the operator

187  
00:07:44,309 --> 00:07:43,360  
eventually it will also prescribe a

188  
00:07:48,150 --> 00:07:44,319

solution

189

00:07:53,189 --> 00:07:50,710

before the actual observations begin

190

00:07:54,070 --> 00:07:53,199

nasa must calibrate hst's various

191

00:07:56,150 --> 00:07:54,080

systems

192

00:07:59,110 --> 00:07:56,160

during a crucial seven-month period

193

00:08:01,589 --> 00:07:59,120

following launch marshall space flight

194

00:08:04,629 --> 00:08:01,599

center located in huntsville alabama

195

00:08:06,390 --> 00:08:04,639

was responsible for building hst

196

00:08:07,990 --> 00:08:06,400

early in the calibration process

197

00:08:09,749 --> 00:08:08,000

marshall personnel managed the

198

00:08:12,950 --> 00:08:09,759

spacecraft's initial checkout

199

00:08:14,469 --> 00:08:12,960

from goddard's control center

200

00:08:16,150 --> 00:08:14,479

at the beginning of deployment the

201

00:08:19,189 --> 00:08:16,160

shuttle bay doors open

202

00:08:21,270 --> 00:08:19,199

and the arbiter applies power to hst

203

00:08:23,270 --> 00:08:21,280

communication is then established

204

00:08:25,909 --> 00:08:23,280

between the ground control center

205

00:08:26,950 --> 00:08:25,919

and the spacecraft to verify proper

206

00:08:29,029 --> 00:08:26,960

configuration

207

00:08:31,350 --> 00:08:29,039

and to activate basic systems for

208

00:08:34,230 --> 00:08:31,360

thermal safety

209

00:08:35,029 --> 00:08:34,240

next the arbiter's arm lifts hst out of

210

00:08:36,949 --> 00:08:35,039

the bay

211

00:08:39,269 --> 00:08:36,959

so the telescope's solar arrays and

212

00:08:41,350 --> 00:08:39,279

antennas can be extended

213

00:08:44,790 --> 00:08:41,360

the arm releases the observatory into

214

00:08:47,910 --> 00:08:44,800

orbit some 300 miles above the earth

215

00:08:49,670 --> 00:08:47,920

hst's solar arrays are oriented properly

216

00:08:53,190 --> 00:08:49,680

to convert the sun's energy into

217

00:08:55,430 --> 00:08:53,200

electrical power for the observatory

218

00:08:56,870 --> 00:08:55,440

the arbiter stays nearby for about two

219

00:08:59,430 --> 00:08:56,880

days after release

220

00:09:02,230 --> 00:08:59,440

in case hst needs further assistance

221

00:09:04,070 --> 00:09:02,240

during this early critical period

222

00:09:05,750 --> 00:09:04,080

once we establish that the spacecraft

223

00:09:08,949 --> 00:09:05,760

can operate on its own

224

00:09:10,949 --> 00:09:08,959

the arbiter returns to earth meanwhile

225

00:09:11,590 --> 00:09:10,959

ground control engineers continue to

226  
00:09:14,070 --> 00:09:11,600  
verify

227  
00:09:15,750 --> 00:09:14,080  
that major components are up and running

228  
00:09:17,750 --> 00:09:15,760  
and that the telescope is pointing

229  
00:09:19,430 --> 00:09:17,760  
properly

230  
00:09:21,110 --> 00:09:19,440  
next through a long series of

231  
00:09:23,350 --> 00:09:21,120  
calibrations the telescope

232  
00:09:25,829 --> 00:09:23,360  
mirrors star trackers fine guidance

233  
00:09:27,829 --> 00:09:25,839  
sensors and rate gyros are aligned

234  
00:09:30,070 --> 00:09:27,839  
at approximately the end of the first

235  
00:09:32,630 --> 00:09:30,080  
month marshall officially turns

236  
00:09:34,310 --> 00:09:32,640  
responsibility for hst operations over

237  
00:09:36,310 --> 00:09:34,320  
to goddard

238  
00:09:38,230 --> 00:09:36,320

during the second month goddard conducts

239

00:09:39,750 --> 00:09:38,240

further telescope calibrations

240

00:09:41,269 --> 00:09:39,760

and early checkout of the science

241

00:09:43,030 --> 00:09:41,279

instruments

242

00:09:44,550 --> 00:09:43,040

subsequent checkout of the optics and

243

00:09:46,790 --> 00:09:44,560

the instruments occurs during the

244

00:09:48,550 --> 00:09:46,800

remaining five months

245

00:09:59,670 --> 00:09:48,560

only then can the long-awaited

246

00:10:02,790 --> 00:10:02,150

to make these observations hst's

247

00:10:05,030 --> 00:10:02,800

commands

248

00:10:07,190 --> 00:10:05,040

must travel an intricate path the

249

00:10:08,150 --> 00:10:07,200

science commands from the institute are

250

00:10:10,710 --> 00:10:08,160

integrated with

251  
00:10:11,990 --> 00:10:10,720  
spacecraft commands at goddard's control

252  
00:10:14,470 --> 00:10:12,000  
center

253  
00:10:15,190 --> 00:10:14,480  
ultimately the signals are relayed to a

254  
00:10:17,750 --> 00:10:15,200  
nasa

255  
00:10:20,870 --> 00:10:17,760  
tracking and data relay satellite

256  
00:10:23,509 --> 00:10:20,880  
orbiting 23 000 miles above earth

257  
00:10:25,750 --> 00:10:23,519  
the commands then go into hst's onboard

258  
00:10:28,389 --> 00:10:25,760  
computers to be implemented

259  
00:10:31,670 --> 00:10:28,399  
this path reverses when data gathered by

260  
00:10:33,670 --> 00:10:31,680  
an observation is sent back to earth

261  
00:10:35,509 --> 00:10:33,680  
with commands loaded into its computers

262  
00:10:36,949 --> 00:10:35,519  
the telescope automatically proceeds

263  
00:10:39,750 --> 00:10:36,959

with observations

264

00:10:41,509 --> 00:10:39,760

in this case hst pivots slowly to its

265

00:10:43,110 --> 00:10:41,519

new target

266

00:10:45,670 --> 00:10:43,120

light from the target goes down the

267

00:10:48,550 --> 00:10:45,680

telescope and hits the primary mirror

268

00:10:50,710 --> 00:10:48,560

it reflects back to the secondary mirror

269

00:10:52,630 --> 00:10:50,720

reduced to a narrow beam the light is

270

00:10:54,150 --> 00:10:52,640

aimed back to the focal plane just

271

00:10:56,630 --> 00:10:54,160

behind it

272

00:10:57,990 --> 00:10:56,640

the image is directed to hst's fine

273

00:11:00,550 --> 00:10:58,000

guidance sensors

274

00:11:03,110 --> 00:11:00,560

which locate and lock onto guide stars

275

00:11:05,829 --> 00:11:03,120

on either side of the target

276  
00:11:07,509 --> 00:11:05,839  
with hst now centered on its target the

277  
00:11:08,710 --> 00:11:07,519  
light travels into the science

278  
00:11:10,870 --> 00:11:08,720  
instruments which will make the

279  
00:11:13,990 --> 00:11:10,880  
observation

280  
00:11:17,670 --> 00:11:14,000  
the instrument shutters open the correct

281  
00:11:21,430 --> 00:11:17,680  
filter is selected and hst begins its

282  
00:11:26,470 --> 00:11:23,910  
while most observations are pre-planned

283  
00:11:30,150 --> 00:11:26,480  
10 percent require real-time interaction

284  
00:11:32,310 --> 00:11:30,160  
at the institute by scientists

285  
00:11:34,630 --> 00:11:32,320  
real-time observations with the space

286  
00:11:37,350 --> 00:11:34,640  
telescope defy pre-programming

287  
00:11:37,829 --> 00:11:37,360  
for example we want to observe the red

288  
00:11:40,389 --> 00:11:37,839

spots

289

00:11:43,269 --> 00:11:40,399

on jupiter this is a complicated

290

00:11:46,230 --> 00:11:43,279

operation because the planet moves

291

00:11:47,829 --> 00:11:46,240

and it also rotates in order to be able

292

00:11:49,190 --> 00:11:47,839

to do this we have to take an early

293

00:11:52,150 --> 00:11:49,200

picture of the planet

294

00:11:52,550 --> 00:11:52,160

send information down to the ground and

295

00:11:54,870 --> 00:11:52,560

then

296

00:11:56,710 --> 00:11:54,880

have an operator make a very quick

297

00:11:59,269 --> 00:11:56,720

decision as to exactly

298

00:12:00,790 --> 00:11:59,279

where the instrument that is being used

299

00:12:02,389 --> 00:12:00,800

has to be pointed

300

00:12:04,389 --> 00:12:02,399

this is a very challenging operation

301  
00:12:06,710 --> 00:12:04,399  
indeed

302  
00:12:08,470 --> 00:12:06,720  
within 24 hours of an observation the

303  
00:12:10,069 --> 00:12:08,480  
observer can obtain the data from the

304  
00:12:13,110 --> 00:12:10,079  
science institute's data

305  
00:12:15,350 --> 00:12:13,120  
archive and distribution service the

306  
00:12:17,509 --> 00:12:15,360  
investigator who submitted the proposal

307  
00:12:19,269 --> 00:12:17,519  
has exclusive rights to this information

308  
00:12:21,590 --> 00:12:19,279  
for one year

309  
00:12:24,310 --> 00:12:21,600  
after this period the data is available

310  
00:12:26,069 --> 00:12:24,320  
to scientists around the world serving

311  
00:12:27,670 --> 00:12:26,079  
as an hst library

312  
00:12:30,310 --> 00:12:27,680  
the archive will distribute an

313  
00:12:31,110 --> 00:12:30,320

equivalent of 500 million pages of

314

00:12:34,150 --> 00:12:31,120

information

315

00:12:35,670 --> 00:12:34,160

over a single year the observations are

316

00:12:38,310 --> 00:12:35,680

distributed through worldwide

317

00:12:42,870 --> 00:12:38,320

astronomical computer networks

318

00:12:45,829 --> 00:12:42,880

are through optical disks magnetic tapes

319

00:12:48,150 --> 00:12:45,839

and photographs astronomers can use this

320

00:12:52,949 --> 00:12:48,160

information at their home institution

321

00:12:55,110 --> 00:12:52,959

to further their own research

322

00:12:56,710 --> 00:12:55,120

from this data who can say what great

323

00:12:59,030 --> 00:12:56,720

discoveries will be made

324

00:13:00,230 --> 00:12:59,040

astronomers hope for answers about black

325

00:13:02,870 --> 00:13:00,240

holes

326

00:13:04,389 --> 00:13:02,880

the evolution of galaxies and the size

327

00:13:06,230 --> 00:13:04,399

of our universe

328

00:13:08,870 --> 00:13:06,240

looking to the future to ensure the

329

00:13:12,389 --> 00:13:08,880

continuous flow of such exciting data

330

00:13:14,790 --> 00:13:12,399

nasa has created contingency plans

331

00:13:17,190 --> 00:13:14,800

in contrast to the unexpected repair of

332

00:13:18,629 --> 00:13:17,200

the solar maximum mission spacecraft in

333

00:13:21,430 --> 00:13:18,639

1984

334

00:13:24,470 --> 00:13:21,440

nasa has prepared for hst's on orbit

335

00:13:30,150 --> 00:13:26,870

hst is designed and developed by nasa

336

00:13:32,790 --> 00:13:30,160

for on-orbit servicing by astronauts

337

00:13:37,670 --> 00:13:32,800

consequently hst instruments and various

338

00:13:41,590 --> 00:13:39,269

this allows the astronauts to replace

339

00:13:44,150 --> 00:13:41,600

degradable parts such as solar arrays

340

00:13:45,829 --> 00:13:44,160

and batteries during routine servicing

341

00:13:47,750 --> 00:13:45,839

missions

342

00:13:49,990 --> 00:13:47,760

the modular design also makes it

343

00:13:51,990 --> 00:13:50,000

possible to update the observatory with

344

00:13:54,069 --> 00:13:52,000

new instruments

345

00:13:55,829 --> 00:13:54,079

during the first planned maintenance

346

00:13:57,910 --> 00:13:55,839

mission for the hst

347

00:13:59,829 --> 00:13:57,920

we expect to remove one of the original

348

00:14:02,389 --> 00:13:59,839

scientific instruments and replace it

349

00:14:04,150 --> 00:14:02,399

with a near-infrared instrument

350

00:14:07,269 --> 00:14:04,160

the first scientific instruments on the

351

00:14:08,949 --> 00:14:07,279

hst are sensitive to the ultraviolet

352

00:14:10,710 --> 00:14:08,959

and visible portions of the

353

00:14:13,670 --> 00:14:10,720

electromagnetic spectrum

354

00:14:15,750 --> 00:14:13,680

when we add an infrared capability we

355

00:14:16,550 --> 00:14:15,760

will be able to examine regions such as

356

00:14:18,150 --> 00:14:16,560

this

357

00:14:19,750 --> 00:14:18,160

where stars are in the process of

358

00:14:21,750 --> 00:14:19,760

formation today

359

00:14:22,790 --> 00:14:21,760

and we'll also be able to probe still

360

00:14:33,910 --> 00:14:22,800

further back

361

00:14:38,470 --> 00:14:36,310

hubble space telescope operations can be

362

00:14:40,710 --> 00:14:38,480

compared to the complexity and challenge

363

00:14:43,990 --> 00:14:40,720

of the operations necessary to send

364

00:14:46,069 --> 00:14:44,000

astronauts to the moon the expertise of

365

00:14:47,509 --> 00:14:46,079

thousands of individuals has contributed

366

00:14:50,790 --> 00:14:47,519

to the innovative

367

00:14:53,030 --> 00:14:50,800

science instruments computer systems

368

00:14:55,269 --> 00:14:53,040

information systems and maintenance

369

00:14:57,509 --> 00:14:55,279

hardware that constitute hst's

370

00:14:59,670 --> 00:14:57,519

operations network

371

00:15:01,030 --> 00:14:59,680

this elaborate system supporting hubble

372

00:15:02,949 --> 00:15:01,040

space telescope

373

00:15:04,470 --> 00:15:02,959

promises long-sought answers to

374

00:15:07,030 --> 00:15:04,480

universal questions

375

00:15:07,990 --> 00:15:07,040

exciting discoveries to ponder and

