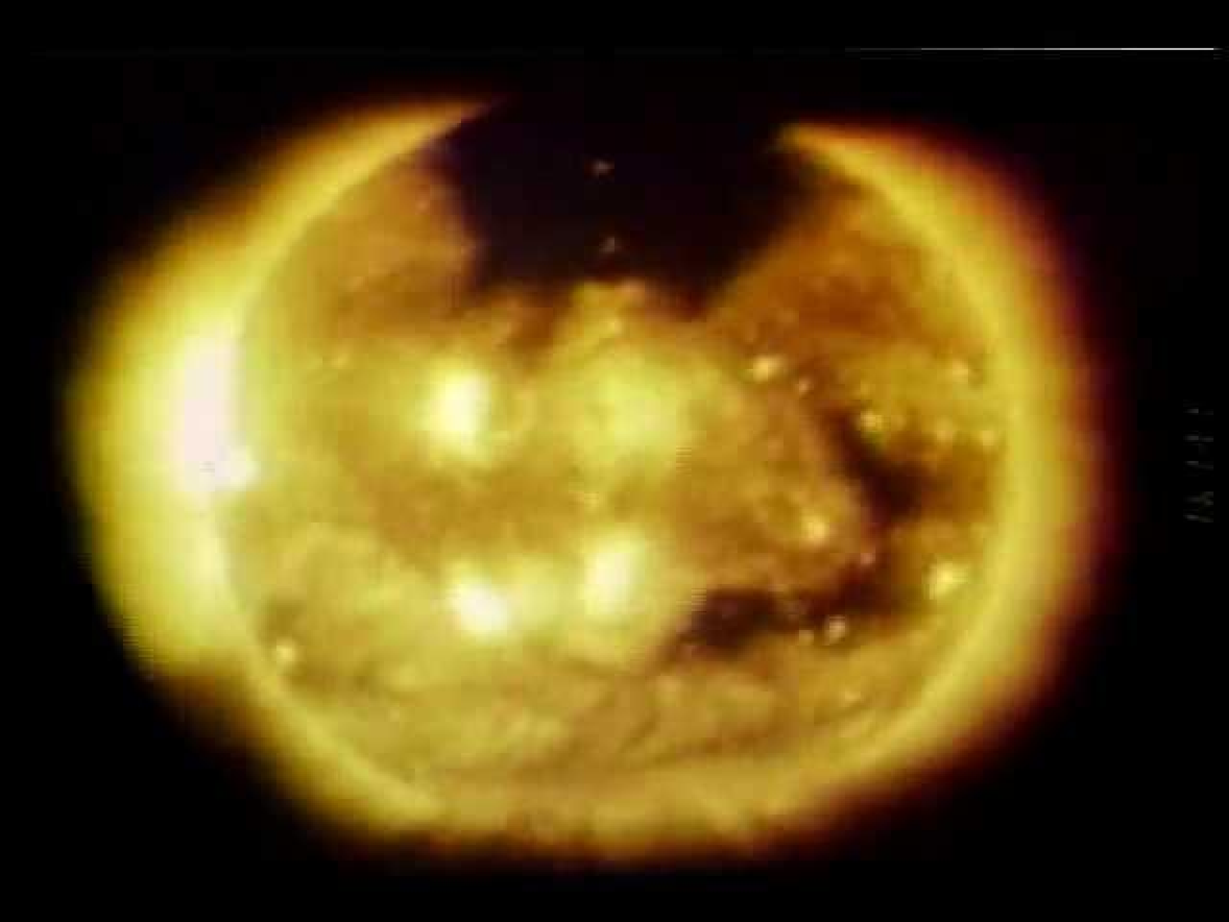

1
00:00:08,070 --> 00:00:05,910
this presentation will address the

2
00:00:09,509 --> 00:00:08,080
flight operations plan for the orbiting

3
00:00:12,870 --> 00:00:09,519
solar laboratory

4
00:00:14,870 --> 00:00:12,880
osl it will describe utilization of the

5
00:00:16,150 --> 00:00:14,880
nasa ground system and control the

6
00:00:18,550 --> 00:00:16,160
observatory pointing

7
00:00:19,429 --> 00:00:18,560
from instrumental workstations during a

8
00:00:23,109 --> 00:00:19,439
typical

9
00:00:23,750 --> 00:00:23,119
science campaign the osl will be

10
00:00:26,070 --> 00:00:23,760
creating

11
00:00:28,870 --> 00:00:26,080
high-resolution motion pictures of the

12
00:00:32,630 --> 00:00:28,880
dynamic activities on the sun's surface

13
00:00:34,870 --> 00:00:32,640

and in the overlying chronosphere

14
00:00:36,709 --> 00:00:34,880
digitizing this data for real-time

15
00:00:37,670 --> 00:00:36,719
transmission to the ground requires a

16
00:00:42,150 --> 00:00:37,680
relatively

17
00:00:44,389 --> 00:00:42,160
high data rate of 16 megabits per second

18
00:00:45,270 --> 00:00:44,399
in comparison other solar imaging

19
00:00:48,709 --> 00:00:45,280
satellites like

20
00:00:50,389 --> 00:00:48,719
smm took still photos stored them on

21
00:00:50,869 --> 00:00:50,399
board and transmitted them later at

22
00:00:54,470 --> 00:00:50,879
about

23
00:00:57,350 --> 00:00:54,480
32 kilobits per second or less

24
00:00:58,790 --> 00:00:57,360
however the landsat satellites take even

25
00:01:01,029 --> 00:00:58,800
higher resolution still

26
00:01:04,630 --> 00:01:01,039
photos of the earth and transmit them in

27
00:01:07,429 --> 00:01:04,640
real time at 85 megabits per second

28
00:01:09,270 --> 00:01:07,439
but the total data required for landsat

29
00:01:12,070 --> 00:01:09,280
is lower than for osl

30
00:01:12,710 --> 00:01:12,080
because landsat takes individual scenes

31
00:01:16,710 --> 00:01:12,720
only

32
00:01:19,190 --> 00:01:16,720
while osl takes movies in both cases

33
00:01:22,230 --> 00:01:19,200
there is too much data for a nominal

34
00:01:24,469 --> 00:01:22,240
onboard storage device

35
00:01:26,630 --> 00:01:24,479
tdrs is the only way to get real-time

36
00:01:29,429 --> 00:01:26,640
data rate telemetry from a low

37
00:01:31,030 --> 00:01:29,439
polar orbiting satellite like landsat or

38
00:01:33,429 --> 00:01:31,040

osl

39
00:01:34,950 --> 00:01:33,439
tdrs must point its high gain antennas

40
00:01:36,710 --> 00:01:34,960
at these satellites

41
00:01:38,390 --> 00:01:36,720
whenever their science data is to be

42
00:01:40,870 --> 00:01:38,400
collected therefore

43
00:01:42,630 --> 00:01:40,880
availability of the tdrs single access k

44
00:01:44,950 --> 00:01:42,640
band ksa

45
00:01:46,069 --> 00:01:44,960
links will limit the amount of science

46
00:01:49,109 --> 00:01:46,079
data that osl

47
00:01:51,590 --> 00:01:49,119
transmits typically tdrs

48
00:01:52,550 --> 00:01:51,600
has authorized from four to eight hours

49
00:01:55,590 --> 00:01:52,560
per day

50
00:01:57,429 --> 00:01:55,600
on their ksa links as long as it's at

51
00:02:00,310 --> 00:01:57,439
their convenience

52
00:02:01,350 --> 00:02:00,320
for osl this is no problem since osl

53
00:02:03,990 --> 00:02:01,360
will see the sun

54
00:02:05,670 --> 00:02:04,000
100 percent of the time and we'll see at

55
00:02:09,029 --> 00:02:05,680
least one tdrs satellite

56
00:02:10,949 --> 00:02:09,039
97 percent of the time

57
00:02:13,750 --> 00:02:10,959
during these real-time telemetry

58
00:02:15,830 --> 00:02:13,760
sessions data from osl is received at

59
00:02:19,589 --> 00:02:15,840
the data capture facility

60
00:02:22,710 --> 00:02:19,599
dcf at the goddard space flight center

61
00:02:25,510 --> 00:02:22,720
all raw data is recorded on high density

62
00:02:27,670 --> 00:02:25,520
digital recorders it is processed to

63
00:02:29,270 --> 00:02:27,680

level zero and forwarded to the science

64
00:02:33,430 --> 00:02:29,280
operations facility

65
00:02:37,070 --> 00:02:33,440
sof in near enough real time

66
00:02:40,229 --> 00:02:37,080
because the osl is using nasa's standard

67
00:02:42,390 --> 00:02:40,239
telepathization formats and protocols

68
00:02:43,910 --> 00:02:42,400
the nasa communications network can

69
00:02:47,110 --> 00:02:43,920
easily handle it within their

70
00:02:49,990 --> 00:02:47,120
institutional ground system capabilities

71
00:02:52,150 --> 00:02:50,000
this data output from the dcf is easily

72
00:02:54,070 --> 00:02:52,160
converted into viewable movies

73
00:02:55,910 --> 00:02:54,080
by the instrument or workstations and

74
00:02:57,110 --> 00:02:55,920
the entire communications link is

75
00:02:59,910 --> 00:02:57,120
transparent

76
00:03:02,149 --> 00:02:59,920
in addition the dcf recorded data is

77
00:03:04,390 --> 00:03:02,159
eventually sent to the goddard science

78
00:03:07,350 --> 00:03:04,400
data processing facility

79
00:03:09,430 --> 00:03:07,360
for offline bulk data processing

80
00:03:12,869 --> 00:03:09,440
distribution to the scientists

81
00:03:15,990 --> 00:03:15,270
the project operations control center

82
00:03:18,470 --> 00:03:16,000
park

83
00:03:19,670 --> 00:03:18,480
located goddard will handle all flight

84
00:03:22,149 --> 00:03:19,680
operations

85
00:03:23,910 --> 00:03:22,159
this requires only an s-band link

86
00:03:26,229 --> 00:03:23,920
through tdrs

87
00:03:28,309 --> 00:03:26,239
during science data collection times a

88
00:03:29,190 --> 00:03:28,319

single access system is available but

89
00:03:31,830 --> 00:03:29,200
otherwise

90
00:03:33,430 --> 00:03:31,840
a low gain multiple access system is

91
00:03:35,990 --> 00:03:33,440
sufficient

92
00:03:36,949 --> 00:03:36,000
whenever osl is not collecting real-time

93
00:03:38,949 --> 00:03:36,959
science data

94
00:03:40,710 --> 00:03:38,959
the puck is responsible for routine

95
00:03:42,869 --> 00:03:40,720
maintenance and housekeeping

96
00:03:45,350 --> 00:03:42,879
it must ensure that the observatory

97
00:03:48,390 --> 00:03:45,360
stays pointing nominally at the sun

98
00:03:49,910 --> 00:03:48,400
to keep the solar arrays lit even when

99
00:03:51,430 --> 00:03:49,920
the scientists are controlling the

100
00:03:54,309 --> 00:03:51,440
observatory pointing

101
00:03:55,670 --> 00:03:54,319
the puck has inline control over any

102
00:03:59,589 --> 00:03:55,680
uplinked commands

103
00:04:02,470 --> 00:03:59,599
and it prevents any hazardous commands

104
00:04:04,550 --> 00:04:02,480
osl will be available for real-time

105
00:04:05,509 --> 00:04:04,560
science campaigns during nine months

106
00:04:09,030 --> 00:04:05,519
each year

107
00:04:11,270 --> 00:04:09,040
at pre-planned tdrs observation windows

108
00:04:13,110 --> 00:04:11,280
a typical campaign is planned by the

109
00:04:14,789 --> 00:04:13,120
scientists based on inputs from other

110
00:04:17,349 --> 00:04:14,799
solar observatories

111
00:04:19,509 --> 00:04:17,359
and requests from the osl scientists and

112
00:04:22,230 --> 00:04:19,519
the solar physics community

113
00:04:24,790 --> 00:04:22,240

the sof coordinates these inputs and

114
00:04:27,430 --> 00:04:24,800
dictates the campaign scenario

115
00:04:29,350 --> 00:04:27,440
it is possible to conduct retargeting

116
00:04:33,749 --> 00:04:29,360
and near real-time science data

117
00:04:36,390 --> 00:04:33,759
processing operations from the sof

118
00:04:37,990 --> 00:04:36,400
a typical science observation campaign

119
00:04:41,030 --> 00:04:38,000
first requires a course

120
00:04:42,150 --> 00:04:41,040
pointing of the osl to a new location on

121
00:04:44,230 --> 00:04:42,160
the sun

122
00:04:45,189 --> 00:04:44,240
the initial course pointing can be done

123
00:04:47,350 --> 00:04:45,199
with the

124
00:04:48,950 --> 00:04:47,360
low rate multiple access tdrs

125
00:04:51,110 --> 00:04:48,960
communications links

126
00:04:53,590 --> 00:04:51,120
before the high gain tdrs antennas are

127
00:04:56,710 --> 00:04:53,600
scheduled for osl

128
00:04:58,469 --> 00:04:56,720
in the sof the scientists have full

129
00:05:00,310 --> 00:04:58,479
sun images from ground-based

130
00:05:03,749 --> 00:05:00,320
observatories displayed

131
00:05:08,550 --> 00:05:03,759
on their workstations the yellow disk

132
00:05:12,469 --> 00:05:10,629
the real full sun image will indicate

133
00:05:15,029 --> 00:05:12,479
which local feature on the sun is

134
00:05:16,950 --> 00:05:15,039
currently being viewed by the osl

135
00:05:19,670 --> 00:05:16,960
and the location of the new feature to

136
00:05:24,390 --> 00:05:22,230
using a mouse the operator positions his

137
00:05:29,110 --> 00:05:24,400
display window over the new location

138
00:05:32,230 --> 00:05:29,120

and initiates a command to move the osl

139
00:05:34,870 --> 00:05:32,240
in addition the osl must be rotated

140
00:05:37,029 --> 00:05:34,880
to align the osl cameras properly for

141
00:05:38,790 --> 00:05:37,039
this feature

142
00:05:41,029 --> 00:05:38,800
this is also done by rotating the

143
00:05:43,830 --> 00:05:41,039
display window and initiating a command

144
00:05:46,550 --> 00:05:43,840
to the osl

145
00:05:48,230 --> 00:05:46,560
the poc must approve all commands before

146
00:05:50,950 --> 00:05:48,240
it uplinks them

147
00:05:52,550 --> 00:05:50,960
then the osl will begin to reorient

148
00:05:54,950 --> 00:05:52,560
itself as directed

149
00:05:56,230 --> 00:05:54,960
the only data received to verify this

150
00:05:58,629 --> 00:05:56,240
course pointing

151
00:05:59,590 --> 00:05:58,639
is found in the spacecraft housekeeping

152
00:06:01,749 --> 00:05:59,600
telemetry

153
00:06:02,790 --> 00:06:01,759
that is received through multiple access

154
00:06:06,230 --> 00:06:02,800
tdrs

155
00:06:08,390 --> 00:06:06,240
by the park now the scientists wait for

156
00:06:09,430 --> 00:06:08,400
the pre-scheduled tdrs high data rate

157
00:06:11,909 --> 00:06:09,440
link

158
00:06:13,830 --> 00:06:11,919
once tdrs points its high gain antenna

159
00:06:15,909 --> 00:06:13,840
towards osl

160
00:06:19,270 --> 00:06:15,919
the ongoing science data is relayed to

161
00:06:22,629 --> 00:06:19,280
the dcf and forwarded to the sof

162
00:06:24,469 --> 00:06:22,639
where it is viewed as a movie

163
00:06:27,350 --> 00:06:24,479

the workstation display is replaced by

164
00:06:29,670 --> 00:06:27,360
this near real-time osl data

165
00:06:30,469 --> 00:06:29,680
which is a very high-resolution blow-up

166
00:06:33,670 --> 00:06:30,479
of a small

167
00:06:35,830 --> 00:06:33,680
area on the sun within this blow-up the

168
00:06:36,629 --> 00:06:35,840
scientist can exactly locate the feature

169
00:06:40,550 --> 00:06:36,639
of interest

170
00:06:42,710 --> 00:06:40,560
and do the necessary fine pointing again

171
00:06:45,189 --> 00:06:42,720
he moves his display window across the

172
00:06:47,270 --> 00:06:45,199
image and rotates it as necessary

173
00:06:49,510 --> 00:06:47,280
he initiates the appropriate command

174
00:06:51,990 --> 00:06:49,520
request and the poc screens it and

175
00:06:54,070 --> 00:06:52,000
uplinks it if valid

176
00:06:55,110 --> 00:06:54,080
this time the image displayed on the

177
00:06:57,909 --> 00:06:55,120
workstation will

178
00:06:59,510 --> 00:06:57,919
update as the osl moves and the

179
00:07:01,670 --> 00:06:59,520
scientists can verify

180
00:07:02,710 --> 00:07:01,680
the new pointing in near enough real

181
00:07:05,909 --> 00:07:02,720
time

182
00:07:07,430 --> 00:07:05,919
once satisfied he can set the osl auto

183
00:07:12,230 --> 00:07:07,440
track system by another

184
00:07:16,070 --> 00:07:14,710
oso will now recognize the feature in

185
00:07:17,990 --> 00:07:16,080
its field of view

186
00:07:19,510 --> 00:07:18,000
and track it even as it changes and

187
00:07:22,309 --> 00:07:19,520
moves

188
00:07:23,990 --> 00:07:22,319

since there are no eclipses oso never

189
00:07:26,150 --> 00:07:24,000
loses the target

190
00:07:28,070 --> 00:07:26,160
and it will track it even after tdrs

191
00:07:31,510 --> 00:07:28,080
breaks contact

192
00:07:33,350 --> 00:07:31,520
hours or days later when tdrs resumes

193
00:07:35,510 --> 00:07:33,360
real-time science data

194
00:07:36,790 --> 00:07:35,520
the feature is still centered in the osl

195
00:07:39,909 --> 00:07:36,800
field of view and

196
00:07:42,390 --> 00:07:39,919
once again displayed on the workstation

197
00:07:44,309 --> 00:07:42,400
scientists are thus able to more easily

198
00:07:46,629 --> 00:07:44,319
interpolate the missing data

199
00:07:48,629 --> 00:07:46,639
because they know that this is the same

200
00:07:51,350 --> 00:07:48,639
feature

201
00:07:51,830 --> 00:07:51,360
in addition to auto tracking the osl has

202
00:07:54,150 --> 00:07:51,840
image

203
00:07:55,589 --> 00:07:54,160
stabilization systems on each of its

204
00:07:57,749 --> 00:07:55,599
instruments

205
00:08:00,550 --> 00:07:57,759
these systems remove any jitter in the

206
00:08:01,510 --> 00:08:00,560
data caused by random vibrations of the

207
00:08:03,830 --> 00:08:01,520
observatory

208
00:08:04,710 --> 00:08:03,840
that might be caused by the steerable

209
00:08:06,869 --> 00:08:04,720
antennas

210
00:08:09,029 --> 00:08:06,879
or the reaction wheels in the attitude

211
00:08:11,430 --> 00:08:09,039
control subsystem

212
00:08:13,510 --> 00:08:11,440
this capability is demonstrated by these

213
00:08:14,390 --> 00:08:13,520

before and after pictures taken of the

214
00:08:16,869 --> 00:08:14,400
sun

215
00:08:17,749 --> 00:08:16,879
using this image stabilization system at

216
00:08:21,189 --> 00:08:17,759
a ground-based

217
00:08:22,070 --> 00:08:21,199
observatory the jitter was introduced

218
00:08:24,950 --> 00:08:22,080
mechanically

219
00:08:26,390 --> 00:08:24,960
to simulate onboard vibrations of

220
00:08:29,749 --> 00:08:26,400
various frequencies

221
00:08:31,749 --> 00:08:29,759
and has been totally removed notice that

222
00:08:34,469 --> 00:08:31,759
the data quality is degraded

223
00:08:38,389 --> 00:08:34,479
by the atmospheric distortions as it is

224
00:08:40,149 --> 00:08:38,399
with all ground-based observations

225
00:08:42,870 --> 00:08:40,159
because of these state-of-the-art

226
00:08:45,350 --> 00:08:42,880
capabilities provided by the osl

227
00:08:47,430 --> 00:08:45,360
in this continuous sunlit orbit the

228
00:08:49,110 --> 00:08:47,440
scientist will also be able to conduct

229
00:08:50,790 --> 00:08:49,120
some near-real-time

230
00:08:53,670 --> 00:08:50,800
science data processing from his

231
00:08:55,430 --> 00:08:53,680
workstation as he views the data

232
00:08:58,230 --> 00:08:55,440
he can select various filters for

233
00:08:59,030 --> 00:08:58,240
example to emphasize the events of most

234
00:09:01,750 --> 00:08:59,040
interest and

235
00:09:02,310 --> 00:09:01,760
quickly evaluate his decision in this

236
00:09:04,070 --> 00:09:02,320
way

237
00:09:06,070 --> 00:09:04,080
he can ensure that the data being

238
00:09:09,350 --> 00:09:06,080

collected back at the dcf is

239
00:09:11,910 --> 00:09:09,360
just what he needs he also knows where

240
00:09:14,070 --> 00:09:11,920
in the raw database it will be and

241
00:09:14,949 --> 00:09:14,080
he can request only the essential data

242
00:09:18,310 --> 00:09:14,959
to be bulk

243
00:09:20,230 --> 00:09:18,320
processed offline this inherently will

244
00:09:22,470 --> 00:09:20,240
reduce the amount of bulk data

245
00:09:25,750 --> 00:09:22,480
processing required to produce

246
00:09:27,190 --> 00:09:25,760
a prescribed data product

247
00:09:28,870 --> 00:09:27,200
a number of types of science

248
00:09:31,670 --> 00:09:28,880
observations can be accomplished

249
00:09:34,470 --> 00:09:31,680
just as easily by this osl for example

250
00:09:36,949 --> 00:09:34,480
some dynamic solar processors require

251
00:09:38,150 --> 00:09:36,959
a quick look every so often and the data

252
00:09:41,430 --> 00:09:38,160
can be collected during

253
00:09:43,670 --> 00:09:41,440
short tdrs contacts other events require

254
00:09:46,230 --> 00:09:43,680
a continuous look for several hours to

255
00:09:48,550 --> 00:09:46,240
capture the entire process

256
00:09:49,829 --> 00:09:48,560
tdrs has assured at least a three hour

257
00:09:52,470 --> 00:09:49,839
science data contact

258
00:09:53,829 --> 00:09:52,480
every day to enable this type of science

259
00:09:56,630 --> 00:09:53,839
to be conducted

260
00:09:59,350 --> 00:09:56,640
the fact that the osl orbit provides 100

261
00:10:01,990 --> 00:09:59,360
percent continuous solar viewing

262
00:10:04,310 --> 00:10:02,000
is also critical to this type of science

263
00:10:05,350 --> 00:10:04,320

and the flexibility it provides greatly

264
00:10:08,470 --> 00:10:05,360
facilitates

265
00:10:10,310 --> 00:10:08,480
the use of tdrs with osl

266
00:10:12,310 --> 00:10:10,320
the solar physics community has an

267
00:10:12,870 --> 00:10:12,320
unprecedented opportunity to conduct

268
00:10:15,910 --> 00:10:12,880
solar

269
00:10:17,509 --> 00:10:15,920
dynamic science on a scale well beyond