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1
00:00:06,630 --> 00:00:04,070
this is mission control houston while

2
00:00:08,230 --> 00:00:06,640
the expedition 34 crew is busy inside

3
00:00:10,870 --> 00:00:08,240
the orbiting complex working on a

4
00:00:12,629 --> 00:00:10,880
variety of different experiments a major

5
00:00:15,669 --> 00:00:12,639
experiment is taking place outside the

6
00:00:17,750 --> 00:00:15,679
station the robotic refueling mission is

7
00:00:19,750 --> 00:00:17,760
underway out on the far right hand side

8
00:00:20,870 --> 00:00:19,760
of the station's truss structure again

9
00:00:23,189 --> 00:00:20,880
this is a big

10
00:00:25,429 --> 00:00:23,199
washing machine sized experiment that is

11
00:00:26,630 --> 00:00:25,439
using the station's robotic arm and also

12
00:00:29,029 --> 00:00:26,640
the dexter

13
00:00:31,269 --> 00:00:29,039

robot itself to prove that satellites in

14
00:00:32,709 --> 00:00:31,279
the future can be refueled in space

15
00:00:34,950 --> 00:00:32,719
we're pleased now to be joined by

16
00:00:37,270 --> 00:00:34,960
benjamin reed who is the deputy project

17
00:00:38,869 --> 00:00:37,280
manager of nasa's satellite servicing

18
00:00:40,630 --> 00:00:38,879
capabilities office up at the goddard

19
00:00:43,590 --> 00:00:40,640
space flight center he has been an

20
00:00:45,190 --> 00:00:43,600
integral part of this rrm experiment ben

21
00:00:46,950 --> 00:00:45,200
how are you doing

22
00:00:49,510 --> 00:00:46,960
i'm doing actually great

23
00:00:50,630 --> 00:00:49,520
really pumped about the success we had

24
00:00:53,270 --> 00:00:50,640
last night

25
00:00:55,670 --> 00:00:53,280
a little little sleepy eyed but but

26
00:00:57,189 --> 00:00:55,680
really excited that the first day of

27
00:00:59,910 --> 00:00:57,199
operations

28
00:01:01,270 --> 00:00:59,920
was so successful and looking eagerly

29
00:01:03,270 --> 00:01:01,280
forward to

30
00:01:05,189 --> 00:01:03,280
four more days

31
00:01:06,469 --> 00:01:05,199
so let's talk about why this is

32
00:01:07,910 --> 00:01:06,479
important there's

33
00:01:09,910 --> 00:01:07,920
literally hundreds and thousands of

34
00:01:11,590 --> 00:01:09,920
satellites up you know both

35
00:01:13,429 --> 00:01:11,600
you know a few hundred miles away from

36
00:01:16,149 --> 00:01:13,439
earth's orbit and also far out there in

37
00:01:18,310 --> 00:01:16,159
space by you know 22 000 miles or more

38
00:01:19,910 --> 00:01:18,320

why why is refueling these satellites

39
00:01:21,910 --> 00:01:19,920
important and why is it important to

40
00:01:23,990 --> 00:01:21,920
demonstrate this on the space station

41
00:01:25,990 --> 00:01:24,000
well i i think you uh you hit the nail

42
00:01:27,190 --> 00:01:26,000
on the head with your numbers

43
00:01:28,070 --> 00:01:27,200
there are

44
00:01:30,789 --> 00:01:28,080
as

45
00:01:33,190 --> 00:01:30,799
is available on the web

46
00:01:35,429 --> 00:01:33,200
something right around a thousand

47
00:01:39,030 --> 00:01:35,439
operational satellites in orbit right

48
00:01:40,630 --> 00:01:39,040
now in space a thousand and of those one

49
00:01:42,389 --> 00:01:40,640
000

50
00:01:43,670 --> 00:01:42,399
all but two

51
00:01:44,870 --> 00:01:43,680
are

52
00:01:46,149 --> 00:01:44,880
serviceable

53
00:01:48,469 --> 00:01:46,159
um so

54
00:01:50,710 --> 00:01:48,479
pardon me check that the reverse and uh

55
00:01:53,190 --> 00:01:50,720
only two of the 1000 are serviceable and

56
00:01:54,550 --> 00:01:53,200
that is the international space station

57
00:01:58,149 --> 00:01:54,560
and

58
00:01:59,030 --> 00:01:58,159
hubble space telescope the other 998

59
00:02:01,190 --> 00:01:59,040
are

60
00:02:03,030 --> 00:02:01,200
not designed for servicing

61
00:02:06,069 --> 00:02:03,040
it's like having

62
00:02:08,710 --> 00:02:06,079
an iphone a skilled technician can get

63
00:02:11,350 --> 00:02:08,720

into an iphone to replace a battery or

64
00:02:12,790 --> 00:02:11,360
crack screen if necessary but but not

65
00:02:16,150 --> 00:02:12,800
the general public not without

66
00:02:20,150 --> 00:02:16,160
specialized tools so these are the 998

67
00:02:23,750 --> 00:02:22,390
can be accessed we are demonstrating on

68
00:02:25,990 --> 00:02:23,760
space station

69
00:02:28,949 --> 00:02:26,000
that the tools the technologies and the

70
00:02:31,110 --> 00:02:28,959
techniques are available now for

71
00:02:33,270 --> 00:02:31,120
accessing um a

72
00:02:36,309 --> 00:02:33,280
satellite's refueling system to give it

73
00:02:38,390 --> 00:02:36,319
more more propellant but it's not easy

74
00:02:41,270 --> 00:02:38,400
it requires sophisticated tools it

75
00:02:44,309 --> 00:02:41,280
requires careful planning um but that's

76
00:02:46,710 --> 00:02:44,319
the sort of thing that that that we do

77
00:02:47,910 --> 00:02:46,720
uh for a living here at nasa

78
00:02:48,869 --> 00:02:47,920
you know let's talk about the history of

79
00:02:50,630 --> 00:02:48,879
this a little bit because we mentioned

80
00:02:52,390 --> 00:02:50,640
this yesterday that you know there's

81
00:02:54,390 --> 00:02:52,400
been a number of times that nasa and its

82
00:02:56,869 --> 00:02:54,400
partners have had to go up and service

83
00:02:58,070 --> 00:02:56,879
something that wasn't exactly designed

84
00:02:59,350 --> 00:02:58,080
uh to have that happen to it you

85
00:03:01,190 --> 00:02:59,360
mentioned hubble because there's been a

86
00:03:02,710 --> 00:03:01,200
lot of work that was done on hubble over

87
00:03:04,470 --> 00:03:02,720
the years that uh

88
00:03:05,910 --> 00:03:04,480

it wasn't you know in the in the

89
00:03:08,149 --> 00:03:05,920
planning stages they didn't envision

90
00:03:09,910 --> 00:03:08,159
having to do that but they created

91
00:03:11,750 --> 00:03:09,920
specific tools for it they practice it

92
00:03:13,910 --> 00:03:11,760
like you said um

93
00:03:15,589 --> 00:03:13,920
is any of that uh learning that we've

94
00:03:17,270 --> 00:03:15,599
had both on hubble and other satellites

95
00:03:19,670 --> 00:03:17,280
is that being applied to this in terms

96
00:03:21,030 --> 00:03:19,680
of how you go about sort of

97
00:03:23,270 --> 00:03:21,040
you know attacking something that wasn't

98
00:03:26,470 --> 00:03:23,280
really designed to do that absolutely

99
00:03:29,350 --> 00:03:26,480
absolutely we spent 20 years servicing

100
00:03:31,270 --> 00:03:29,360
hubble we the agency

101
00:03:33,910 --> 00:03:31,280
and throughout those five servicing

102
00:03:36,309 --> 00:03:33,920
missions spread out across 20 years

103
00:03:38,630 --> 00:03:36,319
we became comfortable with the paradigm

104
00:03:40,470 --> 00:03:38,640
that the hardware was in orbit we

105
00:03:42,949 --> 00:03:40,480
certainly knew a lot about it although

106
00:03:44,550 --> 00:03:42,959
never quite as much as you wish you knew

107
00:03:46,789 --> 00:03:44,560
when you were building the tools and the

108
00:03:49,270 --> 00:03:46,799
replacement hardware

109
00:03:51,830 --> 00:03:49,280
so the hardware is in orbit so we on the

110
00:03:54,869 --> 00:03:51,840
ground are charged with putting together

111
00:03:56,390 --> 00:03:54,879
a robust servicing mission and that

112
00:03:58,149 --> 00:03:56,400
involves

113
00:03:59,429 --> 00:03:58,159

the replacement hardware how is it going

114
00:04:01,589 --> 00:03:59,439
to be attached is it going to be

115
00:04:04,070 --> 00:04:01,599
attached with the same technique that

116
00:04:06,470 --> 00:04:04,080
the original hardware had on it

117
00:04:08,789 --> 00:04:06,480
the tools to do that work

118
00:04:10,149 --> 00:04:08,799
the procedures development what in the

119
00:04:12,390 --> 00:04:10,159
procedures

120
00:04:13,589 --> 00:04:12,400
are going to be the the special trips

121
00:04:15,110 --> 00:04:13,599
that would

122
00:04:18,310 --> 00:04:15,120
cause the

123
00:04:22,390 --> 00:04:18,320
the engineers on the ground to go into

124
00:04:27,270 --> 00:04:25,030
so all that that that planning the

125
00:04:30,230 --> 00:04:27,280
philosophy of how you build

126
00:04:32,070 --> 00:04:30,240
a robust servicing mission was exactly

127
00:04:34,390 --> 00:04:32,080
the

128
00:04:36,629 --> 00:04:34,400
what has positioned us for

129
00:04:38,469 --> 00:04:36,639
being able to do what we do now on the

130
00:04:40,870 --> 00:04:38,479
international space station with the

131
00:04:42,950 --> 00:04:40,880
robots with dexter that's up there and

132
00:04:46,469 --> 00:04:42,960
our sophisticated tools that we built

133
00:04:47,830 --> 00:04:46,479
for dexter to use to service a satellite

134
00:04:51,430 --> 00:04:47,840
so what you're looking on the screen

135
00:04:53,749 --> 00:04:51,440
right now is an animation of

136
00:04:56,469 --> 00:04:53,759
the stowing of a cap that was not

137
00:04:59,909 --> 00:04:56,479
designed to be removed by a robot when

138
00:05:02,390 --> 00:04:59,919

this cap was and when a cap like that

139
00:05:03,510 --> 00:05:02,400
was installed um

140
00:05:05,350 --> 00:05:03,520
and so

141
00:05:08,710 --> 00:05:05,360
it's just a quick little example if you

142
00:05:12,469 --> 00:05:08,720
don't mind of contingency procedures

143
00:05:16,230 --> 00:05:12,479
so we just last night uh cut a safety

144
00:05:19,270 --> 00:05:16,240
wire this is a very small wire um

145
00:05:21,909 --> 00:05:19,280
20 thousandths of an inch thick two of

146
00:05:23,990 --> 00:05:21,919
them twisted together

147
00:05:26,070 --> 00:05:24,000
you can see a fragment of one on the

148
00:05:29,270 --> 00:05:26,080
screen right now

149
00:05:31,909 --> 00:05:29,280
and when it was cut it popped itself

150
00:05:33,990 --> 00:05:31,919
into a position that wasn't optimal for

151
00:05:36,710 --> 00:05:34,000
a subsequent operation so immediately

152
00:05:39,350 --> 00:05:36,720
the team recognized this with the video

153
00:05:41,270 --> 00:05:39,360
that we got and they said okay well we

154
00:05:44,070 --> 00:05:41,280
know how to handle this situation we'll

155
00:05:45,270 --> 00:05:44,080
use the tool that's already in dexter's

156
00:05:46,150 --> 00:05:45,280
grip

157
00:05:47,909 --> 00:05:46,160
to

158
00:05:49,830 --> 00:05:47,919
move that wire out of the way so that

159
00:05:52,870 --> 00:05:49,840
the the following operation that would

160
00:05:55,990 --> 00:05:52,880
occur a couple hours later

161
00:05:58,230 --> 00:05:56,000
could be successful so that type of

162
00:06:01,990 --> 00:05:58,240
immediate recognition of the situation

163
00:06:04,230 --> 00:06:02,000

and executing pre-planned procedures

164
00:06:05,909 --> 00:06:04,240
worked perfectly last night and that's

165
00:06:08,710 --> 00:06:05,919
the sort of thing we did time and time

166
00:06:10,150 --> 00:06:08,720
again on hubble space telescope

167
00:06:12,150 --> 00:06:10,160
hal you know one of the main differences

168
00:06:14,150 --> 00:06:12,160
between hubble and this is that you had

169
00:06:16,390 --> 00:06:14,160
astronauts up there with their own eyes

170
00:06:17,749 --> 00:06:16,400
on it this is uh quite different because

171
00:06:19,430 --> 00:06:17,759
you guys are commanding it from the

172
00:06:21,350 --> 00:06:19,440
ground while the space station is up

173
00:06:22,950 --> 00:06:21,360
there orbiting so what are some of the

174
00:06:25,110 --> 00:06:22,960
challenges and you know does it make

175
00:06:27,670 --> 00:06:25,120
does it make you nervous to be uh to be

176
00:06:28,629 --> 00:06:27,680
doing something of this size um you know

177
00:06:29,909 --> 00:06:28,639
with something that you really can't

178
00:06:31,110 --> 00:06:29,919
send you've got cameras on it but you

179
00:06:31,990 --> 00:06:31,120
really can't see it up close and

180
00:06:35,590 --> 00:06:32,000
personal you're having to do this

181
00:06:37,670 --> 00:06:35,600
remotely it it's different and it's the

182
00:06:39,749 --> 00:06:37,680
same we still have humans and robots

183
00:06:41,670 --> 00:06:39,759
working together

184
00:06:45,350 --> 00:06:41,680
astronauts routinely would stand at the

185
00:06:46,230 --> 00:06:45,360
end of the shuttle rms the 39-foot arm

186
00:06:50,309 --> 00:06:46,240
and

187
00:06:52,390 --> 00:06:50,319
operations

188
00:06:54,469 --> 00:06:52,400

and now we simply have the humans on the

189
00:06:57,029 --> 00:06:54,479
ground controlling the arm from the

190
00:06:59,270 --> 00:06:57,039
ground so in that regard

191
00:07:01,029 --> 00:06:59,280
it is still humans and robots working

192
00:07:03,510 --> 00:07:01,039
together

193
00:07:06,309 --> 00:07:03,520
being able to do things that neither one

194
00:07:08,550 --> 00:07:06,319
can do by themselves as well or as

195
00:07:10,070 --> 00:07:08,560
quickly as efficiently

196
00:07:13,189 --> 00:07:10,080
but it is different you are absolutely

197
00:07:15,589 --> 00:07:13,199
right the the innate abilities that

198
00:07:18,469 --> 00:07:15,599
humans have the the the on the spot

199
00:07:21,670 --> 00:07:18,479
judgment um the ability to assess the

200
00:07:24,870 --> 00:07:21,680
situation to automatically adjust your

201
00:07:27,270 --> 00:07:24,880
hand your wrist if you're not um

202
00:07:29,909 --> 00:07:27,280
rotating the screw perfectly actual to

203
00:07:31,909 --> 00:07:29,919
to how it's screwed on for example those

204
00:07:34,150 --> 00:07:31,919
are things that robots can't do unless

205
00:07:37,110 --> 00:07:34,160
we tell them to do it

206
00:07:38,550 --> 00:07:37,120
so we are quite fortunate that space

207
00:07:41,670 --> 00:07:38,560
station has

208
00:07:43,430 --> 00:07:41,680
an excellent on-orbit dexterous robot

209
00:07:45,350 --> 00:07:43,440
dexter

210
00:07:47,350 --> 00:07:45,360
and so it was

211
00:07:49,110 --> 00:07:47,360
considerably easier for us to put

212
00:07:51,189 --> 00:07:49,120
together a suite of sophisticated

213
00:07:53,670 --> 00:07:51,199

robotic tools

214
00:07:56,150 --> 00:07:53,680
because dexter existed in orbit and

215
00:07:57,670 --> 00:07:56,160
dexter of course is brought to us by our

216
00:07:59,830 --> 00:07:57,680
international partners the canadian

217
00:08:02,390 --> 00:07:59,840
space agency

218
00:08:03,589 --> 00:08:02,400
so it is different because we get so

219
00:08:05,270 --> 00:08:03,599
used to

220
00:08:07,589 --> 00:08:05,280
knowing what humans can do and not even

221
00:08:08,469 --> 00:08:07,599
thinking about it so it requires us to

222
00:08:10,469 --> 00:08:08,479
to

223
00:08:12,629 --> 00:08:10,479
decompose the way humans normally

224
00:08:15,110 --> 00:08:12,639
perform tasks and to make sure that

225
00:08:16,950 --> 00:08:15,120
we've programmed the robot and the tools

226
00:08:18,550 --> 00:08:16,960
to uh

227
00:08:19,830 --> 00:08:18,560
to still be able to accomplish their

228
00:08:20,629 --> 00:08:19,840
their mission

229
00:08:22,070 --> 00:08:20,639
so

230
00:08:23,990 --> 00:08:22,080
it does require

231
00:08:25,430 --> 00:08:24,000
a different type of thinking but i'll

232
00:08:27,909 --> 00:08:25,440
tell you what we've got a great team

233
00:08:30,629 --> 00:08:27,919
here at goddard and at johnson and at

234
00:08:32,389 --> 00:08:30,639
csa so i'm incredibly proud of what

235
00:08:33,990 --> 00:08:32,399
they've put together

236
00:08:35,350 --> 00:08:34,000
so you talked about the wire sniff that

237
00:08:37,190 --> 00:08:35,360
took place yesterday you guys are going

238
00:08:38,550 --> 00:08:37,200

to get kicked off this afternoon with

239
00:08:41,190 --> 00:08:38,560
some more activities talk about what's

240
00:08:42,630 --> 00:08:41,200
ahead for today and the rest of the week

241
00:08:46,389 --> 00:08:42,640
sure

242
00:08:50,630 --> 00:08:49,190
dexter as i said has got two arms you

243
00:08:53,509 --> 00:08:50,640
can you might think of it as a

244
00:08:56,389 --> 00:08:53,519
gunslinger with a gun in each hand or or

245
00:08:59,030 --> 00:08:56,399
ambidextrous mechanic who's got a socket

246
00:09:01,590 --> 00:08:59,040
wrench on one side and a

247
00:09:03,509 --> 00:09:01,600
a drill or another tool in his other

248
00:09:05,750 --> 00:09:03,519
hand so right now

249
00:09:06,949 --> 00:09:05,760
we've got two tools out

250
00:09:08,790 --> 00:09:06,959
a wire cutter tool and the

251
00:09:10,790 --> 00:09:08,800
multi-function tool

252
00:09:13,750 --> 00:09:10,800
the wire cutter tool

253
00:09:15,670 --> 00:09:13,760
not surprisingly cuts wire and

254
00:09:18,389 --> 00:09:15,680
and that's what it's going to be doing

255
00:09:19,829 --> 00:09:18,399
later today and into the wee hours of

256
00:09:21,670 --> 00:09:19,839
tomorrow

257
00:09:22,389 --> 00:09:21,680
and in the other hand

258
00:09:24,230 --> 00:09:22,399
we

259
00:09:26,870 --> 00:09:24,240
dexter is holding the

260
00:09:28,389 --> 00:09:26,880
multifunction tool and in it is a

261
00:09:30,790 --> 00:09:28,399
tertiary cap

262
00:09:33,910 --> 00:09:30,800
and we need that was removed yesterday

263
00:09:36,389 --> 00:09:33,920

so it's about the size of pardon the

264
00:09:38,949 --> 00:09:36,399
analogy of a shot glass

265
00:09:40,070 --> 00:09:38,959
but this tertiary cap needs to be stowed

266
00:09:41,750 --> 00:09:40,080
safely

267
00:09:44,389 --> 00:09:41,760
to make sure that it doesn't come free

268
00:09:46,070 --> 00:09:44,399
at any time in the future so

269
00:09:48,829 --> 00:09:46,080
we will command

270
00:09:52,070 --> 00:09:48,839
the the stowage of that tertiary

271
00:09:54,070 --> 00:09:52,080
cap and then we will commence to cutting

272
00:09:56,710 --> 00:09:54,080
two more wires

273
00:09:59,350 --> 00:09:56,720
and we will see where they pop and we

274
00:10:02,790 --> 00:09:59,360
will react accordingly and that will

275
00:10:05,269 --> 00:10:02,800
close out day three's partly day two's

276
00:10:06,870 --> 00:10:05,279
activities

277
00:10:08,230 --> 00:10:06,880
all right well we will uh continue to

278
00:10:09,750 --> 00:10:08,240
watch this here on nasa tv of course

279
00:10:10,790 --> 00:10:09,760
we'll have live coverage uh throughout

280
00:10:12,150 --> 00:10:10,800
the week ben i want to thank you for

281
00:10:13,430 --> 00:10:12,160
your time we'll uh

282
00:10:15,190 --> 00:10:13,440
it's uh it's pretty cool to watch the

283
00:10:16,870 --> 00:10:15,200
stuff with these robots in space taking

284
00:10:18,069 --> 00:10:16,880
place outside the space station it's a

285
00:10:19,430 --> 00:10:18,079
it's a radically different type of

286
00:10:21,190 --> 00:10:19,440
experiment but it's one that's

287
00:10:23,269 --> 00:10:21,200
incredibly interesting to watch well

288
00:10:24,630 --> 00:10:23,279

thank you for the time to uh to let me

289
00:10:26,949 --> 00:10:24,640
explain what we're doing and i look