
NASA

1
00:00:07,349 --> 00:00:05,110
good day and welcome to the kennedy

2
00:00:09,430 --> 00:00:07,359
space center i am d wayne washington

3
00:00:11,270 --> 00:00:09,440
from the office of communications at

4
00:00:13,350 --> 00:00:11,280
nasa's goddard space flight center in

5
00:00:15,589 --> 00:00:13,360
greenbelt maryland today we're here to

6
00:00:17,349 --> 00:00:15,599
talk about the robotic refueling mission

7
00:00:19,510 --> 00:00:17,359
the module to be carried on the final

8
00:00:21,830 --> 00:00:19,520
shuttle mission here to explain the

9
00:00:24,390 --> 00:00:21,840
mission to my left

10
00:00:26,150 --> 00:00:24,400
frank cepellini

11
00:00:28,710 --> 00:00:26,160
project manager for the satellite

12
00:00:30,870 --> 00:00:28,720
servicing capabilities office at nasa's

13
00:00:35,990 --> 00:00:30,880

goddard space flight center

14
00:00:42,709 --> 00:00:39,350
matthew caron mission operations manager

15
00:00:46,950 --> 00:00:42,719
canadian space agency

16
00:00:50,950 --> 00:00:49,190
and finally we have ben reed deputy

17
00:00:53,430 --> 00:00:50,960
project manager for the satellite

18
00:00:55,750 --> 00:00:53,440
servicing capabilities office at nasa's

19
00:00:57,670 --> 00:00:55,760
goddard space flight center we'll begin

20
00:00:59,990 --> 00:00:57,680
with sepi

21
00:01:01,750 --> 00:01:00,000
well thank you for coming

22
00:01:03,590 --> 00:01:01,760
i look around the room and i see a lot

23
00:01:05,910 --> 00:01:03,600
of familiar faces

24
00:01:08,789 --> 00:01:05,920
we've been here for the last 20 years if

25
00:01:11,190 --> 00:01:08,799
you all remember with repair activities

26
00:01:13,670 --> 00:01:11,200
human repair activities on hubble

27
00:01:17,510 --> 00:01:13,680
but then i really started with you all

28
00:01:20,630 --> 00:01:17,520
back in that with kennedy back in 1984

29
00:01:23,670 --> 00:01:20,640
where we robotically captured solar max

30
00:01:24,390 --> 00:01:23,680
and then with humans repaired solar max

31
00:01:26,950 --> 00:01:24,400
so

32
00:01:29,270 --> 00:01:26,960
the servicing capabilities

33
00:01:31,590 --> 00:01:29,280
primarily vested with humans and with

34
00:01:33,749 --> 00:01:31,600
robotics started way back

35
00:01:35,670 --> 00:01:33,759
some 35 years ago

36
00:01:37,670 --> 00:01:35,680
and the interesting part about it is

37
00:01:40,469 --> 00:01:37,680
here we are today

38
00:01:43,590 --> 00:01:40,479

opening up a brand new era

39
00:01:45,830 --> 00:01:43,600
and i underscore brand new era

40
00:01:48,710 --> 00:01:45,840
in servicing of

41
00:01:50,950 --> 00:01:48,720
expensive satellite systems

42
00:01:54,870 --> 00:01:50,960
through the use of robotics

43
00:01:57,190 --> 00:01:54,880
and that's represents a new major

44
00:01:59,749 --> 00:01:57,200
initiative and capability

45
00:02:01,590 --> 00:01:59,759
that the global space community is now

46
00:02:02,950 --> 00:02:01,600
stepping up to and i want to introduce

47
00:02:06,230 --> 00:02:02,960
our partner

48
00:02:08,790 --> 00:02:06,240
who we've worked hard with at canadian

49
00:02:10,949 --> 00:02:08,800
space agency matthew carone and the

50
00:02:13,350 --> 00:02:10,959
canadian space agency that have been the

51
00:02:15,430 --> 00:02:13,360
other part of this u.s

52
00:02:17,030 --> 00:02:15,440
canadian partnership and they are the

53
00:02:19,910 --> 00:02:17,040
folks that build

54
00:02:22,790 --> 00:02:19,920
the robotic arm the canadian robotic arm

55
00:02:25,110 --> 00:02:22,800
for iss and spit them

56
00:02:27,270 --> 00:02:25,120
did what we affectionately called the

57
00:02:28,710 --> 00:02:27,280
dexter robot which we will be using on

58
00:02:33,430 --> 00:02:28,720
this mission

59
00:02:34,869 --> 00:02:33,440
is going to talk about the details as to

60
00:02:38,309 --> 00:02:34,879
how it works

61
00:02:40,949 --> 00:02:38,319
but it focuses on two principal issues

62
00:02:43,350 --> 00:02:40,959
the first principle issue is the ability

63
00:02:45,670 --> 00:02:43,360

to capture and repair

64
00:02:48,150 --> 00:02:45,680
satellites that have never been designed

65
00:02:49,270 --> 00:02:48,160
for in-orbit repair or capture

66
00:02:52,070 --> 00:02:49,280
if you remember

67
00:02:54,070 --> 00:02:52,080
hubble and solar max had elements of

68
00:02:55,110 --> 00:02:54,080
designability incorporated into their

69
00:02:57,990 --> 00:02:55,120
systems

70
00:03:00,869 --> 00:02:58,000
where in fact they were amenable to

71
00:03:04,550 --> 00:03:00,879
repair via humans

72
00:03:06,869 --> 00:03:04,560
in the present state there's over 370

73
00:03:08,869 --> 00:03:06,879
semi-commercial communication satellites

74
00:03:09,830 --> 00:03:08,879
in geosynchronous orbit and over a

75
00:03:11,910 --> 00:03:09,840
hundred

76
00:03:13,910 --> 00:03:11,920
government-owned systems none of which

77
00:03:15,589 --> 00:03:13,920
have been designed for repair

78
00:03:17,589 --> 00:03:15,599
yet what we're trying to do and

79
00:03:18,949 --> 00:03:17,599
demonstrate is that the

80
00:03:20,470 --> 00:03:18,959
technology

81
00:03:21,990 --> 00:03:20,480
and capability

82
00:03:24,229 --> 00:03:22,000
through robotics

83
00:03:27,190 --> 00:03:24,239
today exists

84
00:03:28,550 --> 00:03:27,200
and by use of the space station external

85
00:03:30,470 --> 00:03:28,560
platform

86
00:03:33,190 --> 00:03:30,480
we can in fact

87
00:03:35,350 --> 00:03:33,200
eliminate or reduce the risks

88
00:03:37,670 --> 00:03:35,360

of doing those kinds of tasks

89
00:03:39,670 --> 00:03:37,680
robotically in space

90
00:03:41,030 --> 00:03:39,680
and so with that let me turn it over to

91
00:03:42,710 --> 00:03:41,040
ben

92
00:03:44,830 --> 00:03:42,720
and oh excuse me

93
00:03:47,270 --> 00:03:44,840
matt it's all

94
00:03:49,509 --> 00:03:47,280
yours you very much um the canadian

95
00:03:52,149 --> 00:03:49,519
space agency is very pleased to be

96
00:03:54,229 --> 00:03:52,159
collaborating with nasa on this on the

97
00:03:55,110 --> 00:03:54,239
robotics refueling mission

98
00:03:57,110 --> 00:03:55,120
um

99
00:03:58,710 --> 00:03:57,120
we're quite looking forward to to this

100
00:04:01,750 --> 00:03:58,720
demonstration that will show that that

101
00:04:04,470 --> 00:04:01,760
space robots can use special tools and

102
00:04:06,710 --> 00:04:04,480
unique maneuvers in order to

103
00:04:08,390 --> 00:04:06,720
to service satellites even to the extent

104
00:04:11,110 --> 00:04:08,400
of refueling them

105
00:04:12,869 --> 00:04:11,120
and as was pointed out this this mission

106
00:04:14,710 --> 00:04:12,879
will be using the canadian build dexter

107
00:04:16,390 --> 00:04:14,720
which is a two-armed robot which was

108
00:04:17,590 --> 00:04:16,400
designed for the the space station's

109
00:04:19,509 --> 00:04:17,600
maintenance

110
00:04:21,349 --> 00:04:19,519
but this will be the first time for

111
00:04:22,629 --> 00:04:21,359
dexter that that dexter will be involved

112
00:04:24,950 --> 00:04:22,639
in such a research and development

113
00:04:26,310 --> 00:04:24,960

project as opposed to the routine

114
00:04:28,310 --> 00:04:26,320
maintenance

115
00:04:29,909 --> 00:04:28,320
and logistics on board the international

116
00:04:32,070 --> 00:04:29,919
space station

117
00:04:33,350 --> 00:04:32,080
so in canada we're we're quite proud of

118
00:04:34,710 --> 00:04:33,360
our our legacy in the field of space

119
00:04:35,990 --> 00:04:34,720
robotics

120
00:04:37,350 --> 00:04:36,000
if we look at the canadarm which has

121
00:04:38,550 --> 00:04:37,360
been on the space shuttle for the last

122
00:04:40,310 --> 00:04:38,560
30 years

123
00:04:41,590 --> 00:04:40,320
we alluded to early

124
00:04:43,270 --> 00:04:41,600
satellite servicing missions for

125
00:04:44,950 --> 00:04:43,280
instance the hubble space telescope

126
00:04:46,550 --> 00:04:44,960
servicing missions where the shuttle

127
00:04:50,310 --> 00:04:46,560
astronauts used

128
00:04:51,830 --> 00:04:50,320
the count arm to to catch and retrieve

129
00:04:53,110 --> 00:04:51,840
satellites to be repaired before

130
00:04:54,070 --> 00:04:53,120
releasing them

131
00:04:56,070 --> 00:04:54,080
so

132
00:04:57,830 --> 00:04:56,080
really that we had a lot of success with

133
00:05:00,230 --> 00:04:57,840
this and if you look more recently we've

134
00:05:01,430 --> 00:05:00,240
celebrated 10 years of canadarm2

135
00:05:03,510 --> 00:05:01,440
operations

136
00:05:06,790 --> 00:05:03,520
onboard the space station and this

137
00:05:09,029 --> 00:05:06,800
anniversary also marked the decade of of

138
00:05:10,950 --> 00:05:09,039

of intense collaboration between nasa

139
00:05:12,790 --> 00:05:10,960
and the canadian space agency

140
00:05:14,950 --> 00:05:12,800
as our respective teams of engineers

141
00:05:17,350 --> 00:05:14,960
have been working very closely together

142
00:05:18,710 --> 00:05:17,360
in the preparation and execution of

143
00:05:20,870 --> 00:05:18,720
day-to-day

144
00:05:24,150 --> 00:05:20,880
robotics operations and now if you look

145
00:05:26,629 --> 00:05:24,160
with dexter more recently even more

146
00:05:29,189 --> 00:05:26,639
dexter has been used recently for to

147
00:05:30,710 --> 00:05:29,199
offload the kunatori japanese resupply

148
00:05:32,950 --> 00:05:30,720
vehicle

149
00:05:34,550 --> 00:05:32,960
later on this summer it will be used in

150
00:05:37,029 --> 00:05:34,560
order to

151
00:05:39,189 --> 00:05:37,039
to replace a remote power controller

152
00:05:41,110 --> 00:05:39,199
module on board the space station

153
00:05:42,950 --> 00:05:41,120
so you can see that

154
00:05:44,870 --> 00:05:42,960
the robotics refueling mission is really

155
00:05:46,710 --> 00:05:44,880
falls well in line with with canada's

156
00:05:48,550 --> 00:05:46,720
own

157
00:05:49,909 --> 00:05:48,560
efforts in order to advance the field of

158
00:05:52,070 --> 00:05:49,919
space robotics

159
00:05:53,590 --> 00:05:52,080
um and and falls in line also with our

160
00:05:55,909 --> 00:05:53,600
the development of our and next

161
00:05:57,590 --> 00:05:55,919
generation canadarm project

162
00:05:58,790 --> 00:05:57,600
and um

163
00:06:00,790 --> 00:05:58,800

basically uh

164
00:06:02,950 --> 00:06:00,800
one one key difference though is that so

165
00:06:05,430 --> 00:06:02,960
far dexter has been used primarily in

166
00:06:07,990 --> 00:06:05,440
order to maintain uh devices that have

167
00:06:10,230 --> 00:06:08,000
been designed for robotic manipulation

168
00:06:12,150 --> 00:06:10,240
so we're quite looking forward to see

169
00:06:13,430 --> 00:06:12,160
how dexter will perform with those new

170
00:06:14,710 --> 00:06:13,440
tools

171
00:06:16,390 --> 00:06:14,720
because if you look at the tasks

172
00:06:18,070 --> 00:06:16,400
involved which are

173
00:06:19,670 --> 00:06:18,080
you know removing caps

174
00:06:21,590 --> 00:06:19,680
cutting through the exterior of a simula

175
00:06:23,110 --> 00:06:21,600
as the simulated exterior of a satellite

176
00:06:25,670 --> 00:06:23,120
or

177
00:06:28,469 --> 00:06:25,680
connecting a hose to a fuel valve

178
00:06:29,430 --> 00:06:28,479
those are all tasks which will

179
00:06:31,590 --> 00:06:29,440
you know

180
00:06:33,430 --> 00:06:31,600
present unprecedented demands on

181
00:06:36,309 --> 00:06:33,440
dexter's sense of touch

182
00:06:37,909 --> 00:06:36,319
and and find emotion so we're we're

183
00:06:41,110 --> 00:06:37,919
quite looking forward to

184
00:06:43,270 --> 00:06:41,120
to executing those tasks and seeing um

185
00:06:44,710 --> 00:06:43,280
basically how we can work together share

186
00:06:46,710 --> 00:06:44,720
our expertise

187
00:06:48,950 --> 00:06:46,720
as we tackle those those

188
00:06:51,029 --> 00:06:48,960

well these these new operations thank

189
00:06:52,309 --> 00:06:51,039
you

190
00:06:54,230 --> 00:06:52,319
all right so now we'll go to ben and

191
00:06:56,710 --> 00:06:54,240
hill give us a demonstration on just

192
00:06:58,150 --> 00:06:56,720
what the rrm mission will look like

193
00:07:01,830 --> 00:06:58,160
thank you d wayne

194
00:07:03,909 --> 00:07:01,840
thank you sepi and and matt

195
00:07:05,670 --> 00:07:03,919
name is ben reed i am the deputy project

196
00:07:07,430 --> 00:07:05,680
manager of the satellite servicing

197
00:07:09,749 --> 00:07:07,440
capabilities office

198
00:07:11,749 --> 00:07:09,759
so you heard both sepi and matt talk

199
00:07:12,950 --> 00:07:11,759
about different satellite servicing

200
00:07:14,830 --> 00:07:12,960
capabilities

201
00:07:16,950 --> 00:07:14,840
i like to think of it as a three-legged

202
00:07:19,029 --> 00:07:16,960
stool the first leg of satellite

203
00:07:21,189 --> 00:07:19,039
servicing is repair

204
00:07:22,710 --> 00:07:21,199
and refueling so i'm going to talk a lot

205
00:07:23,830 --> 00:07:22,720
about repair and refueling in just a

206
00:07:26,309 --> 00:07:23,840
minute here

207
00:07:27,589 --> 00:07:26,319
the second leg is in-orbit construction

208
00:07:29,350 --> 00:07:27,599
you have something that's too big to fit

209
00:07:31,270 --> 00:07:29,360
in a single rocket when you fly up two

210
00:07:33,749 --> 00:07:31,280
halves you join in space that's another

211
00:07:36,629 --> 00:07:33,759
capability that satellite servicing

212
00:07:39,029 --> 00:07:36,639
brings to the agency and to the to the

213
00:07:42,629 --> 00:07:39,039

international space community

214
00:07:45,350 --> 00:07:42,639
the third is active orbital debris

215
00:07:47,029 --> 00:07:45,360
uh removal to be able to the ability to

216
00:07:48,550 --> 00:07:47,039
go up and grapple something that wasn't

217
00:07:50,550 --> 00:07:48,560
designed to be grappled and then do

218
00:07:52,950 --> 00:07:50,560
something with it push it up push it

219
00:07:54,950 --> 00:07:52,960
down dispose of it somehow so those are

220
00:07:57,510 --> 00:07:54,960
the three main

221
00:07:59,270 --> 00:07:57,520
legs of the satellite servicing stool so

222
00:08:01,430 --> 00:07:59,280
i'm going to talk a lot about repair and

223
00:08:03,990 --> 00:08:01,440
refueling

224
00:08:05,270 --> 00:08:04,000
so i've got four wonderful kids at home

225
00:08:06,710 --> 00:08:05,280
they're a little bit older now but when

226
00:08:08,550 --> 00:08:06,720
they were small

227
00:08:11,350 --> 00:08:08,560
i used to buy them toys obviously one of

228
00:08:13,189 --> 00:08:11,360
which was a fisher-price workbench right

229
00:08:14,710 --> 00:08:13,199
what comes in the box when you get it

230
00:08:16,790 --> 00:08:14,720
it's a little tool bench with some

231
00:08:19,110 --> 00:08:16,800
little plastic nails and a plastic

232
00:08:21,589 --> 00:08:19,120
hammer so the nails is what the hammer

233
00:08:23,430 --> 00:08:21,599
hits you don't get a little arm inside

234
00:08:25,670 --> 00:08:23,440
there to control it that's what the kid

235
00:08:27,749 --> 00:08:25,680
provides the kid picks up the tool hits

236
00:08:30,390 --> 00:08:27,759
the little plastic nails well that's

237
00:08:34,389 --> 00:08:30,400
exactly what we have here on our high

238
00:08:37,750 --> 00:08:34,399

fidelity mechanical simulator that we

239
00:08:41,909 --> 00:08:37,760
at goddard built so to help us with the

240
00:08:44,949 --> 00:08:41,919
rrm module which is obviously on um in

241
00:08:46,710 --> 00:08:44,959
the sts-135 right now ready for launch

242
00:08:49,350 --> 00:08:46,720
and just let me pause for a moment to

243
00:08:51,590 --> 00:08:49,360
say how humbled and proud we are to be

244
00:08:53,590 --> 00:08:51,600
part of sts-135 could not be more

245
00:08:55,110 --> 00:08:53,600
excited to be here

246
00:08:57,590 --> 00:08:55,120
for this launch

247
00:08:59,110 --> 00:08:57,600
so here we have our fisher-price toy box

248
00:09:01,110 --> 00:08:59,120
at the risk of being misquoted i'm going

249
00:09:03,190 --> 00:09:01,120
to try to stick with that analogy

250
00:09:04,790 --> 00:09:03,200
so

251
00:09:07,110 --> 00:09:04,800
what are the nails what are the things

252
00:09:09,269 --> 00:09:07,120
we're going to work on well those are

253
00:09:11,990 --> 00:09:09,279
legacy satellite interfaces interfaces

254
00:09:13,190 --> 00:09:12,000
that were not designed to be serviced in

255
00:09:16,070 --> 00:09:13,200
orbit

256
00:09:18,310 --> 00:09:16,080
primarily i will talk about a fill and

257
00:09:19,829 --> 00:09:18,320
drain valve so

258
00:09:22,470 --> 00:09:19,839
satellites

259
00:09:24,070 --> 00:09:22,480
that are built around the nation

260
00:09:26,150 --> 00:09:24,080
at goddard and many other places are

261
00:09:27,829 --> 00:09:26,160
sent to kennedy for processing they are

262
00:09:29,829 --> 00:09:27,839
empty they have no propellant inside

263
00:09:31,350 --> 00:09:29,839

when they arrive they get to the launch

264
00:09:33,269 --> 00:09:31,360
pad and now they're ready to receive

265
00:09:35,269 --> 00:09:33,279
their propellant right very hazardous so

266
00:09:36,870 --> 00:09:35,279
we do it late in the flow

267
00:09:38,790 --> 00:09:36,880
so this is what a fill and drain valve

268
00:09:40,630 --> 00:09:38,800
looks like right you see a quarter inch

269
00:09:42,230 --> 00:09:40,640
diameter hole here so somehow we're

270
00:09:43,829 --> 00:09:42,240
going to get the fuel in through this

271
00:09:45,910 --> 00:09:43,839
quarter inch diameter hole into the

272
00:09:48,949 --> 00:09:45,920
satellite so when it gets in orbit it's

273
00:09:51,829 --> 00:09:48,959
got propellant so they thread on to this

274
00:09:53,070 --> 00:09:51,839
last male threads here they pump in the

275
00:09:56,550 --> 00:09:53,080
hydrazine

276
00:09:58,550 --> 00:09:56,560
tetroxide

277
00:10:00,949 --> 00:09:58,560
they then rotate this silver nut here

278
00:10:02,949 --> 00:10:00,959
and that closes off an internal seal now

279
00:10:04,470 --> 00:10:02,959
the fluid is contained inside the

280
00:10:06,470 --> 00:10:04,480
satellite but

281
00:10:08,470 --> 00:10:06,480
it's so hazardous they need extra

282
00:10:11,110 --> 00:10:08,480
precaution right if that seal were to

283
00:10:13,430 --> 00:10:11,120
fail and to propel them or to leak out

284
00:10:16,150 --> 00:10:13,440
very bad for the humans in the area and

285
00:10:18,550 --> 00:10:16,160
we like to be safe so they put on

286
00:10:21,509 --> 00:10:18,560
a secondary cap that provides additional

287
00:10:23,030 --> 00:10:21,519
safety and it is cleverly called a

288
00:10:23,990 --> 00:10:23,040

safety cap

289
00:10:26,389 --> 00:10:24,000
so

290
00:10:28,069 --> 00:10:26,399
safety cap goes on next now we've got

291
00:10:30,470 --> 00:10:28,079
two seals the internal seal and the

292
00:10:32,630 --> 00:10:30,480
safety cap

293
00:10:35,110 --> 00:10:32,640
now they put on safety wire to prevent

294
00:10:37,509 --> 00:10:35,120
the actuation nut or the safety cap from

295
00:10:40,069 --> 00:10:37,519
inadvertently backing off during launch

296
00:10:41,750 --> 00:10:40,079
loads or ground processing loads they

297
00:10:43,829 --> 00:10:41,760
put safety wire

298
00:10:47,190 --> 00:10:43,839
to hold it in place and i'll show you

299
00:10:49,750 --> 00:10:47,200
safety wire on the module in a moment

300
00:10:51,509 --> 00:10:49,760
finally they put on a tertiary cap the

301
00:10:52,790 --> 00:10:51,519
tertiary cap goes over the whole

302
00:10:54,790 --> 00:10:52,800
assembly

303
00:10:56,630 --> 00:10:54,800
and it is safety wired shut so now we

304
00:10:58,230 --> 00:10:56,640
have two fault tolerance two of the

305
00:11:00,630 --> 00:10:58,240
seals can fail we've got a third one

306
00:11:03,670 --> 00:11:00,640
that will keep the hazardous fuel inside

307
00:11:05,269 --> 00:11:03,680
the spacecraft not where the humans are

308
00:11:06,870 --> 00:11:05,279
so if we're going to undo this

309
00:11:08,550 --> 00:11:06,880
robotically we've got to reverse those

310
00:11:09,990 --> 00:11:08,560
steps so

311
00:11:12,550 --> 00:11:10,000
safety wire is the first thing we need

312
00:11:16,389 --> 00:11:12,560
to tackle so take a guess what we call

313
00:11:18,710 --> 00:11:16,399

the tool that we use to cut wire

314
00:11:20,710 --> 00:11:18,720
the wire cutter tool exactly right

315
00:11:22,630 --> 00:11:20,720
so we have a wire cutter tool

316
00:11:24,470 --> 00:11:22,640
and rather than pulling out of the bays

317
00:11:25,990 --> 00:11:24,480
where it's stored for launch i'll show

318
00:11:27,110 --> 00:11:26,000
you this one so here's our wire cutter

319
00:11:30,870 --> 00:11:27,120
tool

320
00:11:32,310 --> 00:11:30,880
has at the tip of it

321
00:11:34,389 --> 00:11:32,320
a hook it's kind of hard to see it's on

322
00:11:37,110 --> 00:11:34,399
the back side that we use to hook around

323
00:11:38,150 --> 00:11:37,120
a piece of wire we then use the dexter

324
00:11:39,750 --> 00:11:38,160
robot

325
00:11:42,550 --> 00:11:39,760
by our good friends at the canadian

326
00:11:45,190 --> 00:11:42,560
space agency which is holding our tool

327
00:11:47,269 --> 00:11:45,200
to drive the torque or drive which

328
00:11:48,949 --> 00:11:47,279
activates a lead screw inside and it

329
00:11:51,030 --> 00:11:48,959
closes down a little blade which chops

330
00:11:53,030 --> 00:11:51,040
the wire in half so now we've just done

331
00:11:55,590 --> 00:11:53,040
our first robotic activity

332
00:11:57,590 --> 00:11:55,600
this robotic activity is controlled via

333
00:12:00,150 --> 00:11:57,600
our friends down in johnson space center

334
00:12:01,509 --> 00:12:00,160
a partner with us on the rrm mission

335
00:12:03,910 --> 00:12:01,519
they are flying the robot they are

336
00:12:05,750 --> 00:12:03,920
flying the dexter robot from the thicker

337
00:12:08,389 --> 00:12:05,760
one at mission control in houston so

338
00:12:11,509 --> 00:12:08,399

very tight collaboration with our robo

339
00:12:14,150 --> 00:12:11,519
friends in houston so we cut the wire

340
00:12:16,150 --> 00:12:14,160
and now we're ready to we put that tool

341
00:12:17,670 --> 00:12:16,160
away now we're ready to go after the

342
00:12:25,030 --> 00:12:17,680
tertiary cap

343
00:12:27,030 --> 00:12:25,040
that be the sole function of the tool

344
00:12:28,389 --> 00:12:27,040
we designed a tool that has multiple

345
00:12:30,790 --> 00:12:28,399
functions

346
00:12:32,389 --> 00:12:30,800
so we call it the multi-function tool

347
00:12:33,829 --> 00:12:32,399
so the multi-function tool will pick up

348
00:12:35,990 --> 00:12:33,839
one of four adapters and the four

349
00:12:38,150 --> 00:12:36,000
adapters are stored in these four

350
00:12:39,509 --> 00:12:38,160
receptacles you see on top of our

351
00:12:41,829 --> 00:12:39,519
mock-up here

352
00:12:44,069 --> 00:12:41,839
so we pick up the tertiary cap adapter

353
00:12:46,310 --> 00:12:44,079
out of this location

354
00:12:48,470 --> 00:12:46,320
it attaches to the end of the

355
00:12:49,269 --> 00:12:48,480
multi-function tool and now with that

356
00:12:53,430 --> 00:12:49,279
tool

357
00:12:54,710 --> 00:12:53,440
we engage the tertiary cap unscrew it

358
00:12:57,110 --> 00:12:54,720
take it off

359
00:12:59,910 --> 00:12:57,120
so that cap is then stowed

360
00:13:02,150 --> 00:12:59,920
in here and now we've exposed the two

361
00:13:04,389 --> 00:13:02,160
safety wires and the safety cap

362
00:13:06,069 --> 00:13:04,399
we picked the wire cutter tool back up

363
00:13:07,829 --> 00:13:06,079

we cut the two pieces of wire here just

364
00:13:08,949 --> 00:13:07,839
like we did the first one

365
00:13:11,269 --> 00:13:08,959
and

366
00:13:13,910 --> 00:13:11,279
we then use our safety cap tool

367
00:13:15,509 --> 00:13:13,920
and i will remove the safety cap tool

368
00:13:20,389 --> 00:13:15,519
just the way the dexter robot would do

369
00:13:23,590 --> 00:13:21,829
so

370
00:13:26,470 --> 00:13:23,600
this is how the safety cap tool is

371
00:13:27,590 --> 00:13:26,480
removed so here is our 18 pound safety

372
00:13:29,430 --> 00:13:27,600
cap tool

373
00:13:31,269 --> 00:13:29,440
it looks rather complex let me see if i

374
00:13:33,350 --> 00:13:31,279
can break it down a little bit simpler

375
00:13:35,190 --> 00:13:33,360
so the active part of the tool is right

376
00:13:37,430 --> 00:13:35,200
down the center the center shaft is

377
00:13:40,870 --> 00:13:37,440
where all the gears the mechanisms are

378
00:13:42,310 --> 00:13:40,880
that allow the dexter robot to actuate

379
00:13:45,189 --> 00:13:42,320
its torque or drive

380
00:13:48,069 --> 00:13:45,199
to engage the safety cap and unscrew it

381
00:13:50,150 --> 00:13:48,079
from the robot well the robo flyers as

382
00:13:51,350 --> 00:13:50,160
good as they are down in houston they

383
00:13:53,189 --> 00:13:51,360
have to be able to see what they're

384
00:13:55,829 --> 00:13:53,199
doing obviously so

385
00:13:58,470 --> 00:13:55,839
we have two integral cameras and their

386
00:13:59,350 --> 00:13:58,480
led lights which allow the robo flyer to

387
00:14:01,670 --> 00:13:59,360
see

388
00:14:02,629 --> 00:14:01,680

the business end of the tool

389
00:14:05,030 --> 00:14:02,639
so

390
00:14:07,750 --> 00:14:05,040
the safety cap tool then engages the

391
00:14:11,509 --> 00:14:07,760
safety cap removes it

392
00:14:14,470 --> 00:14:11,519
and that part of the job is done

393
00:14:17,030 --> 00:14:14,480
so now we have an exposed or

394
00:14:19,910 --> 00:14:17,040
naked fill and drain valve so the safety

395
00:14:21,590 --> 00:14:19,920
cap has now been removed

396
00:14:23,269 --> 00:14:21,600
leaving behind a fill and drain valve

397
00:14:25,110 --> 00:14:23,279
that looks like this so now we would

398
00:14:27,030 --> 00:14:25,120
need to

399
00:14:28,389 --> 00:14:27,040
do the robotic activity to attach to

400
00:14:30,949 --> 00:14:28,399
these male threads

401
00:14:32,790 --> 00:14:30,959
and transfer fluid into it just as a

402
00:14:34,550 --> 00:14:32,800
spacecraft in orbit would give the

403
00:14:36,150 --> 00:14:34,560
customer satellite

404
00:14:37,269 --> 00:14:36,160
more propellant

405
00:14:39,910 --> 00:14:37,279
so

406
00:14:41,430 --> 00:14:39,920
we use our final tool here our fourth

407
00:14:43,670 --> 00:14:41,440
tool

408
00:14:45,269 --> 00:14:43,680
and that is an embedded acronym

409
00:14:47,829 --> 00:14:45,279
it's the evr

410
00:14:50,470 --> 00:14:47,839
nozzle tool or ent

411
00:14:52,069 --> 00:14:50,480
so not an eva activity no astronauts

412
00:14:54,310 --> 00:14:52,079
involved with this demonstration it's

413
00:14:55,750 --> 00:14:54,320

all robotic so it's an evr

414
00:14:56,949 --> 00:14:55,760
nozzle tool

415
00:14:58,629 --> 00:14:56,959
and you can see what's different about

416
00:15:00,470 --> 00:14:58,639
this one right off the bat is that it

417
00:15:02,550 --> 00:15:00,480
has this hose connected to it well

418
00:15:04,790 --> 00:15:02,560
obviously we have to flow fluid somehow

419
00:15:07,509 --> 00:15:04,800
so we use that hose

420
00:15:10,069 --> 00:15:07,519
which after we thread on to the exposed

421
00:15:12,949 --> 00:15:10,079
threads here we're able to pump fluid

422
00:15:15,829 --> 00:15:12,959
through the ent and into an internal

423
00:15:18,310 --> 00:15:15,839
system we have a series of tanks valves

424
00:15:21,829 --> 00:15:18,320
latches inside

425
00:15:24,069 --> 00:15:21,839
the module that we command through elc

426
00:15:25,509 --> 00:15:24,079
via our other partner in this mission

427
00:15:28,230 --> 00:15:25,519
and that is the marshall space flight

428
00:15:31,430 --> 00:15:28,240
center we have been working very well uh

429
00:15:32,230 --> 00:15:31,440
with the command team down at marshall

430
00:15:44,230 --> 00:15:32,240
to

431
00:15:45,910 --> 00:15:44,240
about the the steps involved with

432
00:15:47,430 --> 00:15:45,920
robotic refueling

433
00:15:50,949 --> 00:15:47,440
we have a lot of other tasks we're going

434
00:15:52,550 --> 00:15:50,959
to do on this mission but refueling is

435
00:15:54,230 --> 00:15:52,560
one of them so

436
00:15:56,310 --> 00:15:54,240
i have a video now that i've gone into

437
00:15:58,710 --> 00:15:56,320
great detail and i'm sure have confused

438
00:15:59,749 --> 00:15:58,720

all of you if we could roll the video

439
00:16:01,590 --> 00:15:59,759
please

440
00:16:03,189 --> 00:16:01,600
and you'll be able to get

441
00:16:08,069 --> 00:16:03,199
an overview of what the mission is going

442
00:16:10,949 --> 00:16:09,269
okay

443
00:16:13,670 --> 00:16:10,959
so

444
00:16:16,150 --> 00:16:13,680
after launch on flight day five

445
00:16:18,629 --> 00:16:16,160
we will be picked up by the eva crew

446
00:16:22,550 --> 00:16:18,639
member the iss eva crew member and

447
00:16:24,230 --> 00:16:22,560
transfer it over to the eotp platform

448
00:16:28,150 --> 00:16:24,240
a few weeks after that we'll be moved

449
00:16:30,150 --> 00:16:28,160
from the eotp platform to elc 4

450
00:16:31,590 --> 00:16:30,160
which is at the far right side of the

451
00:16:34,310 --> 00:16:31,600
video screen

452
00:16:35,509 --> 00:16:34,320
once we are located on elc 4

453
00:16:37,110 --> 00:16:35,519
then the

454
00:16:38,949 --> 00:16:37,120
ssrms

455
00:16:40,629 --> 00:16:38,959
picking up the two arm dexter will be

456
00:16:41,430 --> 00:16:40,639
moved over just as you see in the video

457
00:16:43,350 --> 00:16:41,440
now

458
00:16:45,670 --> 00:16:43,360
and it will begin the operation so i've

459
00:16:46,710 --> 00:16:45,680
talked about the four tools that will be

460
00:16:48,870 --> 00:16:46,720
picked up

461
00:16:49,670 --> 00:16:48,880
here you can see in the video

462
00:16:53,269 --> 00:16:49,680
that

463
00:16:55,030 --> 00:16:53,279

one of dexter's arms is going in

464
00:16:58,069 --> 00:16:55,040
and making contact

465
00:17:00,790 --> 00:16:58,079
so this shows you from a big picture how

466
00:17:03,670 --> 00:17:00,800
at the end of a 55 foot arm the two arm

467
00:17:06,710 --> 00:17:03,680
dexter will be doing the operations

468
00:17:09,909 --> 00:17:06,720
so here you see a split screen

469
00:17:12,150 --> 00:17:09,919
the image in the upper left is the view

470
00:17:13,990 --> 00:17:12,160
that the robo flyer will get right these

471
00:17:16,230 --> 00:17:14,000
are from the the camera is located on

472
00:17:18,069 --> 00:17:16,240
top you see the god's eye view in the

473
00:17:20,390 --> 00:17:18,079
center of the screen but you see the

474
00:17:22,549 --> 00:17:20,400
tool camera view so that's the view that

475
00:17:23,270 --> 00:17:22,559
the robo flyer gets when the operations

476
00:17:25,350 --> 00:17:23,280
are

477
00:17:27,669 --> 00:17:25,360
being conducted so you can see that

478
00:17:30,549 --> 00:17:27,679
safety wire is mighty hard to see so it

479
00:17:32,390 --> 00:17:30,559
took a tremendous amount of coordination

480
00:17:35,669 --> 00:17:32,400
with our tool development team

481
00:17:38,789 --> 00:17:35,679
at goddard the robo flyers at johnson

482
00:17:40,470 --> 00:17:38,799
the operations folks up at csa who are

483
00:17:42,950 --> 00:17:40,480
building um

484
00:17:44,710 --> 00:17:42,960
the re configuration files for the robot

485
00:17:46,710 --> 00:17:44,720
for this so tremendous amount of

486
00:17:48,789 --> 00:17:46,720
coordination was required

487
00:17:50,310 --> 00:17:48,799
so now you see

488
00:17:52,390 --> 00:17:50,320

a close-up view

489
00:17:53,110 --> 00:17:52,400
of the very end of dexter's arm picking

490
00:17:55,350 --> 00:17:53,120
up

491
00:17:58,950 --> 00:17:55,360
the multi-function tool

492
00:18:00,390 --> 00:17:58,960
quiz anyone paying attention what does

493
00:18:02,870 --> 00:18:00,400
it need to pick up to remove the

494
00:18:06,710 --> 00:18:02,880
tertiary cap

495
00:18:09,669 --> 00:18:06,720
people in the audience that are on my

496
00:18:10,950 --> 00:18:09,679
team you guys should know the answer

497
00:18:13,590 --> 00:18:10,960
all right so here we have the tertiary

498
00:18:15,909 --> 00:18:13,600
cap adapter and it is going to go after

499
00:18:18,230 --> 00:18:15,919
you got it the tertiary cap again the

500
00:18:20,150 --> 00:18:18,240
split screen the window and window

501
00:18:23,430 --> 00:18:20,160
that is the actual laboratory footage

502
00:18:25,110 --> 00:18:23,440
sped up tremendously i might add

503
00:18:26,710 --> 00:18:25,120
the removing of the tertiary cap so

504
00:18:29,350 --> 00:18:26,720
we've done these operations on the

505
00:18:31,590 --> 00:18:29,360
ground in the lab many many times what

506
00:18:35,590 --> 00:18:31,600
we haven't done is these operations in

507
00:18:36,870 --> 00:18:35,600
orbit so that's what rrm is it's the on

508
00:18:39,430 --> 00:18:36,880
orbit

509
00:18:42,950 --> 00:18:39,440
the zero-g demonstration

510
00:18:44,390 --> 00:18:42,960
of robotic refueling of legacy

511
00:18:46,150 --> 00:18:44,400
interfaces

512
00:18:47,590 --> 00:18:46,160
for the first time

513
00:18:48,950 --> 00:18:47,600

again we've done it many times on the

514
00:18:50,390 --> 00:18:48,960
ground but we've never been able we've

515
00:18:51,669 --> 00:18:50,400
never done it in orbit so that's what

516
00:18:54,950 --> 00:18:51,679
rrm we

517
00:18:56,950 --> 00:18:54,960
anticipate it enabling future missions

518
00:18:59,750 --> 00:18:56,960
future capabilities for the

519
00:19:01,430 --> 00:18:59,760
international aerospace community

520
00:19:03,350 --> 00:19:01,440
thank you very much

521
00:19:04,870 --> 00:19:03,360
all right so now we'll open up for

522
00:19:06,549 --> 00:19:04,880
questions

523
00:19:08,150 --> 00:19:06,559
i'll ask that you wait for the

524
00:19:09,669 --> 00:19:08,160
microphone first

525
00:19:10,470 --> 00:19:09,679
when we get there please state your full

526
00:19:12,310 --> 00:19:10,480
name

527
00:19:14,150 --> 00:19:12,320
and your affiliation

528
00:19:17,669 --> 00:19:14,160
so we'll begin with the gentleman

529
00:19:20,789 --> 00:19:19,590
uh jim siegel celebration independent

530
00:19:22,549 --> 00:19:20,799
newspaper

531
00:19:23,909 --> 00:19:22,559
um i may be a little slow here i just

532
00:19:25,590 --> 00:19:23,919
kind of wanted to make sure that i

533
00:19:27,830 --> 00:19:25,600
understood what you were talking about

534
00:19:29,590 --> 00:19:27,840
so this this module

535
00:19:31,510 --> 00:19:29,600
is going to be attached to the outside

536
00:19:33,669 --> 00:19:31,520
of the international space station

537
00:19:35,350 --> 00:19:33,679
correct correct and it's going to stay

538
00:19:37,350 --> 00:19:35,360

there indefinitely is that correct it's

539
00:19:39,430 --> 00:19:37,360
not coming back or land operation just

540
00:19:42,230 --> 00:19:39,440
two years of operations afterward that

541
00:19:43,669 --> 00:19:42,240
is the current plan okay and then the

542
00:19:48,549 --> 00:19:43,679
arm

543
00:19:50,950 --> 00:19:48,559
would uh capture and retrieve a

544
00:19:53,110 --> 00:19:50,960
satellite

545
00:19:56,630 --> 00:19:53,120
correct let me correct you there okay so

546
00:19:58,310 --> 00:19:56,640
rather than bringing a satellite to iss

547
00:20:00,150 --> 00:19:58,320
that would be rather challenging to do

548
00:20:01,909 --> 00:20:00,160
from an orbit dynamics point of view and

549
00:20:04,470 --> 00:20:01,919
from a safety point of view

550
00:20:06,870 --> 00:20:04,480
so rather than bringing a customer

551
00:20:09,190 --> 00:20:06,880
satellite to iss first we need to

552
00:20:10,870 --> 00:20:09,200
demonstrate the technology on mock

553
00:20:12,789 --> 00:20:10,880
satellite interfaces

554
00:20:15,270 --> 00:20:12,799
so what you see here

555
00:20:18,549 --> 00:20:15,280
is a fill and drain valve that is

556
00:20:20,630 --> 00:20:18,559
exactly like it would be on

557
00:20:23,590 --> 00:20:20,640
a real satellite in orbit so we are

558
00:20:25,590 --> 00:20:23,600
going to demonstrate the capability here

559
00:20:27,590 --> 00:20:25,600
before we do it for real on a satellite

560
00:20:30,149 --> 00:20:27,600
so i've seen in the press i've seen in

561
00:20:33,190 --> 00:20:30,159
the press it is easy to talk about rrm

562
00:20:36,070 --> 00:20:33,200
as a gas station in space

563
00:20:38,390 --> 00:20:36,080

that is the next mission this mission is

564
00:20:40,549 --> 00:20:38,400
to show that the technology exists today

565
00:20:42,710 --> 00:20:40,559
to show that we have the the capability

566
00:20:44,470 --> 00:20:42,720
today rather than to start refueling

567
00:20:46,149 --> 00:20:44,480
satellites

568
00:20:48,710 --> 00:20:46,159
a week from now when we're in orbit okay

569
00:20:51,350 --> 00:20:48,720
so this demonstration module is going to

570
00:20:53,190 --> 00:20:51,360
stay attached to the iss for two years

571
00:20:55,350 --> 00:20:53,200
yes and it's going to be

572
00:20:57,909 --> 00:20:55,360
only demonstrating it's not going to be

573
00:21:00,310 --> 00:20:57,919
servicing any other i went into great

574
00:21:02,149 --> 00:21:00,320
detail about the refueling part of it we

575
00:21:04,149 --> 00:21:02,159
have five major tasks that we are going

576
00:21:06,549 --> 00:21:04,159
to do with rrm but for the sake of time

577
00:21:09,350 --> 00:21:06,559
i focus just on refueling we have a lot

578
00:21:11,830 --> 00:21:09,360
of other interfaces you can see

579
00:21:13,590 --> 00:21:11,840
she's a pretty porcupine is she not

580
00:21:15,270 --> 00:21:13,600
well

581
00:21:16,630 --> 00:21:15,280
there we've got lots of other tools

582
00:21:18,230 --> 00:21:16,640
we've got lots of other adapters we've

583
00:21:21,270 --> 00:21:18,240
got lots of other legacy satellite

584
00:21:22,870 --> 00:21:21,280
interfaces that we're going to practice

585
00:21:25,590 --> 00:21:22,880
limited repair

586
00:21:27,669 --> 00:21:25,600
and other servicing tasks on it so i've

587
00:21:29,270 --> 00:21:27,679
just talked about refueling today so

588
00:21:31,430 --> 00:21:29,280

it's going to take us two years to make

589
00:21:32,390 --> 00:21:31,440
it through the entire gamut of planned

590
00:21:34,230 --> 00:21:32,400
tasks

591
00:21:35,190 --> 00:21:34,240
and then there is is there a timeline

592
00:21:38,070 --> 00:21:35,200
for

593
00:21:40,149 --> 00:21:38,080
when something like this an operational

594
00:21:41,909 --> 00:21:40,159
phase ii whatever device

595
00:21:44,549 --> 00:21:41,919
would be attached to the space station

596
00:21:46,470 --> 00:21:44,559
and the idea is eventually phase two

597
00:21:48,390 --> 00:21:46,480
phase three whatever to capture

598
00:21:51,350 --> 00:21:48,400
satellites and bring them in and the

599
00:21:54,470 --> 00:21:51,360
substance the subsequent phase would be

600
00:21:57,029 --> 00:21:54,480
to build a standalone robotic servicing

601
00:22:01,350 --> 00:21:57,039
spacecraft to go do real satellites in

602
00:22:02,950 --> 00:22:01,360
orbit orbit dynamics being what they are

603
00:22:05,190 --> 00:22:02,960
if you're not near space station it

604
00:22:06,710 --> 00:22:05,200
takes a tremendous amount of fuel to get

605
00:22:09,029 --> 00:22:06,720
there so

606
00:22:11,190 --> 00:22:09,039
or somebody to need service in orbit you

607
00:22:13,350 --> 00:22:11,200
send a tow truck to them or

608
00:22:15,110 --> 00:22:13,360
geosynchronous orbit as my boss frank

609
00:22:17,029 --> 00:22:15,120
seppolina mentioned there's well over

610
00:22:18,230 --> 00:22:17,039
400 satellites they're all at the same

611
00:22:20,390 --> 00:22:18,240
altitude

612
00:22:21,510 --> 00:22:20,400
almost the same angle and going the same

613
00:22:23,510 --> 00:22:21,520

direction

614
00:22:26,230 --> 00:22:23,520
so geosynchronous orbit seems like a

615
00:22:28,070 --> 00:22:26,240
very logical place to launch the first

616
00:22:28,950 --> 00:22:28,080
servicing mission right you're not going

617
00:22:33,590 --> 00:22:28,960
to

618
00:22:34,870 --> 00:22:33,600
come by right

619
00:22:36,950 --> 00:22:34,880
you're going to put it strategically

620
00:22:39,510 --> 00:22:36,960
where you can get to a lot of customers

621
00:22:41,830 --> 00:22:39,520
quickly so were i to be designing a

622
00:22:43,029 --> 00:22:41,840
mission to go and service satellites to

623
00:22:45,110 --> 00:22:43,039
space i'd want to go where there's a lot

624
00:22:46,950 --> 00:22:45,120
of customers going the same direction to

625
00:22:48,390 --> 00:22:46,960
minimize the amount of fuel to get to

626
00:22:50,710 --> 00:22:48,400
them and that would be geosynchronous

627
00:22:52,950 --> 00:22:50,720
orbit

628
00:22:54,630 --> 00:22:52,960
all right so gentlemen right here the

629
00:22:57,029 --> 00:22:54,640
front

630
00:22:58,870 --> 00:22:57,039
hi ken kramer space flight magazine um

631
00:23:01,110 --> 00:22:58,880
question about the canadian involvement

632
00:23:03,270 --> 00:23:01,120
i was wondering um when when dexter was

633
00:23:05,590 --> 00:23:03,280
uh was launched and

634
00:23:07,909 --> 00:23:05,600
conceptualized was was this

635
00:23:10,870 --> 00:23:07,919
rrm on the plate or was this kind of

636
00:23:12,390 --> 00:23:10,880
added afterwards thanks

637
00:23:14,950 --> 00:23:12,400
that's a very good question no it was

638
00:23:17,110 --> 00:23:14,960

not so basically dexter's main mission

639
00:23:18,549 --> 00:23:17,120
on board the station is to

640
00:23:20,310 --> 00:23:18,559
perform maintenance and logistics

641
00:23:21,830 --> 00:23:20,320
operations for

642
00:23:23,909 --> 00:23:21,840
components that have been designed to be

643
00:23:27,510 --> 00:23:23,919
handled robotically and clearly one of

644
00:23:28,630 --> 00:23:27,520
the purposes of this demonstration is to

645
00:23:30,470 --> 00:23:28,640
demonstrate that you can actually

646
00:23:33,110 --> 00:23:30,480
interact with components that have not

647
00:23:35,110 --> 00:23:33,120
been designed for robotic manipulation

648
00:23:36,870 --> 00:23:35,120
so i think we had enough flexibility in

649
00:23:38,950 --> 00:23:36,880
the system

650
00:23:40,870 --> 00:23:38,960
the ability to interface with tools to

651
00:23:43,750 --> 00:23:40,880
upgrade software to

652
00:23:45,750 --> 00:23:43,760
optimize its performance using special

653
00:23:48,230 --> 00:23:45,760
specialized robotics

654
00:23:49,990 --> 00:23:48,240
configuration files that allows us to do

655
00:23:51,669 --> 00:23:50,000
that but definitely one of the objective

656
00:23:53,909 --> 00:23:51,679
for us of this

657
00:23:55,750 --> 00:23:53,919
of this particular demonstration is to

658
00:23:58,870 --> 00:23:55,760
see just how far we can push dexter and

659
00:24:01,350 --> 00:23:58,880
accomplish those those exciting tasks

660
00:24:04,390 --> 00:24:01,360
that must be very exciting

661
00:24:07,190 --> 00:24:04,400
a very exciting uh uh avenue for you are

662
00:24:08,630 --> 00:24:07,200
there any other um dexter um

663
00:24:10,549 --> 00:24:08,640

operations coming up that are new that

664
00:24:12,789 --> 00:24:10,559
you could tell us about

665
00:24:15,029 --> 00:24:12,799
well dexter really has been in full

666
00:24:17,990 --> 00:24:15,039
operation since 2010 it arrived in 2008

667
00:24:20,230 --> 00:24:18,000
but we really started in earnest to to

668
00:24:20,950 --> 00:24:20,240
operate it for for instance to offload

669
00:24:25,269 --> 00:24:20,960
the

670
00:24:28,230 --> 00:24:25,279
next year

671
00:24:29,830 --> 00:24:28,240
sorry later on this summer we will be

672
00:24:32,390 --> 00:24:29,840
changing out a remote power controller

673
00:24:34,950 --> 00:24:32,400
module if you recall last year we had

674
00:24:36,950 --> 00:24:34,960
we had attempted to do so but the

675
00:24:39,590 --> 00:24:36,960
the module did not meet exactly all the

676
00:24:41,990 --> 00:24:39,600
the required robotics requirements

677
00:24:43,830 --> 00:24:42,000
and uh but we were able to perform more

678
00:24:46,549 --> 00:24:43,840
analysis and now we're we're going to

679
00:24:49,669 --> 00:24:46,559
continue doing so so in a way

680
00:24:52,390 --> 00:24:49,679
um all new operations every every new on

681
00:24:54,789 --> 00:24:52,400
orbit replaceable unit we we we change

682
00:24:56,230 --> 00:24:54,799
out brings us a wealth of additional

683
00:24:58,070 --> 00:24:56,240
knowledge for us

684
00:25:00,230 --> 00:24:58,080
if you look just at the operation of the

685
00:25:01,990 --> 00:25:00,240
of dexter it originally it was uh

686
00:25:03,590 --> 00:25:02,000
conceived as purely operated by

687
00:25:05,510 --> 00:25:03,600
astronauts onboard the station and now

688
00:25:07,669 --> 00:25:05,520

its primary mode of operation has

689
00:25:09,669 --> 00:25:07,679
transitioned over to ground operators so

690
00:25:11,350 --> 00:25:09,679
it's a very exciting time for all

691
00:25:15,190 --> 00:25:11,360
involved

692
00:25:18,310 --> 00:25:15,200
all right take this gentleman right here

693
00:25:20,390 --> 00:25:18,320
yeah hi mike wahl from space.com um so

694
00:25:21,510 --> 00:25:20,400
yeah so this is actually already i mean

695
00:25:23,510 --> 00:25:21,520
you've already shown this can work in

696
00:25:25,029 --> 00:25:23,520
the lab i was just wondering i mean what

697
00:25:26,390 --> 00:25:25,039
are your your kind of thoughts about

698
00:25:28,230 --> 00:25:26,400
what the main challenges are going to be

699
00:25:29,190 --> 00:25:28,240
in space what are what are some of the

700
00:25:31,110 --> 00:25:29,200
biggest hurdles that you're going to

701
00:25:33,029 --> 00:25:31,120
have to overcome and i mean how much

702
00:25:35,909 --> 00:25:33,039
more difficult is that going to be than

703
00:25:37,510 --> 00:25:35,919
what you've already seen it do

704
00:25:39,190 --> 00:25:37,520
so to answer that question it sounds

705
00:25:41,350 --> 00:25:39,200
like we need somebody with expertise in

706
00:25:42,950 --> 00:25:41,360
both robotics and in

707
00:25:44,310 --> 00:25:42,960
tools

708
00:25:45,669 --> 00:25:44,320
so

709
00:25:48,549 --> 00:25:45,679
i would like to turn it over to my

710
00:25:50,470 --> 00:25:48,559
colleague joe mcguire jill it was the

711
00:25:51,669 --> 00:25:50,480
tool manager for the hubble servicing

712
00:25:54,390 --> 00:25:51,679
missions

713
00:25:57,190 --> 00:25:54,400

and she is a project manager for

714
00:25:58,470 --> 00:25:57,200
rrm here so jill would you uh help me

715
00:25:59,990 --> 00:25:58,480
answer this one

716
00:26:01,430 --> 00:26:00,000
i knew that uh

717
00:26:03,190 --> 00:26:01,440
ben prepped me to say he was going to

718
00:26:05,110 --> 00:26:03,200
turn a question over me i see he decided

719
00:26:08,870 --> 00:26:05,120
to give me the hard question save the

720
00:26:11,029 --> 00:26:08,880
easy ones for himself i'm no dummy

721
00:26:12,549 --> 00:26:11,039
so um just to make sure i understood

722
00:26:14,470 --> 00:26:12,559
what you asked the biggest difference

723
00:26:16,310 --> 00:26:14,480
between doing this in the ground in in

724
00:26:17,909 --> 00:26:16,320
orbit what we can expect the biggest

725
00:26:20,789 --> 00:26:17,919
difference is really in the orbital

726
00:26:23,190 --> 00:26:20,799
dynamics or how the contact dynamics

727
00:26:25,750 --> 00:26:23,200
on the ground we can control it

728
00:26:28,390 --> 00:26:25,760
how when we interface to this we can't

729
00:26:29,990 --> 00:26:28,400
100 percent control that in space and if

730
00:26:33,350 --> 00:26:30,000
you think about when we use the dexter

731
00:26:35,750 --> 00:26:33,360
robot it's on the end of the canadian

732
00:26:38,070 --> 00:26:35,760
arm 2. so you've got the dynamics in

733
00:26:40,710 --> 00:26:38,080
play between the canadian r2 and the

734
00:26:42,230 --> 00:26:40,720
spdm robot and then our tool so when you

735
00:26:43,269 --> 00:26:42,240
have all of that dynamics coming into

736
00:26:45,110 --> 00:26:43,279
play there's going to be some

737
00:26:47,669 --> 00:26:45,120
oscillations so

738
00:26:50,070 --> 00:26:47,679

coming trying to

739
00:26:53,190 --> 00:26:50,080
downplay that or figure out how that how

740
00:26:54,630 --> 00:26:53,200
you can react your to the spacecraft

741
00:26:57,029 --> 00:26:54,640
the interface when you touch it is the

742
00:27:00,390 --> 00:26:57,039
biggest thing so we built a contact

743
00:27:02,630 --> 00:27:00,400
dynamics facility at goddard where we

744
00:27:04,470 --> 00:27:02,640
simulate the dynamics that we expect to

745
00:27:06,950 --> 00:27:04,480
see on orbit so that when we practice on

746
00:27:08,549 --> 00:27:06,960
the ground we have those dynamics

747
00:27:11,350 --> 00:27:08,559
simulated so we know how the tool will

748
00:27:12,230 --> 00:27:11,360
react when it touches the spacecraft so

749
00:27:18,950 --> 00:27:12,240
the

750
00:27:21,110 --> 00:27:18,960
on orbit and we learn how

751
00:27:23,750 --> 00:27:21,120
the tools react to the interface we can

752
00:27:25,669 --> 00:27:23,760
then get ground characterization of our

753
00:27:27,110 --> 00:27:25,679
ground test bed or characterization of

754
00:27:28,470 --> 00:27:27,120
our ground test but excuse me so that

755
00:27:30,950 --> 00:27:28,480
will be the key thing is really the

756
00:27:33,269 --> 00:27:30,960
on-orbit dynamics that we don't have 100

757
00:27:34,389 --> 00:27:33,279
simulated on the ground

758
00:27:38,149 --> 00:27:34,399
all right thank you

759
00:27:41,750 --> 00:27:40,070
james dean with florida today can you

760
00:27:46,230 --> 00:27:41,760
identify the satellite that you're

761
00:27:48,310 --> 00:27:46,240
planning to service and and when and um

762
00:27:49,909 --> 00:27:48,320
when that time comes will will it is

763
00:27:51,350 --> 00:27:49,919

there a possibility you're going to you

764
00:27:52,870 --> 00:27:51,360
know add customers or is that just going

765
00:27:54,789 --> 00:27:52,880
to be a one-off test

766
00:27:55,590 --> 00:27:54,799
well it's um

767
00:28:00,470 --> 00:27:55,600
it's

768
00:28:03,669 --> 00:28:00,480
try to usurp commercial industry

769
00:28:05,350 --> 00:28:03,679
what we're trying to do here

770
00:28:07,510 --> 00:28:05,360
although we have looked at a whole

771
00:28:10,389 --> 00:28:07,520
different families of a family of

772
00:28:11,350 --> 00:28:10,399
satellites with different end effectors

773
00:28:12,389 --> 00:28:11,360
different

774
00:28:15,590 --> 00:28:12,399
feeling

775
00:28:18,070 --> 00:28:15,600
fuel valves different kinds of

776
00:28:19,909 --> 00:28:18,080
appendage deployment issues and so on

777
00:28:21,750 --> 00:28:19,919
what we're trying to do here is to

778
00:28:25,590 --> 00:28:21,760
demonstrate

779
00:28:27,830 --> 00:28:25,600
that we can in fact apply the technology

780
00:28:29,590 --> 00:28:27,840
so that no matter who does it and we're

781
00:28:32,310 --> 00:28:29,600
going to make this of data available to

782
00:28:35,029 --> 00:28:32,320
everybody that is all commercial

783
00:28:37,909 --> 00:28:35,039
industry that may want to

784
00:28:40,149 --> 00:28:37,919
leap off and and and start their their

785
00:28:41,269 --> 00:28:40,159
own ventures make that technology

786
00:28:44,310 --> 00:28:41,279
available

787
00:28:46,389 --> 00:28:44,320
allow them to understand what the risks

788
00:28:49,350 --> 00:28:46,399

are what the problems are

789
00:28:52,149 --> 00:28:49,360
and to in effect try to consolidate or

790
00:28:56,950 --> 00:28:54,870
reduce the risks of

791
00:28:59,269 --> 00:28:56,960
in-orbit repair and refueling and

792
00:29:01,269 --> 00:28:59,279
maintenance and super sinking to the

793
00:29:02,870 --> 00:29:01,279
greatest decree possible by being able

794
00:29:04,549 --> 00:29:02,880
to demonstrate

795
00:29:06,630 --> 00:29:04,559
on this

796
00:29:07,669 --> 00:29:06,640
kind of activity that we're running from

797
00:29:08,950 --> 00:29:07,679
station

798
00:29:11,110 --> 00:29:08,960
and therefore

799
00:29:14,549 --> 00:29:11,120
give everybody the encouragement that's

800
00:29:16,389 --> 00:29:14,559
necessary to get them rolling

801
00:29:17,990 --> 00:29:16,399
and there's all kinds of historical

802
00:29:20,230 --> 00:29:18,000
analogies

803
00:29:21,909 --> 00:29:20,240
and reasons for doing this if if one

804
00:29:23,909 --> 00:29:21,919
recalls

805
00:29:26,950 --> 00:29:23,919
what we all depend on today with

806
00:29:30,230 --> 00:29:26,960
blackberries and ipads and ipods and you

807
00:29:33,350 --> 00:29:30,240
know it is bandwidth is calm bandwidth

808
00:29:35,029 --> 00:29:33,360
and bandwidth is expanding exponentially

809
00:29:35,990 --> 00:29:35,039
year after year after year and the need

810
00:29:39,430 --> 00:29:36,000
for it

811
00:29:42,710 --> 00:29:39,440
and so what we're basically trying to do

812
00:29:45,350 --> 00:29:42,720
is to provide the encouragement

813
00:29:47,909 --> 00:29:45,360

to different operators and users to

814
00:29:50,710 --> 00:29:47,919
design their satellites and to

815
00:29:53,110 --> 00:29:50,720
perhaps design build and fly

816
00:29:54,710 --> 00:29:53,120
missions that can take care of the

817
00:29:56,710 --> 00:29:54,720
normal repair

818
00:29:58,470 --> 00:29:56,720
maintenance and refueling

819
00:29:59,909 --> 00:29:58,480
that would normally

820
00:30:02,549 --> 00:29:59,919
be required

821
00:30:04,310 --> 00:30:02,559
and without such a thing the satellites

822
00:30:06,470 --> 00:30:04,320
that are not getting this support or

823
00:30:09,350 --> 00:30:06,480
getting this kind of support would end

824
00:30:12,549 --> 00:30:09,360
in the end in failure would end

825
00:30:15,269 --> 00:30:12,559
their lives either abruptly or short of

826
00:30:18,389 --> 00:30:15,279
a full expectation of utilization

827
00:30:21,909 --> 00:30:18,399
so really this is a level of maturity

828
00:30:23,990 --> 00:30:21,919
for space in the space agency to help

829
00:30:26,149 --> 00:30:24,000
accelerate this maturity level and

830
00:30:28,389 --> 00:30:26,159
demonstrate this maturity level

831
00:30:31,750 --> 00:30:28,399
to give people

832
00:30:34,149 --> 00:30:31,760
like the telstar people in in the early

833
00:30:35,990 --> 00:30:34,159
60s the confidence

834
00:30:38,870 --> 00:30:36,000
to get going with a commercial

835
00:30:40,870 --> 00:30:38,880
communications satellite industry

836
00:30:44,310 --> 00:30:40,880
and that's what in fact has happened

837
00:30:47,190 --> 00:30:44,320
that's what nasa's role is give

838
00:30:51,269 --> 00:30:47,200

potential users the confidence

839
00:30:53,830 --> 00:30:51,279
to go ahead take the risks leap forward

840
00:30:57,029 --> 00:30:53,840
and for all of mankind

841
00:30:58,789 --> 00:30:57,039
to receive the benefits

842
00:31:00,789 --> 00:30:58,799
ten years from now the amount of

843
00:31:03,990 --> 00:31:00,799
bandwidth required

844
00:31:05,750 --> 00:31:04,000
if the rate of expansion of ipods and

845
00:31:08,710 --> 00:31:05,760
kindles and everything else

846
00:31:10,389 --> 00:31:08,720
in computation in the sky

847
00:31:11,990 --> 00:31:10,399
in the clouds

848
00:31:13,190 --> 00:31:12,000
if that expands at the rate we're going

849
00:31:16,070 --> 00:31:13,200
to have we're going to be a hundred

850
00:31:18,630 --> 00:31:16,080
times more in need 10 years from now of

851
00:31:21,350 --> 00:31:18,640
bandwidth than we have today can you

852
00:31:23,269 --> 00:31:21,360
imagine what that says about

853
00:31:25,590 --> 00:31:23,279
communication satellites and how to

854
00:31:27,750 --> 00:31:25,600
handle them and how to maintain them and

855
00:31:29,669 --> 00:31:27,760
how to protect them and how to use them

856
00:31:32,789 --> 00:31:29,679
and even more important

857
00:31:35,110 --> 00:31:32,799
we pay x number of fractions of a cent

858
00:31:36,630 --> 00:31:35,120
per data bit that comes down

859
00:31:37,990 --> 00:31:36,640
can you imagine

860
00:31:40,710 --> 00:31:38,000
what would happen

861
00:31:42,789 --> 00:31:40,720
if that if the numbers of

862
00:31:44,630 --> 00:31:42,799
communications bandwidth capability were

863
00:31:46,549 --> 00:31:44,640

to expand

864
00:31:49,190 --> 00:31:46,559
it would be a supply

865
00:31:51,590 --> 00:31:49,200
demand kind of ratio and you would lower

866
00:31:57,350 --> 00:31:51,600
the cost of operations and that's

867
00:32:02,389 --> 00:31:59,830
um so your intent is to

868
00:32:05,430 --> 00:32:02,399
basically turn over like an rrm type

869
00:32:07,110 --> 00:32:05,440
device to uh to a commercial user that

870
00:32:09,509 --> 00:32:07,120
would like integrate the technology

871
00:32:11,590 --> 00:32:09,519
something other than than dexter to the

872
00:32:13,830 --> 00:32:11,600
technology we we're going to make this

873
00:32:15,909 --> 00:32:13,840
technology

874
00:32:18,549 --> 00:32:15,919
yeah you wouldn't turn rrm over but

875
00:32:21,509 --> 00:32:18,559
you'd turn the technology to the type of

876
00:32:22,950 --> 00:32:21,519
tools the approach the lighting

877
00:32:25,590 --> 00:32:22,960
the cameras

878
00:32:29,190 --> 00:32:25,600
the tele robotic feedback those kinds of

879
00:32:32,310 --> 00:32:30,950
right right in the yellow shirt

880
00:32:34,630 --> 00:32:32,320
wait for the microphone please question

881
00:32:36,789 --> 00:32:34,640
for csa matthew does that mean that the

882
00:32:38,549 --> 00:32:36,799
canadian space agency and mcdonald while

883
00:32:42,070 --> 00:32:38,559
the technology of dexter would also be

884
00:32:43,909 --> 00:32:42,080
turned over to commercial affairs

885
00:32:46,789 --> 00:32:43,919
right now the plans is we're operating

886
00:32:48,149 --> 00:32:46,799
rm exactly like any other

887
00:32:49,590 --> 00:32:48,159
operation on the international space

888
00:32:51,110 --> 00:32:49,600

station we're

889
00:32:53,830 --> 00:32:51,120
you know participating in the flight

890
00:32:55,909 --> 00:32:53,840
control and the production of mission

891
00:32:58,149 --> 00:32:55,919
planning products and so on it will

892
00:33:00,630 --> 00:32:58,159
perform the analysis so basically the

893
00:33:02,950 --> 00:33:00,640
involvement of mcdonald that welder and

894
00:33:05,029 --> 00:33:02,960
associates as a primary contractor to

895
00:33:06,389 --> 00:33:05,039
csa for the international space station

896
00:33:07,430 --> 00:33:06,399
support they support us they provide us

897
00:33:09,269 --> 00:33:07,440
with the engineering support that's

898
00:33:11,269 --> 00:33:09,279
required to

899
00:33:13,430 --> 00:33:11,279
perform these tasks as we would for any

900
00:33:14,710 --> 00:33:13,440
other maintenance task onboard the space

901
00:33:16,549 --> 00:33:14,720
station

902
00:33:18,950 --> 00:33:16,559
in parallel uh what we're doing is that

903
00:33:21,110 --> 00:33:18,960
we're we have put up um

904
00:33:23,830 --> 00:33:21,120
there's a in works a next-generation

905
00:33:26,870 --> 00:33:23,840
cataract project where we're developing

906
00:33:28,710 --> 00:33:26,880
terrestrial prototypes for robots

907
00:33:31,750 --> 00:33:28,720
and defectors tools and so on but at

908
00:33:34,710 --> 00:33:31,760
this point it's it's uh basically uh

909
00:33:36,070 --> 00:33:34,720
the current state of our projects

910
00:33:37,269 --> 00:33:36,080
all right

911
00:33:40,950 --> 00:33:37,279
so a

912
00:33:45,350 --> 00:33:43,029
hi mark kirkman interspace news um

913
00:33:47,669 --> 00:33:45,360

actually a two-part question um in

914
00:33:49,509 --> 00:33:47,679
dealing with the uh or in regards to the

915
00:33:50,630 --> 00:33:49,519
space refueling do you kind of envision

916
00:33:52,789 --> 00:33:50,640
this uh

917
00:33:54,149 --> 00:33:52,799
using this initially at least with

918
00:33:55,830 --> 00:33:54,159
satellites that are at the end of their

919
00:33:57,909 --> 00:33:55,840
life cycle because i can foresee a

920
00:33:59,509 --> 00:33:57,919
scenario for instance you go up there

921
00:34:01,190 --> 00:33:59,519
with a satellite and you manipulate a

922
00:34:02,549 --> 00:34:01,200
valve that hasn't been operated since it

923
00:34:04,470 --> 00:34:02,559
left the ground and now all of a sudden

924
00:34:07,750 --> 00:34:04,480
you're you're leaking gas

925
00:34:09,589 --> 00:34:07,760
um also the second question would be is

926
00:34:11,190 --> 00:34:09,599
there any effort in the industry now i

927
00:34:13,270 --> 00:34:11,200
mean is it too early to kind of

928
00:34:15,270 --> 00:34:13,280
standardize these types of fittings so

929
00:34:17,349 --> 00:34:15,280
that as this technology has developed

930
00:34:18,470 --> 00:34:17,359
you can deal with the new spacecraft

931
00:34:20,629 --> 00:34:18,480
that are being launched are they

932
00:34:23,589 --> 00:34:20,639
standardizing the these fittings the

933
00:34:25,349 --> 00:34:23,599
fuel valves etc etc

934
00:34:26,550 --> 00:34:25,359
um

935
00:34:28,790 --> 00:34:26,560
from the point of view of

936
00:34:30,869 --> 00:34:28,800
standardization most of the valves that

937
00:34:32,869 --> 00:34:30,879
are manufactured and built today are

938
00:34:36,470 --> 00:34:32,879

very very

939
00:34:38,389 --> 00:34:36,480
much the same kinematic principles the

940
00:34:39,829 --> 00:34:38,399
only thing that's different about them

941
00:34:41,829 --> 00:34:39,839
is dimensions

942
00:34:43,349 --> 00:34:41,839
for the most part from a refueling

943
00:34:45,510 --> 00:34:43,359
perspective we notice that that

944
00:34:48,069 --> 00:34:45,520
commonality has happened in the

945
00:34:50,069 --> 00:34:48,079
aerospace industry over the last 30

946
00:34:53,030 --> 00:34:50,079
years 40 years

947
00:34:55,829 --> 00:34:53,040
is really maybe a driver for

948
00:34:58,790 --> 00:34:55,839
consolidation and cost control

949
00:35:02,470 --> 00:34:58,800
but there is very very difficult to try

950
00:35:05,990 --> 00:35:02,480
to standardize anything in space

951
00:35:08,870 --> 00:35:06,000
in this arena because every aerospace

952
00:35:11,510 --> 00:35:08,880
manufacturer of satellites

953
00:35:13,910 --> 00:35:11,520
has his own unique approach

954
00:35:15,990 --> 00:35:13,920
and no way no how do they ever want to

955
00:35:17,910 --> 00:35:16,000
give that approach up because it's

956
00:35:20,150 --> 00:35:17,920
endemic

957
00:35:22,870 --> 00:35:20,160
so where does that leave

958
00:35:24,950 --> 00:35:22,880
repair and maintenance in orbit which is

959
00:35:27,589 --> 00:35:24,960
really the heart of your question

960
00:35:30,230 --> 00:35:27,599
we have to be dexterous enough we have

961
00:35:33,190 --> 00:35:30,240
to be general purpose enough with the

962
00:35:35,990 --> 00:35:33,200
development of our tools

963
00:35:38,470 --> 00:35:36,000

so as to be able to demonstrate that you

964
00:35:39,349 --> 00:35:38,480
can do more than one straightforward

965
00:35:42,630 --> 00:35:39,359
task

966
00:35:44,790 --> 00:35:42,640
on more than one kind of satellite

967
00:35:48,230 --> 00:35:44,800
on more than one kind of fill and

968
00:35:52,150 --> 00:35:50,870
and perhaps maybe on more than one type

969
00:35:55,270 --> 00:35:52,160
of array

970
00:35:57,510 --> 00:35:55,280
or one type of communications antenna

971
00:36:00,710 --> 00:35:57,520
that didn't deploy

972
00:36:02,470 --> 00:36:00,720
now the mix is of how many satellites

973
00:36:03,430 --> 00:36:02,480
the last question the first question you

974
00:36:05,990 --> 00:36:03,440
asked

975
00:36:08,069 --> 00:36:06,000
was what about the old bird that's up

976
00:36:09,670 --> 00:36:08,079
there and you try to refuel it's been up

977
00:36:11,670 --> 00:36:09,680
there 20 years

978
00:36:13,990 --> 00:36:11,680
and you can't do it

979
00:36:16,950 --> 00:36:14,000
well the one thing you can do

980
00:36:18,550 --> 00:36:16,960
is you can supersync it with um

981
00:36:20,310 --> 00:36:18,560
with that kind of

982
00:36:22,470 --> 00:36:20,320
tow truck sort of capability you can

983
00:36:24,069 --> 00:36:22,480
take it out of orbit so to speak

984
00:36:24,950 --> 00:36:24,079
so to speak

985
00:36:28,230 --> 00:36:24,960
so

986
00:36:30,630 --> 00:36:28,240
those are the kinds of thought processes

987
00:36:33,430 --> 00:36:30,640
that one has to come to grips with when

988
00:36:36,630 --> 00:36:33,440

one starts to think about

989
00:36:41,829 --> 00:36:36,640
developing tow trucks in orbit

990
00:36:44,150 --> 00:36:41,839
that can take care of expensive assets

991
00:36:46,470 --> 00:36:44,160
that's key and one has to think about

992
00:36:49,030 --> 00:36:46,480
the ability to leave that asset

993
00:36:50,230 --> 00:36:49,040
leave that tow truck in orbit

994
00:36:51,109 --> 00:36:50,240
long enough

995
00:36:53,190 --> 00:36:51,119
for

996
00:36:55,430 --> 00:36:53,200
several or quite a few

997
00:36:57,670 --> 00:36:55,440
different spacecrafts that get into

998
00:36:59,270 --> 00:36:57,680
trouble to take advantage of it and it's

999
00:37:01,510 --> 00:36:59,280
not going to be able to be all things to

1000
00:37:02,470 --> 00:37:01,520
all people it's not going to be able to

1001
00:37:05,270 --> 00:37:02,480
be that

1002
00:37:08,230 --> 00:37:05,280
but there will be as a result enough

1003
00:37:09,349 --> 00:37:08,240
competition and enough interest i think

1004
00:37:11,990 --> 00:37:09,359
i feel

1005
00:37:14,150 --> 00:37:12,000
that you'll have more than one supplier

1006
00:37:15,990 --> 00:37:14,160
and that's all that's all very good i

1007
00:37:19,190 --> 00:37:16,000
mean you have today you have

1008
00:37:21,109 --> 00:37:19,200
dlr in germany that's looking at similar

1009
00:37:23,109 --> 00:37:21,119
approaches with deals

1010
00:37:25,829 --> 00:37:23,119
you have the japanese that have done

1011
00:37:27,910 --> 00:37:25,839
even some demonstration servicing

1012
00:37:30,790 --> 00:37:27,920
on some of their payloads

1013
00:37:33,270 --> 00:37:30,800

you have canada and mda that are very

1014
00:37:35,349 --> 00:37:33,280
much interested in doing that and yes

1015
00:37:37,030 --> 00:37:35,359
i'm sure we're going to have american

1016
00:37:39,670 --> 00:37:37,040
communications companies that are going

1017
00:37:42,150 --> 00:37:39,680
to stand up and take an interest

1018
00:37:46,550 --> 00:37:42,160
but that's all well and good where would

1019
00:37:51,990 --> 00:37:49,510
competition is wonderful

1020
00:37:53,670 --> 00:37:52,000
and that's the important message here

1021
00:37:55,430 --> 00:37:53,680
and what you have to do to get

1022
00:37:58,230 --> 00:37:55,440
competition started

1023
00:38:00,150 --> 00:37:58,240
is reduce the risks

1024
00:38:01,829 --> 00:38:00,160
that they're walking into

1025
00:38:03,109 --> 00:38:01,839
reduce the risk

1026
00:38:05,510 --> 00:38:03,119
and that's what

1027
00:38:07,589 --> 00:38:05,520
rrm represents

1028
00:38:09,510 --> 00:38:07,599
it's a risk reduction technology

1029
00:38:11,750 --> 00:38:09,520
demonstration

1030
00:38:14,150 --> 00:38:11,760
probably from a space station

1031
00:38:17,270 --> 00:38:14,160
perspective

1032
00:38:19,670 --> 00:38:17,280
the most practical demonstration

1033
00:38:22,710 --> 00:38:19,680
of the worth of station from an

1034
00:38:24,710 --> 00:38:22,720
applications perspective not medical

1035
00:38:27,030 --> 00:38:24,720
not physiological

1036
00:38:30,310 --> 00:38:27,040
not metallurgical

1037
00:38:33,589 --> 00:38:30,320
but applications what does it bring

1038
00:38:35,510 --> 00:38:33,599

as a demonstration to you and i 10 years

1039
00:38:38,630 --> 00:38:35,520
from now

1040
00:38:41,190 --> 00:38:38,640
that's the key that's the key we have to

1041
00:38:42,950 --> 00:38:41,200
have the ability to look forward

1042
00:38:45,270 --> 00:38:42,960
we have to look beyond today and

1043
00:38:46,550 --> 00:38:45,280
tomorrow and keep stretching the

1044
00:38:48,390 --> 00:38:46,560
technology

1045
00:38:50,790 --> 00:38:48,400
and that's what space station is about

1046
00:38:53,910 --> 00:38:50,800
it gives us that applications technology

1047
00:38:56,550 --> 00:38:53,920
capability to push the envelope to get

1048
00:38:59,430 --> 00:38:56,560
us out in front yes

1049
00:39:01,990 --> 00:38:59,440
one day we're going to fly

1050
00:39:04,310 --> 00:39:02,000
a neurosurgical robot that will do

1051
00:39:06,390 --> 00:39:04,320
operations on astronauts

1052
00:39:08,150 --> 00:39:06,400
from the ground

1053
00:39:09,910 --> 00:39:08,160
they do that today and it's called da

1054
00:39:12,470 --> 00:39:09,920
vinci

1055
00:39:15,190 --> 00:39:12,480
and and the canadians have one and i'm

1056
00:39:17,829 --> 00:39:15,200
at a loss to tell you what it called but

1057
00:39:22,069 --> 00:39:17,839
10 of our hospitals today in the united

1058
00:39:23,910 --> 00:39:22,079
states have da vinci robot surgical

1059
00:39:26,950 --> 00:39:23,920
instruments

1060
00:39:28,550 --> 00:39:26,960
are we going to have that 10 20 15 years

1061
00:39:30,310 --> 00:39:28,560
from now when we send our astronauts

1062
00:39:32,710 --> 00:39:30,320
away for a couple years

1063
00:39:35,670 --> 00:39:32,720

to distant locations

1064
00:39:38,790 --> 00:39:35,680
if we keep this up i think we will

1065
00:39:40,829 --> 00:39:38,800
but this is truly applications

1066
00:39:43,510 --> 00:39:40,839
demonstration

1067
00:39:46,150 --> 00:39:43,520
capability right take this uh gentleman

1068
00:39:47,910 --> 00:39:46,160
right here yes yeah i'm p i'm peter

1069
00:39:50,230 --> 00:39:47,920
wright with the canadian press um you

1070
00:39:52,630 --> 00:39:50,240
talked very very shortly about reducing

1071
00:39:54,069 --> 00:39:52,640
risks now over the past few years

1072
00:39:55,829 --> 00:39:54,079
we're seeing satellites starting to

1073
00:39:57,349 --> 00:39:55,839
crash into each other i just wonder if

1074
00:39:59,030 --> 00:39:57,359
there was any urgency to do this in

1075
00:40:01,109 --> 00:39:59,040
light of the fact that there are a lot

1076
00:40:03,109 --> 00:40:01,119
of satellites that are reaching their

1077
00:40:04,550 --> 00:40:03,119
uh best before date uh there are

1078
00:40:05,750 --> 00:40:04,560
satellites starting to crash into each

1079
00:40:07,589 --> 00:40:05,760
other there's a lot of concern about

1080
00:40:10,230 --> 00:40:07,599
that i wonder if that prompted you to

1081
00:40:12,309 --> 00:40:10,240
speed things up a little bit

1082
00:40:14,950 --> 00:40:12,319
i think that was one of the factors i

1083
00:40:17,109 --> 00:40:14,960
think clearly when those two satellites

1084
00:40:19,190 --> 00:40:17,119
collided that that clearly orbital

1085
00:40:21,670 --> 00:40:19,200
debris i think there was a another

1086
00:40:22,390 --> 00:40:21,680
satellite called galaxy 15 or something

1087
00:40:24,630 --> 00:40:22,400
that

1088
00:40:26,309 --> 00:40:24,640

temporarily drifted out of control and

1089
00:40:27,430 --> 00:40:26,319
all all the other communication

1090
00:40:29,670 --> 00:40:27,440
satellites

1091
00:40:30,790 --> 00:40:29,680
were jocking their positions and handing

1092
00:40:32,390 --> 00:40:30,800
off

1093
00:40:33,910 --> 00:40:32,400
calm responsibilities because they

1094
00:40:34,950 --> 00:40:33,920
wanted to get out of the way before they

1095
00:40:37,670 --> 00:40:34,960
got hit

1096
00:40:40,470 --> 00:40:37,680
i think all of those kinds of things are

1097
00:40:43,349 --> 00:40:40,480
what's going to happen tomorrow

1098
00:40:46,550 --> 00:40:43,359
and the day after and the day after

1099
00:40:48,069 --> 00:40:46,560
and the more satellites you put up there

1100
00:40:49,750 --> 00:40:48,079
which you're going to have to do to

1101
00:40:51,589 --> 00:40:49,760
cover bandwidth

1102
00:40:52,950 --> 00:40:51,599
you're going to have to do it

1103
00:40:55,030 --> 00:40:52,960
the more

1104
00:40:57,589 --> 00:40:55,040
probability there is that you're going

1105
00:40:58,710 --> 00:40:57,599
to need a tow truck

1106
00:41:00,470 --> 00:40:58,720
and

1107
00:41:03,910 --> 00:41:00,480
interestingly enough

1108
00:41:08,069 --> 00:41:03,920
probably more than one

1109
00:41:09,829 --> 00:41:08,079
few

1110
00:41:14,309 --> 00:41:09,839
and they're going to have to stay there

1111
00:41:18,150 --> 00:41:16,630
okay all right thank you uh i've got a

1112
00:41:21,510 --> 00:41:18,160
follow-up question

1113
00:41:22,950 --> 00:41:21,520

right here and i'll do that okay uh jim

1114
00:41:25,750 --> 00:41:22,960
siegel again from the celebration

1115
00:41:27,349 --> 00:41:25,760
independent uh with respect to these tow

1116
00:41:30,630 --> 00:41:27,359
trucks that you mentioned

1117
00:41:35,270 --> 00:41:30,640
uh roughly what time frame would you see

1118
00:41:36,790 --> 00:41:35,280
this happening 2025 2050

1119
00:41:39,349 --> 00:41:36,800
where these

1120
00:41:41,349 --> 00:41:39,359
these commercial tow trucks let's say

1121
00:41:43,670 --> 00:41:41,359
gerhard wanted us to start his own truck

1122
00:41:45,109 --> 00:41:43,680
truck company and use your technology

1123
00:41:47,670 --> 00:41:45,119
he's going to put it in space he's going

1124
00:41:49,349 --> 00:41:47,680
to go around and service satellites

1125
00:41:53,030 --> 00:41:49,359
we what kind of time frame are we

1126
00:41:53,040 --> 00:41:57,990
i wish you were here in 1984

1127
00:42:02,630 --> 00:42:00,950
you know i i can't i i think i think the

1128
00:42:04,550 --> 00:42:02,640
time frame is the next three or four

1129
00:42:06,790 --> 00:42:04,560
years five years

1130
00:42:09,829 --> 00:42:06,800
we're going to have to be there done

1131
00:42:12,309 --> 00:42:09,839
that and i maintain that by this kind of

1132
00:42:14,630 --> 00:42:12,319
technology when i say we it doesn't

1133
00:42:16,470 --> 00:42:14,640
necessarily have to be nasa it does not

1134
00:42:18,069 --> 00:42:16,480
have to could be commercial could be

1135
00:42:20,470 --> 00:42:18,079
commercial from any place around the

1136
00:42:23,109 --> 00:42:20,480
world i think the business base will

1137
00:42:27,190 --> 00:42:23,119
start to demonstrate itself

1138
00:42:30,390 --> 00:42:27,200

but don't forget i was here in 1984

1139
00:42:32,390 --> 00:42:30,400
and we had a screwy mission a very

1140
00:42:35,030 --> 00:42:32,400
never been done before mission

1141
00:42:36,710 --> 00:42:35,040
called the repair of solar max

1142
00:42:39,510 --> 00:42:36,720
does anybody remember that you weren't

1143
00:42:40,390 --> 00:42:39,520
born then oh some of you were

1144
00:42:42,630 --> 00:42:40,400
okay

1145
00:42:47,349 --> 00:42:42,640
she's nuts i always thought there was an

1146
00:42:52,309 --> 00:42:48,870
guess what

1147
00:42:55,430 --> 00:42:52,319
nobody but nobody ever envisioned

1148
00:42:57,670 --> 00:42:55,440
that we would capture solar max

1149
00:43:00,470 --> 00:42:57,680
with a robotic arm

1150
00:43:01,510 --> 00:43:00,480
nobody ever envisioned it and some

1151
00:43:03,430 --> 00:43:01,520
idiots

1152
00:43:06,069 --> 00:43:03,440
who had some forethought at goddard

1153
00:43:08,069 --> 00:43:06,079
decided that before they launched they

1154
00:43:10,710 --> 00:43:08,079
would put a grapple fixture on that

1155
00:43:12,230 --> 00:43:10,720
spacecraft but that spacecraft was not

1156
00:43:15,589 --> 00:43:12,240
going to be captured by that grapple

1157
00:43:17,750 --> 00:43:15,599
fixture no no no that was just a

1158
00:43:18,790 --> 00:43:17,760
risk mitigation device whatever you want

1159
00:43:20,950 --> 00:43:18,800
to call it

1160
00:43:23,030 --> 00:43:20,960
that was a contingency

1161
00:43:25,510 --> 00:43:23,040
no but when we tried it the

1162
00:43:26,790 --> 00:43:25,520
old-fashioned way we discovered contact

1163
00:43:28,950 --> 00:43:26,800

dynamics

1164
00:43:31,109 --> 00:43:28,960
like we had never seen them before

1165
00:43:32,550 --> 00:43:31,119
involving humans and free-flying

1166
00:43:34,230 --> 00:43:32,560
spacecrafts

1167
00:43:38,230 --> 00:43:34,240
and guess what

1168
00:43:40,630 --> 00:43:38,240
it was solved by a robotic operation

1169
00:43:44,470 --> 00:43:40,640
of something called the canada arm for

1170
00:43:45,910 --> 00:43:44,480
the first time and after that guess what

1171
00:43:47,829 --> 00:43:45,920
we never

1172
00:43:49,670 --> 00:43:47,839
bothered to deal with capture of

1173
00:43:51,349 --> 00:43:49,680
spacecrafts any other way with robotics

1174
00:43:54,790 --> 00:43:51,359
so technology

1175
00:43:56,790 --> 00:43:54,800
is there technology is coming the issue

1176
00:43:58,710 --> 00:43:56,800
is how do we apply it

1177
00:44:01,589 --> 00:43:58,720
and how do we demonstrate its

1178
00:44:03,430 --> 00:44:01,599
application so that it minimizes risk

1179
00:44:05,430 --> 00:44:03,440
rrm is that way

1180
00:44:07,829 --> 00:44:05,440
and there'll be other missions

1181
00:44:08,550 --> 00:44:07,839
like rrm that'll come after that that

1182
00:44:10,870 --> 00:44:08,560
can

1183
00:44:14,630 --> 00:44:10,880
that will drive from station the ability

1184
00:44:16,069 --> 00:44:14,640
to demonstrate reduction of risk

1185
00:44:18,390 --> 00:44:16,079
all right we're but just about out of

1186
00:44:20,150 --> 00:44:18,400
time uh real quick can you get a

1187
00:44:21,750 --> 00:44:20,160
question really really quick randy

1188
00:44:24,390 --> 00:44:21,760

atwood again was uh spacecraft

1189
00:44:28,630 --> 00:44:24,400
interactive uh also back in 1984 on the

1190
00:44:31,109 --> 00:44:28,640
13th mission 41g there was a an eva and

1191
00:44:32,790 --> 00:44:31,119
there was a demonstration of refueling

1192
00:44:34,790 --> 00:44:32,800
can you did were there any lessons

1193
00:44:36,150 --> 00:44:34,800
learned from that or any applications

1194
00:44:38,950 --> 00:44:36,160
from that

1195
00:44:43,190 --> 00:44:38,960
the biggest one of all was five hubble

1196
00:44:49,750 --> 00:44:46,230
recovery mission right after deployment

1197
00:44:52,150 --> 00:44:49,760
cincom4 intelsat six

1198
00:44:53,910 --> 00:44:52,160
west arm palapa

1199
00:44:55,750 --> 00:44:53,920
there's a total of 11.

1200
00:44:57,670 --> 00:44:55,760
yes we learned a lot and i think we're

1201
00:44:59,910 --> 00:44:57,680
going to learn a lot from here

1202
00:45:02,630 --> 00:44:59,920
okay we're running out of time

1203
00:45:04,150 --> 00:45:02,640
if you've got more questions we can

1204
00:45:05,589 --> 00:45:04,160
deal with the questions a little bit

1205
00:45:09,030 --> 00:45:05,599
later you'll have a chance to talk with

1206
00:45:11,349 --> 00:45:09,040
uh with seppie and ben and the module

1207
00:45:13,430 --> 00:45:11,359
affectionately known as rosie so that

1208
00:45:15,190 --> 00:45:13,440
concludes our demonstration for today

1209
00:45:17,670 --> 00:45:15,200
the next event on nasa tv is the

1210
00:45:19,990 --> 00:45:17,680
multi-purpose crew vehicle demonstration

1211
00:45:21,349 --> 00:45:20,000
tomorrow morning at 9am and for more