



1
00:00:05,110 --> 00:00:03,189
welcome to the space flight operations

2
00:00:07,909 --> 00:00:05,120
facility at nasa's jet propulsion

3
00:00:11,270 --> 00:00:07,919
laboratory in pasadena california this

4
00:00:13,669 --> 00:00:11,280
is the home of nasa's deep space network

5
00:00:16,310 --> 00:00:13,679
in this room is the nerve center of the

6
00:00:19,109 --> 00:00:16,320
network of the network that communicates

7
00:00:20,470 --> 00:00:19,119
with spacecraft across the solar system

8
00:00:23,670 --> 00:00:20,480
commands are both sent to those

9
00:00:25,670 --> 00:00:23,680
spacecraft over 30 of them and data is

10
00:00:28,310 --> 00:00:25,680
received here on the ground from those

11
00:00:30,710 --> 00:00:28,320
spacecraft located millions and billions

12
00:00:32,709 --> 00:00:30,720
of miles away from earth

13
00:00:34,229 --> 00:00:32,719

when we say deep space we're not

14

00:00:36,709 --> 00:00:34,239

exaggerating

15

00:00:40,310 --> 00:00:36,719

hello and welcome i'm veronica mcgregor

16

00:00:47,110 --> 00:00:40,320

and this is our 80th nasa social event

17

00:00:50,790 --> 00:00:48,790

we've been holding nasa social events at

18

00:00:53,430 --> 00:00:50,800

nasa centers and in other locations

19

00:00:55,990 --> 00:00:53,440

across the country since 2009 as a way

20

00:00:58,229 --> 00:00:56,000

to bring in the public to see what their

21

00:01:00,630 --> 00:00:58,239

space agency is doing and to spend a day

22

00:01:02,069 --> 00:01:00,640

or even two days behind the scenes

23

00:01:04,950 --> 00:01:02,079

they'll have the opportunity to talk to

24

00:01:06,630 --> 00:01:04,960

the spacecraft engineers the scientists

25

00:01:08,630 --> 00:01:06,640

and the technicians who make the deep

26

00:01:10,630 --> 00:01:08,640

space network operate

27

00:01:13,429 --> 00:01:10,640

you may recognize this particular room

28

00:01:15,590 --> 00:01:13,439

that we're in this is the same room that

29

00:01:19,350 --> 00:01:15,600

the curiosity landing team used in

30

00:01:21,830 --> 00:01:19,360

august of 2012 to watch intently as the

31

00:01:23,510 --> 00:01:21,840

curiosity rover

32

00:01:26,630 --> 00:01:23,520

became closer to mars and then

33

00:01:28,310 --> 00:01:26,640

ultimately safely landed on the planet

34

00:01:30,230 --> 00:01:28,320

uh of course the deep space network is

35

00:01:32,870 --> 00:01:30,240

crucial to all of our spacecraft

36

00:01:34,069 --> 00:01:32,880

operations and you're going to hear

37

00:01:35,429 --> 00:01:34,079

from the people today you're going to

38

00:01:36,870 --> 00:01:35,439

hear from the scientists and engineers

39

00:01:38,390 --> 00:01:36,880

who rely on it

40

00:01:39,990 --> 00:01:38,400

the people in this room get the added

41

00:01:42,069 --> 00:01:40,000

bonus of tomorrow they're going to the

42

00:01:43,990 --> 00:01:42,079

goldstone complex that's located near

43

00:01:46,149 --> 00:01:44,000

barstow california that is one of three

44

00:01:49,830 --> 00:01:46,159

locations around the world where we have

45

00:01:51,270 --> 00:01:49,840

the deep space network antenna and uh

46

00:01:54,950 --> 00:01:51,280

believe me when you're standing in the

47

00:01:56,870 --> 00:01:54,960

shadow of a 230 foot dish you will be

48

00:01:59,109 --> 00:01:56,880

very impressed the pictures absolutely

49

00:02:01,190 --> 00:01:59,119

do not do it justice now for those of

50

00:02:02,630 --> 00:02:01,200

you who are watching on nasa tv or or

51
00:02:04,310 --> 00:02:02,640
the live stream

52
00:02:05,830 --> 00:02:04,320
obviously you can't be with us tomorrow

53
00:02:07,990 --> 00:02:05,840
but i want to tell you that we're using

54
00:02:10,070 --> 00:02:08,000
the hashtag dsn50

55
00:02:11,830 --> 00:02:10,080
so you can follow hopefully everyone

56
00:02:13,670 --> 00:02:11,840
here in the room is going to be

57
00:02:15,510 --> 00:02:13,680
posting a lot to either instagram or

58
00:02:18,390 --> 00:02:15,520
twitter or any of the other social media

59
00:02:19,830 --> 00:02:18,400
platforms follow that hashtag and you'll

60
00:02:21,430 --> 00:02:19,840
be able to see all those pictures both

61
00:02:23,030 --> 00:02:21,440
later today and tomorrow when we're out

62
00:02:24,869 --> 00:02:23,040
there at goldstone

63
00:02:27,350 --> 00:02:24,879

all right so now we're going to start

64

00:02:36,229 --> 00:02:27,360

with a short overview that explains just

65

00:02:41,110 --> 00:02:39,030

deep space network is basically required

66

00:02:43,030 --> 00:02:41,120

to do the kinds of things that we do in

67

00:02:44,869 --> 00:02:43,040

space clearly if you can't talk to your

68

00:02:46,309 --> 00:02:44,879

spacecraft and they can't talk to you

69

00:02:48,710 --> 00:02:46,319

there's no point in even sending them

70

00:02:50,390 --> 00:02:48,720

out there the deep space network makes

71

00:02:51,990 --> 00:02:50,400

everything that we do possible

72

00:02:53,990 --> 00:02:52,000

imagine landing night for example for

73

00:02:55,110 --> 00:02:54,000

curiosity without the deep space network

74

00:02:56,630 --> 00:02:55,120

there'd be no one in there because

75

00:02:58,390 --> 00:02:56,640

there'd be nothing to see we'd hear

76
00:03:00,390 --> 00:02:58,400
nothing from the spacecraft no touchdown

77
00:03:01,990 --> 00:03:00,400
confirmed no cheering no nothing the

78
00:03:04,390 --> 00:03:02,000
deep space network is what helps us

79
00:03:05,910 --> 00:03:04,400
figure out where the spacecraft is we

80
00:03:07,990 --> 00:03:05,920
wouldn't even get close to mars without

81
00:03:10,550 --> 00:03:08,000
it the deep space network comprises of

82
00:03:13,030 --> 00:03:10,560
three complexes around the world placed

83
00:03:14,949 --> 00:03:13,040
about 120 degrees apart we are

84
00:03:17,030 --> 00:03:14,959
constantly in touch with the spacecraft

85
00:03:20,470 --> 00:03:17,040
as the earth rotates

86
00:03:22,390 --> 00:03:20,480
we're today tracking 33 spacecrafts not

87
00:03:24,869 --> 00:03:22,400
only the u.s spacecraft also the

88
00:03:26,789 --> 00:03:24,879

spacecrafts from other countries and

89

00:03:29,350 --> 00:03:26,799

remember this is not only talking to the

90

00:03:32,309 --> 00:03:29,360

spacecraft we have been able to do radar

91

00:03:34,710 --> 00:03:32,319

and radio astronomy and it was the radar

92

00:03:39,190 --> 00:03:34,720

on this antenna that actually was used

93

00:03:43,270 --> 00:03:41,190

these antennas are generally receive

94

00:03:44,949 --> 00:03:43,280

objects but they also use transmit so we

95

00:03:46,550 --> 00:03:44,959

do radar with them we can start to

96

00:03:49,430 --> 00:03:46,560

tolerate their bowlers on the surface of

97

00:03:52,070 --> 00:03:49,440

an asteroid by beaming radar waves and

98

00:03:53,910 --> 00:03:52,080

then getting them back radar provides

99

00:03:55,509 --> 00:03:53,920

hundred thousands times better

100

00:03:57,429 --> 00:03:55,519

understanding of the orbit of one of

101
00:03:58,470 --> 00:03:57,439
these asteroids it's incredibly

102
00:04:00,309 --> 00:03:58,480
important if you want to make sure it's

103
00:04:02,710 --> 00:04:00,319
not coming at us if you look at the

104
00:04:04,949 --> 00:04:02,720
cassini mission we've got a transmitter

105
00:04:07,270 --> 00:04:04,959
about an average of 800 900 million

106
00:04:09,509 --> 00:04:07,280
miles away the transmitter is about the

107
00:04:12,229 --> 00:04:09,519
power of your refrigerator light bulb

108
00:04:14,630 --> 00:04:12,239
and that is what is bringing all these

109
00:04:16,629 --> 00:04:14,640
incredible images and data back i think

110
00:04:18,629 --> 00:04:16,639
it's a resource to be treasured but it's

111
00:04:20,310 --> 00:04:18,639
a resource that also needs to be

112
00:04:22,390 --> 00:04:20,320
nourished

113
00:04:24,469 --> 00:04:22,400

seeing our success in in almost real

114

00:04:26,230 --> 00:04:24,479

time and knowing right away and seeing

115

00:04:32,870 --> 00:04:26,240

those pictures all possible because the

116

00:04:36,629 --> 00:04:34,870

okay so our first speakers today joining

117

00:04:38,150 --> 00:04:36,639

us will be two of the people who are

118

00:04:39,590 --> 00:04:38,160

very well connected with the deep space

119

00:04:42,390 --> 00:04:39,600

network you're gonna hear a lot of cool

120

00:04:45,749 --> 00:04:42,400

titles today uh and here are two first

121

00:04:48,790 --> 00:04:45,759

we have uh joseph lazio he is the chief

122

00:04:51,110 --> 00:04:48,800

scientist for the interplanetary network

123

00:04:53,189 --> 00:04:51,120

and wayne sybil he is the deputy project

124

00:04:55,110 --> 00:04:53,199

manager for the deep space network come

125

00:04:56,629 --> 00:04:55,120

on over they're going to show you share

126

00:04:58,150 --> 00:04:56,639

with you a little bit about what they do

127

00:04:59,830 --> 00:04:58,160

and how this network operates and then

128

00:05:02,230 --> 00:04:59,840

we'll have time for some questions and

129

00:05:03,749 --> 00:05:02,240

answers afterwards

130

00:05:05,590 --> 00:05:03,759

thank you veronica

131

00:05:07,990 --> 00:05:05,600

good morning and thank you for coming um

132

00:05:10,550 --> 00:05:08,000

this is a big year for the dsn 50 years

133

00:05:11,749 --> 00:05:10,560

was celebrated back on december 24th

134

00:05:14,150 --> 00:05:11,759

last year

135

00:05:15,830 --> 00:05:14,160

that was the day 50 years prior to that

136

00:05:17,749 --> 00:05:15,840

that

137

00:05:19,590 --> 00:05:17,759

the lab director at the time dr

138

00:05:20,629 --> 00:05:19,600

pickering established the deep space

139

00:05:23,270 --> 00:05:20,639

network

140

00:05:24,550 --> 00:05:23,280

and from that time on both from apollo

141

00:05:27,430 --> 00:05:24,560

days through

142

00:05:29,510 --> 00:05:27,440

uh curiosity rover

143

00:05:30,710 --> 00:05:29,520

the dsn has been there to make sure that

144

00:05:32,070 --> 00:05:30,720

we have that vital link to the

145

00:05:34,629 --> 00:05:32,080

spacecraft

146

00:05:35,990 --> 00:05:34,639

once it clears the tower at launch

147

00:05:38,390 --> 00:05:36,000

the only way to communicate with these

148

00:05:39,590 --> 00:05:38,400

spacecrafts is through the dsn and the

149

00:05:40,310 --> 00:05:39,600

dsn

150

00:05:42,230 --> 00:05:40,320

is

151
00:05:44,550 --> 00:05:42,240
the only lifeline from the time you get

152
00:05:47,029 --> 00:05:44,560
to the moon and beyond that allows the

153
00:05:49,350 --> 00:05:47,039
commands to get to the spacecraft

154
00:05:52,310 --> 00:05:49,360
allow sequences to be uploaded

155
00:05:54,550 --> 00:05:52,320
allows data to be returned and science

156
00:05:57,189 --> 00:05:54,560
all the science that comes back

157
00:05:59,430 --> 00:05:57,199
wouldn't be possible without the dsn

158
00:06:01,909 --> 00:05:59,440
so let me sort of describe how things

159
00:06:03,749 --> 00:06:01,919
work this is the dark room you guys

160
00:06:05,590 --> 00:06:03,759
were in that dark room a little bit

161
00:06:08,629 --> 00:06:05,600
earlier what you see is the complement

162
00:06:10,469 --> 00:06:08,639
of people we have normally

163
00:06:12,870 --> 00:06:10,479

24 hours a day seven days a week about

164

00:06:14,629 --> 00:06:12,880

five people per shift four to five

165

00:06:15,909 --> 00:06:14,639

and they're the ones that establish the

166

00:06:17,990 --> 00:06:15,919

communication link between the

167

00:06:20,070 --> 00:06:18,000

spacecraft mission controllers wherever

168

00:06:21,749 --> 00:06:20,080

they're located around the world and the

169

00:06:23,110 --> 00:06:21,759

link operators are actually driving the

170

00:06:24,550 --> 00:06:23,120

antenna

171

00:06:26,629 --> 00:06:24,560

those folks will make sure that the

172

00:06:28,550 --> 00:06:26,639

predicts get out to the intended so they

173

00:06:30,150 --> 00:06:28,560

can point properly they'll make sure

174

00:06:32,230 --> 00:06:30,160

that the data flows to and from the

175

00:06:34,469 --> 00:06:32,240

antennas to the missions

176

00:06:36,710 --> 00:06:34,479

they make sure that the data that comes

177

00:06:38,150 --> 00:06:36,720

in gets processed and distributed

178

00:06:39,510 --> 00:06:38,160

throughout the world to the to the

179

00:06:41,510 --> 00:06:39,520

investigators

180

00:06:43,670 --> 00:06:41,520

it's a it's a uh

181

00:06:45,909 --> 00:06:43,680

not a glamorous job but it's a critical

182

00:06:47,350 --> 00:06:45,919

job if they don't do that job

183

00:06:48,629 --> 00:06:47,360

you don't get commands of the spacecraft

184

00:06:51,270 --> 00:06:48,639

tell it to point

185

00:06:54,230 --> 00:06:51,280

to capture a comet to capture uh to

186

00:06:56,629 --> 00:06:54,240

execute a landing so it's a it's a vital

187

00:06:58,230 --> 00:06:56,639

critical job that's handled by just a

188

00:06:59,749 --> 00:06:58,240

few people and they're in the background

189

00:07:01,430 --> 00:06:59,759

you don't really see them

190

00:07:02,790 --> 00:07:01,440

there's probably five people back there

191

00:07:04,390 --> 00:07:02,800

right now

192

00:07:07,510 --> 00:07:04,400

and then around the world the way the

193

00:07:10,469 --> 00:07:07,520

dsm was set up i think i have a graphic

194

00:07:14,150 --> 00:07:10,479

an animation that

195

00:07:19,510 --> 00:07:17,270

the rotation we have a complex in just

196

00:07:21,589 --> 00:07:19,520

outside of camber australia just outside

197

00:07:22,790 --> 00:07:21,599

of madrid spain and out in the goldstone

198

00:07:23,909 --> 00:07:22,800

goldstone is where you'll be tomorrow

199

00:07:26,070 --> 00:07:23,919

and you get a chance to see all the

200

00:07:28,309 --> 00:07:26,080

antennas we have out there but these are

201
00:07:30,550 --> 00:07:28,319
spaced about 120 degrees apart so at any

202
00:07:33,110 --> 00:07:30,560
time any missions that that's at the

203
00:07:35,510 --> 00:07:33,120
moon and beyond we can stay in constant

204
00:07:37,909 --> 00:07:35,520
contact sending commands receiving

205
00:07:38,950 --> 00:07:37,919
information so if a spacecraft gets into

206
00:07:40,390 --> 00:07:38,960
trouble

207
00:07:42,870 --> 00:07:40,400
we're that first line of defense we

208
00:07:45,189 --> 00:07:42,880
notify the missions we we allow them to

209
00:07:46,710 --> 00:07:45,199
start commanding right away

210
00:07:48,629 --> 00:07:46,720
and that's their link that's the only

211
00:07:51,670 --> 00:07:48,639
way that they can survive

212
00:07:53,430 --> 00:07:51,680
and around the world we have

213
00:07:54,550 --> 00:07:53,440

a number of antennas the most direct

214

00:07:56,309 --> 00:07:54,560

gold stone which is where you'll be

215

00:07:57,909 --> 00:07:56,319

tomorrow

216

00:08:00,150 --> 00:07:57,919

we have

217

00:08:01,830 --> 00:08:00,160

the next number in madrid

218

00:08:03,189 --> 00:08:01,840

which is four antennas and then we

219

00:08:05,589 --> 00:08:03,199

currently have three operating antennas

220

00:08:07,830 --> 00:08:05,599

in australia but we're also building two

221

00:08:09,990 --> 00:08:07,840

new antennas in australia

222

00:08:11,670 --> 00:08:10,000

one goes operational this october one

223

00:08:13,270 --> 00:08:11,680

two years later

224

00:08:14,550 --> 00:08:13,280

this will help balance the load between

225

00:08:17,029 --> 00:08:14,560

the northern hemisphere southern

226

00:08:20,070 --> 00:08:17,039

hemisphere so that we can always

227

00:08:22,629 --> 00:08:20,080

make contact with the missions

228

00:08:25,350 --> 00:08:22,639

it's it's it's a great great environment

229

00:08:27,350 --> 00:08:25,360

to work in it's challenging because each

230

00:08:30,150 --> 00:08:27,360

one of these complexes around the world

231

00:08:31,670 --> 00:08:30,160

has their own power generation

232

00:08:33,190 --> 00:08:31,680

they also get commercial power but if

233

00:08:34,949 --> 00:08:33,200

for some reason we don't have commercial

234

00:08:38,070 --> 00:08:34,959

power we can't say

235

00:08:40,870 --> 00:08:38,080

we can't support you project x

236

00:08:42,389 --> 00:08:40,880

so so we have uh generating power to

237

00:08:43,829 --> 00:08:42,399

power the entire complex at each of the

238

00:08:45,509 --> 00:08:43,839

three locations

239

00:08:47,829 --> 00:08:45,519

uh we have a faultless power system at

240

00:08:49,430 --> 00:08:47,839

goldstone in madrid so the power fails

241

00:08:50,870 --> 00:08:49,440

automatically the generators kick in and

242

00:08:53,829 --> 00:08:50,880

the entire complex is picked up on

243

00:08:56,630 --> 00:08:53,839

batteries until the generators spin up

244

00:09:03,110 --> 00:08:59,829

it's manned by probably about 150 people

245

00:09:05,430 --> 00:09:03,120

at goldstone 100 at madrid and 100 at

246

00:09:07,350 --> 00:09:05,440

canberra and they're dedicated to seeing

247

00:09:09,670 --> 00:09:07,360

and making sure the missions are

248

00:09:11,030 --> 00:09:09,680

successful

249

00:09:13,110 --> 00:09:11,040

it's mostly behind the scenes you don't

250

00:09:15,910 --> 00:09:13,120

see the projects

251
00:09:17,350 --> 00:09:15,920
when you when you saw curiosity landing

252
00:09:19,030 --> 00:09:17,360
in this room full of people you didn't

253
00:09:21,829 --> 00:09:19,040
see the dsn but they were behind the

254
00:09:23,590 --> 00:09:21,839
scene making sure it was successful

255
00:09:25,030 --> 00:09:23,600
let me give you uh

256
00:09:26,870 --> 00:09:25,040
dr lazio

257
00:09:29,110 --> 00:09:26,880
to explain a little bit about the

258
00:09:31,110 --> 00:09:29,120
science return and the science that dsn

259
00:09:31,910 --> 00:09:31,120
does thanks wayne

260
00:09:33,190 --> 00:09:31,920
um

261
00:09:35,910 --> 00:09:33,200
wayne has already made this comment i

262
00:09:38,150 --> 00:09:35,920
think veronica's has said it as well but

263
00:09:41,190 --> 00:09:38,160

and you saw it somewhat in that video

264

00:09:42,710 --> 00:09:41,200

essentially any image that we get back

265

00:09:46,949 --> 00:09:42,720

from planets

266

00:09:48,550 --> 00:09:46,959

mars venus mercury jupiter saturn think

267

00:09:51,110 --> 00:09:48,560

juno the spacecraft that's currently on

268

00:09:53,430 --> 00:09:51,120

route to to jupiter new horizons the

269

00:09:55,350 --> 00:09:53,440

spacecraft that's unroot to pluto that

270

00:09:57,509 --> 00:09:55,360

all flows through those antennas and in

271

00:10:00,070 --> 00:09:57,519

fact this graphic is showing the

272

00:10:01,910 --> 00:10:00,080

communications with antennas

273

00:10:04,310 --> 00:10:01,920

with uh well between the antennas and

274

00:10:05,990 --> 00:10:04,320

the spacecraft now the other thing i

275

00:10:08,310 --> 00:10:06,000

want to sort of draw your attention to

276

00:10:10,710 --> 00:10:08,320

you know plant the seed there are some

277

00:10:12,790 --> 00:10:10,720

other uses of these antennas for science

278

00:10:14,389 --> 00:10:12,800

let me give you one example consider

279

00:10:15,829 --> 00:10:14,399

something like mro the mars

280

00:10:17,590 --> 00:10:15,839

reconnaissance orbiter that's actually

281

00:10:18,870 --> 00:10:17,600

orbiting a planet well it's kind of

282

00:10:20,150 --> 00:10:18,880

obvious right when spacecraft goes

283

00:10:22,310 --> 00:10:20,160

behind the planet you can't get the

284

00:10:23,829 --> 00:10:22,320

signal that's a duh

285

00:10:25,350 --> 00:10:23,839

but now suppose the planet has an

286

00:10:28,150 --> 00:10:25,360

atmosphere

287

00:10:30,150 --> 00:10:28,160

as the spacecraft goes behind the signal

288

00:10:31,829 --> 00:10:30,160

has to pass through the atmosphere and

289

00:10:33,190 --> 00:10:31,839

you might worry oh is this going to

290

00:10:34,550 --> 00:10:33,200

cause a problem for the reception of the

291

00:10:36,069 --> 00:10:34,560

signal is it going to somehow corrupt

292

00:10:38,389 --> 00:10:36,079

the signal

293

00:10:40,310 --> 00:10:38,399

or you can turn that around and say hey

294

00:10:42,389 --> 00:10:40,320

if i can track that signal very

295

00:10:43,670 --> 00:10:42,399

accurately i can probe the planet's

296

00:10:45,030 --> 00:10:43,680

atmosphere without actually putting

297

00:10:47,350 --> 00:10:45,040

anything in it

298

00:10:49,750 --> 00:10:47,360

and in fact these antennas are so

299

00:10:51,110 --> 00:10:49,760

sensitive and the tracking is done so

300

00:10:52,550 --> 00:10:51,120

precisely not only can you start

301
00:10:54,310 --> 00:10:52,560
thinking about the atmosphere but

302
00:10:55,829 --> 00:10:54,320
remember the spacecraft moves with

303
00:10:58,710 --> 00:10:55,839
response to the gravity within the

304
00:11:00,389 --> 00:10:58,720
planet right so depending upon how mass

305
00:11:02,470 --> 00:11:00,399
or matter is distributed within the

306
00:11:04,310 --> 00:11:02,480
planet we can actually start to figure

307
00:11:06,630 --> 00:11:04,320
out what the interior of the planet or

308
00:11:08,470 --> 00:11:06,640
the satellite looks like so if you've

309
00:11:11,350 --> 00:11:08,480
ever heard for instance of subsurface

310
00:11:12,870 --> 00:11:11,360
oceans on europa or ganymede some of the

311
00:11:14,870 --> 00:11:12,880
evidence comes from that kind of

312
00:11:16,949 --> 00:11:14,880
spacecraft tracking of as it moves

313
00:11:19,509 --> 00:11:16,959

around the the moon

314

00:11:23,110 --> 00:11:19,519

there's another uh use this particular

315

00:11:24,310 --> 00:11:23,120

antenna the gold dss 14 the the 70 meter

316

00:11:27,110 --> 00:11:24,320

out at goldstone which you'll see

317

00:11:29,030 --> 00:11:27,120

tomorrow sometimes uh actually beams

318

00:11:30,310 --> 00:11:29,040

intense radio waves out we use it for

319

00:11:31,990 --> 00:11:30,320

radar

320

00:11:33,910 --> 00:11:32,000

and you saw in the video they when we

321

00:11:35,190 --> 00:11:33,920

get the reflection you can actually

322

00:11:37,110 --> 00:11:35,200

start making

323

00:11:38,630 --> 00:11:37,120

images equivalent to as if you'd send a

324

00:11:40,230 --> 00:11:38,640

spacecraft there i'm not going to tell

325

00:11:41,750 --> 00:11:40,240

you anything more about that because

326

00:11:43,829 --> 00:11:41,760

marina brockovitz is going to come in

327

00:11:45,269 --> 00:11:43,839

show you some amazing images and again

328

00:11:46,949 --> 00:11:45,279

the other reason that you really care

329

00:11:48,389 --> 00:11:46,959

about that of course is that you get the

330

00:11:49,670 --> 00:11:48,399

orbit very precisely and you want to

331

00:11:51,590 --> 00:11:49,680

know that if there's if there's any

332

00:11:53,590 --> 00:11:51,600

potential issue

333

00:11:54,949 --> 00:11:53,600

uh issue in the sense of is it coming at

334

00:11:57,190 --> 00:11:54,959

us um

335

00:11:59,590 --> 00:11:57,200

the other the other sort of

336

00:12:03,030 --> 00:11:59,600

let me bring this now from the science

337

00:12:04,550 --> 00:12:03,040

to sort of our our uses here at home

338

00:12:07,110 --> 00:12:04,560

perhaps you've had an experience with a

339

00:12:09,030 --> 00:12:07,120

radar gun say you've been at a dodgers

340

00:12:10,629 --> 00:12:09,040

or a washington national chicago cubs

341

00:12:13,030 --> 00:12:10,639

baseball game you've seen the little you

342

00:12:15,590 --> 00:12:13,040

know how fast did the pitcher pitch that

343

00:12:18,870 --> 00:12:15,600

well the kinds of radar that are used in

344

00:12:20,870 --> 00:12:18,880

everyday usage such as sports even

345

00:12:22,710 --> 00:12:20,880

many of those technologies came for

346

00:12:25,110 --> 00:12:22,720

things came from technologies that were

347

00:12:27,430 --> 00:12:25,120

initially either invented at or

348

00:12:29,030 --> 00:12:27,440

developed by the dsn

349

00:12:31,030 --> 00:12:29,040

you see me flashing around this thing

350

00:12:32,310 --> 00:12:31,040

and i see various people with them this

351

00:12:35,269 --> 00:12:32,320

thing is packed with a couple of

352

00:12:37,829 --> 00:12:35,279

different technologies that again either

353

00:12:39,430 --> 00:12:37,839

were invented by or if not invented were

354

00:12:42,470 --> 00:12:39,440

developed here in a way that you could

355

00:12:43,990 --> 00:12:42,480

move it from this precise scientific use

356

00:12:45,269 --> 00:12:44,000

into something that's for commercial

357

00:12:47,110 --> 00:12:45,279

value

358

00:12:48,870 --> 00:12:47,120

and then my final picture

359

00:12:51,190 --> 00:12:48,880

let me step back now from sort of the

360

00:12:54,069 --> 00:12:51,200

science to and the neat technology you

361

00:12:56,069 --> 00:12:54,079

know radar guns and how fast uh pitchers

362

00:12:58,150 --> 00:12:56,079

pitch baseballs think about some of the

363

00:13:00,389 --> 00:12:58,160

greatest moments in human history and

364

00:13:01,430 --> 00:13:00,399

there should be a still showing up here

365

00:13:04,069 --> 00:13:01,440

you know

366

00:13:05,750 --> 00:13:04,079

humans actually setting foot on another

367

00:13:07,350 --> 00:13:05,760

celestial plant us another celestial

368

00:13:10,230 --> 00:13:07,360

world

369

00:13:13,110 --> 00:13:10,240

or the voyager spacecraft we're sort of

370

00:13:15,670 --> 00:13:13,120

on the verge of becoming an interstellar

371

00:13:17,670 --> 00:13:15,680

space-faring civilization

372

00:13:19,829 --> 00:13:17,680

delivered by the dsn

373

00:13:21,110 --> 00:13:19,839

i think we can take some questions now

374

00:13:23,590 --> 00:13:21,120

right okay so we've got a few minutes

375

00:13:25,350 --> 00:13:23,600

for questions and uh if you have one go

376

00:13:26,389 --> 00:13:25,360

ahead and raise your hand uh if you want

377

00:13:27,990 --> 00:13:26,399

to know a little bit more about what

378

00:13:29,910 --> 00:13:28,000

people do day to day here and just wait

379

00:13:31,030 --> 00:13:29,920

for a microphone to come to you alice we

380

00:13:32,230 --> 00:13:31,040

have

381

00:13:34,230 --> 00:13:32,240

you might it might be easier from the

382

00:13:35,670 --> 00:13:34,240

front okay

383

00:13:37,110 --> 00:13:35,680

i got it

384

00:13:38,710 --> 00:13:37,120

all right go ahead thank you

385

00:13:40,949 --> 00:13:38,720

when you're looking at that graphic that

386

00:13:42,230 --> 00:13:40,959

you have up there the animation so when

387

00:13:44,310 --> 00:13:42,240

it's grayed out

388

00:13:46,710 --> 00:13:44,320

what does that mean when you see those

389

00:13:48,710 --> 00:13:46,720

things coming in those waves is that

390

00:13:50,150 --> 00:13:48,720

specifically from one or multiple ones

391

00:13:52,949 --> 00:13:50,160

that means they're active at that time

392

00:13:54,870 --> 00:13:52,959

that means for example on on dss 54

393

00:13:56,389 --> 00:13:54,880

which is in spain a beam waveguide

394

00:14:00,069 --> 00:13:56,399

antenna is currently tracking the soho

395

00:14:01,350 --> 00:14:00,079

spacecraft um it's the the the signal is

396

00:14:04,470 --> 00:14:01,360

you're doing both uplinking and

397

00:14:05,670 --> 00:14:04,480

downlinking at the same time

398

00:14:08,710 --> 00:14:05,680

this

399

00:14:12,629 --> 00:14:10,949

dss-34 down in australia that means

400

00:14:14,470 --> 00:14:12,639

we're tracking two and two spacecraft at

401
00:14:15,509 --> 00:14:14,480
the same time at mars they're sharing

402
00:14:17,509 --> 00:14:15,519
the link

403
00:14:18,870 --> 00:14:17,519
only one can be uplinking at one time

404
00:14:19,910 --> 00:14:18,880
but both are downlinking at the same

405
00:14:21,990 --> 00:14:19,920
time

406
00:14:23,110 --> 00:14:22,000
and this actually this display is

407
00:14:23,910 --> 00:14:23,120
available

408
00:14:25,590 --> 00:14:23,920
from

409
00:14:28,470 --> 00:14:25,600
the web

410
00:14:30,870 --> 00:14:28,480
anybody can have access to it

411
00:14:32,629 --> 00:14:30,880
can i just can i just expand one when

412
00:14:33,750 --> 00:14:32,639
wayne says uplink and downlink is the

413
00:14:35,030 --> 00:14:33,760

command

414

00:14:36,389 --> 00:14:35,040

downlink is the actual data and of

415

00:14:37,910 --> 00:14:36,399

course if it's not obvious the reason

416

00:14:39,829 --> 00:14:37,920

this one can do those two is because

417

00:14:41,350 --> 00:14:39,839

they're both in orbit about mars so the

418

00:14:43,509 --> 00:14:41,360

antenna essentially sees both at the

419

00:14:45,110 --> 00:14:43,519

same time

420

00:14:46,389 --> 00:14:45,120

and also let you know that uh doug

421

00:14:48,150 --> 00:14:46,399

ellison is going to show us a little bit

422

00:14:52,189 --> 00:14:48,160

more about this tool and explain how it

423

00:14:54,470 --> 00:14:52,199

works and it is uh you can find it at

424

00:14:56,870 --> 00:14:54,480

deepspace.jpl.nasa.gov and click on dsn

425

00:14:57,670 --> 00:14:56,880

now so anyone can watch this at home if

426

00:14:59,670 --> 00:14:57,680

you're interested to see which

427

00:15:01,430 --> 00:14:59,680

spacecraft are in communication with

428

00:15:03,269 --> 00:15:01,440

earth at that moment

429

00:15:05,189 --> 00:15:03,279

any other questions

430

00:15:06,629 --> 00:15:05,199

one more okay we'll get the microphone

431

00:15:09,509 --> 00:15:06,639

to you and then

432

00:15:11,030 --> 00:15:09,519

and then we'll come to you next yeah

433

00:15:12,389 --> 00:15:11,040

when i was in the air force used to work

434

00:15:14,629 --> 00:15:12,399

on power production

435

00:15:17,750 --> 00:15:14,639

what kind of uh generator plant do they

436

00:15:19,269 --> 00:15:17,760

have to operate the radio telescopes

437

00:15:21,189 --> 00:15:19,279

like this

438

00:15:23,110 --> 00:15:21,199

well generally with commercial power and

439

00:15:24,629 --> 00:15:23,120

at goldstone i believe it's about 4.5

440

00:15:27,269 --> 00:15:24,639

megawatts is what we take for the entire

441

00:15:29,269 --> 00:15:27,279

complex it

442

00:15:31,509 --> 00:15:29,279

not gigawatts

443

00:15:32,790 --> 00:15:31,519

megawatts and at the overseas complexes

444

00:15:34,389 --> 00:15:32,800

they have fewer antennas and don't have

445

00:15:36,069 --> 00:15:34,399

radar so they don't have the higher

446

00:15:38,829 --> 00:15:36,079

demand so they're closer to two and a

447

00:15:41,590 --> 00:15:38,839

half to three megawatts of power that's

448

00:15:44,230 --> 00:15:41,600

required and is the power plant located

449

00:15:45,430 --> 00:15:44,240

right on site it is yes so if they were

450

00:15:47,350 --> 00:15:45,440

for some reason that you couldn't get

451
00:15:49,269 --> 00:15:47,360
out to the complex they could hunker

452
00:15:51,430 --> 00:15:49,279
down and be powered on their own there's

453
00:15:53,670 --> 00:15:51,440
water there's there they can pretty much

454
00:15:54,949 --> 00:15:53,680
self-sustain like any city

455
00:15:57,430 --> 00:15:54,959
and i understand this room has been

456
00:15:58,870 --> 00:15:57,440
going 24 7 since what year

457
00:16:01,269 --> 00:15:58,880
oh uh

458
00:16:05,030 --> 00:16:02,949
40 years is that right

459
00:16:07,509 --> 00:16:05,040
about 40 years this room has been

460
00:16:09,749 --> 00:16:07,519
operating 24 7 since uh

461
00:16:11,350 --> 00:16:09,759
yeah about 40 years now so and you even

462
00:16:13,189 --> 00:16:11,360
have a backup for this room so i mean

463
00:16:14,069 --> 00:16:13,199

there's redundancy and redundancy in the

464

00:16:15,350 --> 00:16:14,079

system

465

00:16:17,509 --> 00:16:15,360

to make sure

466

00:16:19,749 --> 00:16:17,519

this this area out here the dark room we

467

00:16:22,310 --> 00:16:19,759

actually have a backup facility located

468

00:16:24,150 --> 00:16:22,320

not too far from here by 18 miles away

469

00:16:25,509 --> 00:16:24,160

and should there be some event that

470

00:16:27,670 --> 00:16:25,519

requires you to move out of the san

471

00:16:29,269 --> 00:16:27,680

gabriel valley area we have a facility

472

00:16:32,710 --> 00:16:29,279

out at the goldstone complex where we

473

00:16:35,269 --> 00:16:34,230

and i think the closest that ever

474

00:16:37,910 --> 00:16:35,279

happened was when we had a massive

475

00:16:40,310 --> 00:16:37,920

wildfire burning uh behind jpl a few

476
00:16:42,470 --> 00:16:40,320
years ago but uh but we stayed right we

477
00:16:45,670 --> 00:16:42,480
stayed yeah um only those employees that

478
00:16:47,990 --> 00:16:45,680
had to stay here but um that was a very

479
00:16:50,069 --> 00:16:48,000
close fire okay well we'll have hugo and

480
00:16:52,310 --> 00:16:50,079
then we have one over here so go ahead

481
00:16:54,870 --> 00:16:52,320
what is the transmitted wattage for the

482
00:16:56,710 --> 00:16:54,880
commands going up uh it varies up to 20

483
00:16:58,949 --> 00:16:56,720
kilowatts

484
00:17:01,030 --> 00:16:58,959
uh we have an 80 kilowatt transmitter

485
00:17:03,590 --> 00:17:01,040
that's in development right now so that

486
00:17:06,150 --> 00:17:03,600
if we didn't have i'm sorry if we didn't

487
00:17:08,150 --> 00:17:06,160
have the 70 meter and it's 20 kilowatt

488
00:17:10,069 --> 00:17:08,160

transmitter then we could go to a 34

489

00:17:12,230 --> 00:17:10,079

meter with an 80 kilowatt transmitter

490

00:17:13,510 --> 00:17:12,240

and get the same power to the spacecraft

491

00:17:15,510 --> 00:17:13,520

but that's under development we're going

492

00:17:17,510 --> 00:17:15,520

to be deploying that uh next year at

493

00:17:19,270 --> 00:17:17,520

goldstone the first production unit and

494

00:17:20,470 --> 00:17:19,280

then eventually

495

00:17:21,750 --> 00:17:20,480

over time we'll get it deployed

496

00:17:25,669 --> 00:17:21,760

throughout the network

497

00:17:28,789 --> 00:17:27,350

i had a question about something you

498

00:17:30,070 --> 00:17:28,799

said i thought i heard you say that

499

00:17:32,630 --> 00:17:30,080

we're on the verge of becoming

500

00:17:35,110 --> 00:17:32,640

intergalactic uh interstellar

501
00:17:37,510 --> 00:17:35,120
interstellar that's where i'm at

502
00:17:39,750 --> 00:17:37,520
um so is there some debate on that like

503
00:17:42,390 --> 00:17:39,760
when is voyager 1 officially like

504
00:17:45,510 --> 00:17:42,400
becoming an interstellar

505
00:17:47,029 --> 00:17:45,520
no the only thing i meant by that is

506
00:17:48,310 --> 00:17:47,039
i think there is a consensus now that

507
00:17:49,990 --> 00:17:48,320
voyager 1

508
00:17:52,390 --> 00:17:50,000
is essentially beyond the solar system

509
00:17:55,909 --> 00:17:52,400
it's beyond the strictly

510
00:17:57,029 --> 00:17:55,919
heliopause i believe is the boundary uh

511
00:17:59,510 --> 00:17:57,039
where the

512
00:18:01,029 --> 00:17:59,520
the influence of the sun is no longer

513
00:18:02,310 --> 00:18:01,039

the dominant it's in the interstellar

514

00:18:03,830 --> 00:18:02,320

space but it's essentially only one

515

00:18:05,669 --> 00:18:03,840

spacecraft right

516

00:18:08,310 --> 00:18:05,679

so that's what i sort of mean by on the

517

00:18:09,909 --> 00:18:08,320

verge of voyager 2 will eventually make

518

00:18:12,390 --> 00:18:09,919

it it's not clear if we'll still be in

519

00:18:13,669 --> 00:18:12,400

contact with voyager 2 when it exits

520

00:18:15,990 --> 00:18:13,679

people have been thinking for a long

521

00:18:17,830 --> 00:18:16,000

time about how could we get

522

00:18:18,789 --> 00:18:17,840

spacecraft not just sort of right at the

523

00:18:21,510 --> 00:18:18,799

edge

524

00:18:23,190 --> 00:18:21,520

but actually well out into interstellar

525

00:18:24,710 --> 00:18:23,200

space and and so it's sort of we're on

526

00:18:26,070 --> 00:18:24,720

the verge

527

00:18:27,350 --> 00:18:26,080

you know think back 50 years or

528

00:18:29,190 --> 00:18:27,360

something when we were just starting to

529

00:18:30,789 --> 00:18:29,200

launch spacecraft

530

00:18:32,470 --> 00:18:30,799

we're sort of now just starting to get

531

00:18:34,870 --> 00:18:32,480

beyond the boundary of the solar system

532

00:18:36,710 --> 00:18:34,880

in comparison to the the dozens of of

533

00:18:37,990 --> 00:18:36,720

spacecraft that that we sent throughout

534

00:18:39,590 --> 00:18:38,000

the solar system

535

00:18:43,590 --> 00:18:39,600

cool okay i think i saw one more

536

00:18:46,870 --> 00:18:44,870

yes uh

537

00:18:49,270 --> 00:18:46,880

sorry for asking this question because i

538

00:18:50,789 --> 00:18:49,280

think i'm bringing everybody down on the

539

00:18:53,270 --> 00:18:50,799

earth again

540

00:18:55,110 --> 00:18:53,280

my question is i think everybody's

541

00:18:58,390 --> 00:18:55,120

question these days

542

00:19:01,750 --> 00:18:58,400

is that why we cannot for example nasa

543

00:19:04,070 --> 00:19:01,760

cannot communicate with this lost plane

544

00:19:06,710 --> 00:19:04,080

which is somewhere on earth and but we

545

00:19:08,549 --> 00:19:06,720

can still we can still communicate with

546

00:19:09,430 --> 00:19:08,559

voyager which is

547

00:19:15,270 --> 00:19:09,440

a

548

00:19:18,150 --> 00:19:15,280

between these two technologies our

549

00:19:20,150 --> 00:19:18,160

antennas are pointing up

550

00:19:20,950 --> 00:19:20,160

and we don't have the ability to point

551
00:19:22,310 --> 00:19:20,960
down

552
00:19:25,029 --> 00:19:22,320
uh so there's nothing that we can do

553
00:19:26,789 --> 00:19:25,039
with our tracking network um other

554
00:19:28,230 --> 00:19:26,799
agencies have other assets and i'm sure

555
00:19:29,830 --> 00:19:28,240
they're playing their part in trying to

556
00:19:31,590 --> 00:19:29,840
do that but but we don't have that

557
00:19:33,590 --> 00:19:31,600
ability

558
00:19:35,510 --> 00:19:33,600
all right okay um actually we need to

559
00:19:36,710 --> 00:19:35,520
wrap up um but you know you're gonna

560
00:19:38,310 --> 00:19:36,720
have plenty of time over the next day

561
00:19:39,750 --> 00:19:38,320
and a half to ask some more questions

562
00:19:41,669 --> 00:19:39,760
but we do want to keep the program

563
00:19:44,150 --> 00:19:41,679

moving right now so i want to thank both

564

00:19:45,669 --> 00:19:44,160

wayne and jose flazio for

565

00:19:47,510 --> 00:19:45,679

spending some time with us this morning

566

00:19:55,750 --> 00:19:47,520

and taking some questions from the group

567

00:19:59,669 --> 00:19:58,310

okay um coming up now i'm going to

568

00:20:02,870 --> 00:19:59,679

introduce the

569

00:20:08,470 --> 00:20:02,880

few members of the curiosity landing

570

00:20:12,630 --> 00:20:10,390

i see there are people sitting in our

571

00:20:15,270 --> 00:20:12,640

chairs

572

00:20:17,110 --> 00:20:15,280

they've taken your seats for today um

573

00:20:19,990 --> 00:20:17,120

everyone this is steve collins and

574

00:20:21,430 --> 00:20:20,000

deveraux and bobac ferdoci and

575

00:20:23,430 --> 00:20:21,440

why don't you go ahead and take a spot

576

00:20:25,270 --> 00:20:23,440

at the front of the room this time

577

00:20:27,110 --> 00:20:25,280

instead of behind the console i know

578

00:20:28,470 --> 00:20:27,120

that's a little different for you

579

00:20:29,990 --> 00:20:28,480

and

580

00:20:31,750 --> 00:20:30,000

they're going to explain to you a little

581

00:20:32,950 --> 00:20:31,760

bit about what makes the dsn so

582

00:20:36,230 --> 00:20:32,960

important for them when they're in a

583

00:20:38,070 --> 00:20:36,240

room like this and so to start with that

584

00:20:39,909 --> 00:20:38,080

though we are going to take you back to

585

00:20:48,950 --> 00:20:39,919

landing night please watch the video

586

00:20:54,870 --> 00:20:50,789

things are looking good

587

00:20:59,430 --> 00:20:57,590

enable reports entry interface

588

00:21:00,870 --> 00:20:59,440

at this time it will begin pressurizing

589

00:21:03,029 --> 00:21:00,880

the propulsion system to increase the

590

00:21:03,990 --> 00:21:03,039

thrust of the system uh we'll use that

591

00:21:11,590 --> 00:21:04,000

for all the maneuvering in the

592

00:21:18,950 --> 00:21:13,430

we're standing by for guidance start

593

00:21:23,830 --> 00:21:21,190

beginning to feel the atmosphere

594

00:21:25,590 --> 00:21:23,840

as we go in here

595

00:21:27,669 --> 00:21:25,600

vehicles just reported via tones that it

596

00:21:29,270 --> 00:21:27,679

has started guided entry

597

00:21:32,070 --> 00:21:29,280

at this time the vehicle is beginning to

598

00:21:35,110 --> 00:21:32,080

steer its way to the target

599

00:21:36,310 --> 00:21:35,120

we have seen peak deceleration

600

00:21:37,909 --> 00:21:36,320

that is starting its first bank

601
00:21:39,430 --> 00:21:37,919
rehearsal

602
00:21:52,230 --> 00:21:39,440
uh it is reporting that we are seeing

603
00:21:59,110 --> 00:21:53,990
we should have parachute deploy around

604
00:21:59,120 --> 00:22:02,230
the parachute is deployed

605
00:22:02,240 --> 00:22:05,830
we are decelerating

606
00:22:09,350 --> 00:22:07,750
has separated on the ground

607
00:22:14,310 --> 00:22:09,360
we're down to 90 meters per second at an

608
00:22:14,320 --> 00:22:20,630
standing by for bachelor separation

609
00:22:20,640 --> 00:22:27,750
we are in power flight

610
00:22:31,669 --> 00:22:29,029
we're an altitude of one kilometer

611
00:22:50,230 --> 00:22:33,669
standing by for skype

612
00:22:50,240 --> 00:23:08,310
touchdown confirmed we're safe

613
00:23:08,320 --> 00:23:26,950

wow

614

00:23:26,960 --> 00:23:46,630

oh

615

00:23:46,640 --> 00:24:13,190

got thumbnails

616

00:24:17,430 --> 00:24:15,669

today right now the wheels of curiosity

617

00:24:20,149 --> 00:24:17,440

have begun to blaze the trail for human

618

00:24:22,950 --> 00:24:20,159

footprints on mars this is an amazing

619

00:24:25,909 --> 00:24:22,960

achievement well today on mars history

620

00:24:27,430 --> 00:24:25,919

was made on earth the successful landing

621

00:24:29,909 --> 00:24:27,440

of curiosity

622

00:24:32,230 --> 00:24:29,919

marks what is really an unprecedented

623

00:24:35,350 --> 00:24:32,240

technological tour de force it will

624

00:24:37,029 --> 00:24:35,360

stand as an american point of pride far

625

00:24:39,269 --> 00:24:37,039

into the future

626
00:24:40,390 --> 00:24:39,279
well tonight was was a great drama that

627
00:24:42,149 --> 00:24:40,400
was played

628
00:24:44,470 --> 00:24:42,159
i could only think of the words of teddy

629
00:24:46,549 --> 00:24:44,480
roosevelt as i was sitting there

630
00:24:48,870 --> 00:24:46,559
it is far better to their mighty things

631
00:24:50,870 --> 00:24:48,880
even though we might fail

632
00:25:06,789 --> 00:24:50,880
than to stay in the twilight that knows

633
00:25:06,799 --> 00:25:10,230
who needs a kleenex

634
00:25:15,029 --> 00:25:12,230
i do have them also in the back

635
00:25:16,630 --> 00:25:15,039
i always joke uh we play these for this

636
00:25:17,909 --> 00:25:16,640
uh video for tour groups on many

637
00:25:20,149 --> 00:25:17,919
different occasions and you can always

638
00:25:22,070 --> 00:25:20,159

tell a room full of jbl's because we all

639

00:25:25,830 --> 00:25:22,080

um still live the emotion of that night

640

00:25:27,029 --> 00:25:25,840

don't we um so ann bobbik and steve uh

641

00:25:29,029 --> 00:25:27,039

why don't you

642

00:25:30,470 --> 00:25:29,039

go ahead and talk about what you were

643

00:25:33,430 --> 00:25:30,480

doing that night in this room how the

644

00:25:36,149 --> 00:25:33,440

dsn plays a role in in something like a

645

00:25:38,789 --> 00:25:36,159

landing night a major event like this

646

00:25:40,950 --> 00:25:38,799

uh sure so i was sitting right over here

647

00:25:43,190 --> 00:25:40,960

in the activity lead chairs as you are

648

00:25:44,710 --> 00:25:43,200

um and we were just you know monitoring

649

00:25:46,470 --> 00:25:44,720

telemetry what's amazing about that

650

00:25:48,549 --> 00:25:46,480

night of course is as probably many of

651
00:25:50,549 --> 00:25:48,559
you guys know there was this 14-minute

652
00:25:51,830 --> 00:25:50,559
delay between uh the events actually

653
00:25:53,669 --> 00:25:51,840
happening and the signal we received

654
00:25:55,590 --> 00:25:53,679
here on earth so

655
00:25:57,029 --> 00:25:55,600
what we were kind of seeing was all kind

656
00:25:59,350 --> 00:25:57,039
of post-fact right it was basically like

657
00:26:01,430 --> 00:25:59,360
taking your sats or your gres and just

658
00:26:02,950 --> 00:26:01,440
waiting for the results to happen

659
00:26:04,070 --> 00:26:02,960
so there's kind of this weird feeling in

660
00:26:05,669 --> 00:26:04,080
the room that there's a little bit at

661
00:26:07,590 --> 00:26:05,679
least for me a little bit of like well

662
00:26:09,110 --> 00:26:07,600
it's all done already

663
00:26:11,110 --> 00:26:09,120

but we're just waiting for the results

664

00:26:12,230 --> 00:26:11,120

and you know we had the tones which was

665

00:26:13,750 --> 00:26:12,240

basically the spacecraft talking

666

00:26:15,110 --> 00:26:13,760

directly back to earth

667

00:26:16,230 --> 00:26:15,120

but those cut out just about a minute

668

00:26:18,470 --> 00:26:16,240

before landing because that's when earth

669

00:26:20,390 --> 00:26:18,480

was setting on mars where we were and

670

00:26:22,789 --> 00:26:20,400

then in addition to that we had these

671

00:26:24,310 --> 00:26:22,799

amazing things uh these two orbiters

672

00:26:26,390 --> 00:26:24,320

already at mars odyssey and mars

673

00:26:28,070 --> 00:26:26,400

accounts order that the the rover was

674

00:26:29,430 --> 00:26:28,080

talking to directly as it landed and

675

00:26:30,950 --> 00:26:29,440

we're getting this data back and of

676

00:26:32,390 --> 00:26:30,960

course um you know one of the first

677

00:26:35,430 --> 00:26:32,400

things that we got back from the surface

678

00:26:37,190 --> 00:26:35,440

of mars was this gorgeous picture of us

679

00:26:38,950 --> 00:26:37,200

just settled on the ground our shadow

680

00:26:40,870 --> 00:26:38,960

long shadow being cast and mount sharp

681

00:26:42,470 --> 00:26:40,880

in the distance that's the photo i chose

682

00:26:44,230 --> 00:26:42,480

over there i feel like it's my favorite

683

00:26:45,350 --> 00:26:44,240

photo um

684

00:26:47,190 --> 00:26:45,360

but one of the things i want to tell you

685

00:26:48,310 --> 00:26:47,200

is kind of the long story that how

686

00:26:49,909 --> 00:26:48,320

i got there and one of the things i

687

00:26:51,110 --> 00:26:49,919

started on this project doing was

688

00:26:52,549 --> 00:26:51,120

mission planning

689

00:26:53,750 --> 00:26:52,559

and the first thing

690

00:26:55,909 --> 00:26:53,760

kind of you do as a mission planner is

691

00:26:58,310 --> 00:26:55,919

you start working on what resources you

692

00:27:01,110 --> 00:26:58,320

have and we start talking about okay you

693

00:27:02,390 --> 00:27:01,120

know on the trip to mars we need dsn

694

00:27:04,470 --> 00:27:02,400

passes because we need to communicate

695

00:27:05,669 --> 00:27:04,480

with the rover or to the spacecraft at

696

00:27:07,029 --> 00:27:05,679

the time of course

697

00:27:08,710 --> 00:27:07,039

every day

698

00:27:09,750 --> 00:27:08,720

or maybe three days a week or whatever

699

00:27:11,350 --> 00:27:09,760

and then we need to make sure that we

700

00:27:13,430 --> 00:27:11,360

have good navigation so we understand

701
00:27:15,029 --> 00:27:13,440
exactly where we're headed and how close

702
00:27:16,230 --> 00:27:15,039
we are to our targets

703
00:27:18,950 --> 00:27:16,240
and steve will probably tell you some

704
00:27:20,549 --> 00:27:18,960
exciting stories about that um

705
00:27:21,990 --> 00:27:20,559
and i remember doing this for the first

706
00:27:23,110 --> 00:27:22,000
time and not knowing what was really

707
00:27:24,389 --> 00:27:23,120
happening because it's basically the

708
00:27:26,389 --> 00:27:24,399
first job i had

709
00:27:27,909 --> 00:27:26,399
and you know writing these these

710
00:27:29,590 --> 00:27:27,919
requirements for the deep space network

711
00:27:31,350 --> 00:27:29,600
and asking you know okay like how much

712
00:27:32,630 --> 00:27:31,360
time do i need per week and who's going

713
00:27:33,830 --> 00:27:32,640

to communicate once we're on the surface

714

00:27:35,029 --> 00:27:33,840

is going to be one of the orbiters it's

715

00:27:36,789 --> 00:27:35,039

going to be us

716

00:27:38,870 --> 00:27:36,799

and i wrote this thing out and i deliver

717

00:27:41,350 --> 00:27:38,880

this you know this great you know first

718

00:27:42,870 --> 00:27:41,360

really proud document that says here's

719

00:27:45,110 --> 00:27:42,880

all our requests

720

00:27:47,990 --> 00:27:45,120

and i get it back and someone says why

721

00:27:50,389 --> 00:27:48,000

does it say mars orbit insertion at the

722

00:27:52,389 --> 00:27:50,399

end two years after landing

723

00:27:53,750 --> 00:27:52,399

and i look and i realize that i've gone

724

00:27:55,750 --> 00:27:53,760

through this and submitted this thing

725

00:27:58,950 --> 00:27:55,760

for mars sample return

726

00:28:00,549 --> 00:27:58,960

instead of our our rover

727

00:28:01,750 --> 00:28:00,559

so that was a learning experience for me

728

00:28:04,630 --> 00:28:01,760

but i think one of the things that kind

729

00:28:06,950 --> 00:28:04,640

of amazes me about this and uh was that

730

00:28:08,950 --> 00:28:06,960

really it took you know me roughly nine

731

00:28:10,950 --> 00:28:08,960

years to get from that point to

732

00:28:11,909 --> 00:28:10,960

seeing that picture for the first time

733

00:28:13,590 --> 00:28:11,919

and there's a little bit of a sense of

734

00:28:14,789 --> 00:28:13,600

relief because

735

00:28:17,590 --> 00:28:14,799

seeing that picture meant that i'd done

736

00:28:18,630 --> 00:28:17,600

my job um

737

00:28:19,590 --> 00:28:18,640

i think all of us kind of have that

738

00:28:21,669 --> 00:28:19,600

sense you know like i don't want to be

739

00:28:23,830 --> 00:28:21,679

the guy to screw it up for everybody

740

00:28:25,190 --> 00:28:23,840

um but you know realizing everything

741

00:28:26,630 --> 00:28:25,200

that it takes to get there and one of

742

00:28:27,430 --> 00:28:26,640

the things of course that takes is not

743

00:28:30,310 --> 00:28:27,440

only

744

00:28:32,470 --> 00:28:30,320

um you know a team of people who can

745

00:28:34,630 --> 00:28:32,480

design and implement something like this

746

00:28:36,950 --> 00:28:34,640

but also you know the rover itself with

747

00:28:38,230 --> 00:28:36,960

this communication talking to an orbiter

748

00:28:40,310 --> 00:28:38,240

that is passing overhead that is

749

00:28:41,510 --> 00:28:40,320

relaying data back here to earth all at

750

00:28:43,190 --> 00:28:41,520

the same time

751
00:28:44,549 --> 00:28:43,200
um that's an incredible achievement and

752
00:28:49,029 --> 00:28:44,559
i'm kind of really proud to be a part of

753
00:28:54,789 --> 00:28:51,669
hi there my name is steve collins and

754
00:28:57,110 --> 00:28:54,799
i'm an attitude control engineer

755
00:29:01,590 --> 00:28:57,120
we have a giant machine in the basement

756
00:29:04,950 --> 00:29:03,669
no actually attitude

757
00:29:07,110 --> 00:29:04,960
control

758
00:29:08,389 --> 00:29:07,120
is the part of the spacecraft that keeps

759
00:29:09,510 --> 00:29:08,399
the spacecraft pointed in the right

760
00:29:10,310 --> 00:29:09,520
direction

761
00:29:13,510 --> 00:29:10,320
so

762
00:29:15,430 --> 00:29:13,520
as we're flying curiosity to mars uh we

763
00:29:17,909 --> 00:29:15,440

have to keep the solar arrays pointed

764

00:29:19,510 --> 00:29:17,919

close to the sun so we get power and we

765

00:29:21,669 --> 00:29:19,520

need to keep the antennas that are on

766

00:29:22,630 --> 00:29:21,679

the spacecraft pointed close to earth so

767

00:29:24,830 --> 00:29:22,640

that we

768

00:29:27,590 --> 00:29:24,840

have communications with the

769

00:29:29,830 --> 00:29:27,600

spacecraft and so i'm responsible for

770

00:29:31,590 --> 00:29:29,840

that the all the thrusters and

771

00:29:34,389 --> 00:29:31,600

gyroscopes and star cameras and stuff

772

00:29:36,149 --> 00:29:34,399

like that that do that

773

00:29:37,990 --> 00:29:36,159

also during the mission

774

00:29:39,830 --> 00:29:38,000

the attitude control system is used to

775

00:29:41,830 --> 00:29:39,840

make corrections to the spacecraft's

776
00:29:44,549 --> 00:29:41,840
trajectory

777
00:29:47,190 --> 00:29:44,559
so the spacecraft has to show up at mars

778
00:29:49,350 --> 00:29:47,200
at the top of the atmosphere basically

779
00:29:51,830 --> 00:29:49,360
inside a football field

780
00:29:54,070 --> 00:29:51,840
in order for us to land in the place on

781
00:29:55,110 --> 00:29:54,080
mars that we want to land and to land

782
00:29:57,029 --> 00:29:55,120
safely

783
00:29:59,029 --> 00:29:57,039
and in order to do that we have to

784
00:30:01,190 --> 00:29:59,039
correct the spacecraft's trajectory we

785
00:30:04,070 --> 00:30:01,200
can't just launch it on a rocket from

786
00:30:06,389 --> 00:30:04,080
the earth and hit that tiny little

787
00:30:08,230 --> 00:30:06,399
target all the way at mars

788
00:30:11,269 --> 00:30:08,240

so during the course of the mission

789

00:30:13,350 --> 00:30:11,279

maybe four or five times we make a uh a

790

00:30:15,669 --> 00:30:13,360

correction to the spacecraft's uh

791

00:30:16,710 --> 00:30:15,679

velocity we fire the thrusters for a few

792

00:30:18,630 --> 00:30:16,720

seconds

793

00:30:21,830 --> 00:30:18,640

um there's a there's a little piece of

794

00:30:23,430 --> 00:30:21,840

b-roll here that

795

00:30:24,710 --> 00:30:23,440

shows the spacecraft just as we

796

00:30:26,870 --> 00:30:24,720

separated

797

00:30:30,230 --> 00:30:26,880

from the launch vehicle and i really

798

00:30:31,510 --> 00:30:30,240

like this because you can see um

799

00:30:33,269 --> 00:30:31,520

what's going to happen is the launch

800

00:30:35,750 --> 00:30:33,279

field is going to de-spin and you can

801
00:30:37,830 --> 00:30:35,760
see the motion of the spacecraft as the

802
00:30:39,510 --> 00:30:37,840
launch vehicle despites there

803
00:30:41,750 --> 00:30:39,520
so that's what the spacecraft looks like

804
00:30:44,549 --> 00:30:41,760
in flight and and that's why i i chose

805
00:30:46,310 --> 00:30:44,559
this little picture to show you guys

806
00:30:49,269 --> 00:30:46,320
we very rarely get to see a picture of

807
00:30:51,750 --> 00:30:49,279
the spacecraft actually flying in space

808
00:30:52,950 --> 00:30:51,760
we usually uh you know see it last down

809
00:30:53,990 --> 00:30:52,960
in the clean room and then have to

810
00:30:56,230 --> 00:30:54,000
imagine

811
00:30:59,590 --> 00:30:56,240
it for the rest of the mission

812
00:31:01,190 --> 00:30:59,600
so we spin the spacecraft spins at 2rpm

813
00:31:03,509 --> 00:31:01,200

and if we want to make a correction to

814

00:31:05,830 --> 00:31:03,519

the trajectory we have to fire the

815

00:31:08,549 --> 00:31:05,840

thrusters in a little pulse and we do

816

00:31:11,029 --> 00:31:08,559

that a couple of times each rev as the

817

00:31:13,909 --> 00:31:11,039

spacecraft spins

818

00:31:17,269 --> 00:31:13,919

to tweak the orbit and in order to make

819

00:31:20,310 --> 00:31:17,279

those corrections the deep space network

820

00:31:21,830 --> 00:31:20,320

has to tell us where the spacecraft is

821

00:31:24,070 --> 00:31:21,840

and they do that

822

00:31:26,070 --> 00:31:24,080

by giving us these things that we call

823

00:31:28,710 --> 00:31:26,080

doppels

824

00:31:30,870 --> 00:31:28,720

dopples are the information that's in

825

00:31:33,350 --> 00:31:30,880

the doppler signature of the radio

826

00:31:36,630 --> 00:31:33,360

signal we're getting from the spacecraft

827

00:31:38,310 --> 00:31:36,640

and the dsn can measure uh the frequency

828

00:31:41,430 --> 00:31:38,320

of the radio signal that's coming from

829

00:31:43,029 --> 00:31:41,440

the spacecraft very very accurately we

830

00:31:45,110 --> 00:31:43,039

can measure the velocity of the

831

00:31:47,029 --> 00:31:45,120

spacecraft to like a tenth of a

832

00:31:49,750 --> 00:31:47,039

millimeter per second

833

00:31:50,870 --> 00:31:49,760

and uh we do that pretty much every time

834

00:31:53,750 --> 00:31:50,880

we have communication with the

835

00:31:55,590 --> 00:31:53,760

spacecraft and the navigation team uses

836

00:31:58,230 --> 00:31:55,600

that to figure out where the spacecraft

837

00:32:01,830 --> 00:31:58,240

is in the solar system to within you

838

00:32:03,750 --> 00:32:01,840

know tens of meters and uh and tells us

839

00:32:05,430 --> 00:32:03,760

we want you to change the spacecraft's

840

00:32:08,470 --> 00:32:05,440

velocity by

841

00:32:10,870 --> 00:32:08,480

um let's do eight millimeters per second

842

00:32:13,669 --> 00:32:10,880

today you know our final corrections to

843

00:32:16,789 --> 00:32:13,679

the trajectory are about that size

844

00:32:19,509 --> 00:32:16,799

so that's uh some of the stuff that i uh

845

00:32:22,230 --> 00:32:19,519

work with during flight and do you want

846

00:32:24,310 --> 00:32:22,240

to have your turn and say some things so

847

00:32:25,830 --> 00:32:24,320

i'm ann devereaux um i was actually

848

00:32:28,950 --> 00:32:25,840

sitting where the gentleman with the

849

00:32:29,830 --> 00:32:28,960

gray shirt was on landing night and you

850

00:32:33,990 --> 00:32:29,840

can see

851
00:32:36,470 --> 00:32:34,000
front i was not chief engineer however

852
00:32:37,909 --> 00:32:36,480
if i sidled close to the side because

853
00:32:39,909 --> 00:32:37,919
the chief engineer was roaming the whole

854
00:32:43,509 --> 00:32:39,919
time you might have thought

855
00:32:45,350 --> 00:32:43,519
i was chief engineer for that night um

856
00:32:47,190 --> 00:32:45,360
anyway so i am actually an electrical

857
00:32:50,789 --> 00:32:47,200
engineer my background but like a lot of

858
00:32:52,789 --> 00:32:50,799
people at jpl i have had many hats

859
00:32:54,149 --> 00:32:52,799
my particular disciplines

860
00:32:56,389 --> 00:32:54,159
are telecom

861
00:32:58,950 --> 00:32:56,399
actually i my group were the ones that

862
00:33:02,070 --> 00:32:58,960
built the relay radio elektras that are

863
00:33:04,230 --> 00:33:02,080

on uh msl so when you hear them saying

864

00:33:06,310 --> 00:33:04,240

oh we have uh you know signal from

865

00:33:08,470 --> 00:33:06,320

odyssey that was

866

00:33:10,789 --> 00:33:08,480

our radio the elector radio had talked

867

00:33:13,190 --> 00:33:10,799

to odyssey and odyssey had uh telomered

868

00:33:15,029 --> 00:33:13,200

it to the ground um and so actually it's

869

00:33:16,870 --> 00:33:15,039

not in any of the roles but

870

00:33:19,190 --> 00:33:16,880

randomly i jumped up and i said yeah

871

00:33:20,549 --> 00:33:19,200

elektra because you know until then we

872

00:33:22,470 --> 00:33:20,559

never had to do anything with it i

873

00:33:25,350 --> 00:33:22,480

didn't know it was gonna work i mean i

874

00:33:27,190 --> 00:33:25,360

was hoping um in any case

875

00:33:29,590 --> 00:33:27,200

so uh the other things that i have done

876

00:33:31,350 --> 00:33:29,600

i i was lucky on on msl i was able to

877

00:33:33,509 --> 00:33:31,360

later on move over and be the lead

878

00:33:35,029 --> 00:33:33,519

flight system engineer so that's the

879

00:33:37,430 --> 00:33:35,039

person that's responsible for making

880

00:33:39,110 --> 00:33:37,440

sure as the boxes come in that uh

881

00:33:41,110 --> 00:33:39,120

construct the rover that they are in

882

00:33:42,710 --> 00:33:41,120

fact the box is what we expected and

883

00:33:45,350 --> 00:33:42,720

that when you bolt them all together

884

00:33:47,590 --> 00:33:45,360

they actually do what they you expect

885

00:33:49,990 --> 00:33:47,600

and so that's kind of the trick and part

886

00:33:52,149 --> 00:33:50,000

of that is kind of my last uh field of

887

00:33:53,909 --> 00:33:52,159

expertise which is autonomy uh you know

888

00:33:57,190 --> 00:33:53,919

you heard babic saying you know we have

889

00:33:58,789 --> 00:33:57,200

this giant time delay uh between when uh

890

00:34:00,230 --> 00:33:58,799

you know things actually happen on the

891

00:34:01,590 --> 00:34:00,240

vehicle and when we actually get to see

892

00:34:03,269 --> 00:34:01,600

it on the ground

893

00:34:05,590 --> 00:34:03,279

and it's very much like i actually i

894

00:34:07,669 --> 00:34:05,600

looked up to see what the size of a

895

00:34:09,990 --> 00:34:07,679

tweet was and of course the internet as

896

00:34:11,829 --> 00:34:10,000

usual is confused however it looked like

897

00:34:15,109 --> 00:34:11,839

something like maybe 4k

898

00:34:17,669 --> 00:34:15,119

uh bits was the maximum size for a

899

00:34:20,629 --> 00:34:17,679

message so during entry descent landing

900

00:34:23,589 --> 00:34:20,639

even when we got the the radios online

901
00:34:24,310 --> 00:34:23,599
we were doing eight kilobits per second

902
00:34:26,550 --> 00:34:24,320
so

903
00:34:28,629 --> 00:34:26,560
probably nobody here is tweeting twice a

904
00:34:30,470 --> 00:34:28,639
second that would be kind of fast but if

905
00:34:31,990 --> 00:34:30,480
you think about it that's the kind of

906
00:34:33,829 --> 00:34:32,000
information that we're getting back

907
00:34:36,149 --> 00:34:33,839
basically and it's kind of what

908
00:34:37,589 --> 00:34:36,159
curiosity thinks is important too like i

909
00:34:39,750 --> 00:34:37,599
just did this i just turned on some

910
00:34:41,190 --> 00:34:39,760
heaters i just stopped this i just broke

911
00:34:41,990 --> 00:34:41,200
my arm i just went and you're like what

912
00:34:47,990 --> 00:34:42,000
what

913
00:34:50,710 --> 00:34:48,000

um in the days coming up to edl uh it

914

00:34:53,030 --> 00:34:50,720

was interesting so realistically um we

915

00:34:55,750 --> 00:34:53,040

had sent the command that said literally

916

00:34:58,150 --> 00:34:55,760

i'm not giving any secrets away do edl

917

00:35:00,069 --> 00:34:58,160

something like a week beforehand and re

918

00:35:02,310 --> 00:35:00,079

really the spacecraft and steve can

919

00:35:04,630 --> 00:35:02,320

correct me the state spacecraft because

920

00:35:07,030 --> 00:35:04,640

we had just gotten a good lineup and we

921

00:35:08,710 --> 00:35:07,040

were going on a good uh entry trajectory

922

00:35:11,109 --> 00:35:08,720

the spacecraft could have landed by

923

00:35:13,030 --> 00:35:11,119

itself of course we're the parents right

924

00:35:16,310 --> 00:35:13,040

where the parents you know steadying the

925

00:35:19,190 --> 00:35:16,320

bicycle and we want to help and so from

926
00:35:21,109 --> 00:35:19,200
my kind of autonomy uh hat you know i'd

927
00:35:23,430 --> 00:35:21,119
sit there you know not being chief

928
00:35:24,870 --> 00:35:23,440
engineer i'd sit there and you know i'd

929
00:35:26,069 --> 00:35:24,880
worry well what if something happened we

930
00:35:28,069 --> 00:35:26,079
had these big meetings well what if

931
00:35:30,230 --> 00:35:28,079
something happened you know curiosity

932
00:35:32,150 --> 00:35:30,240
decided she broke her arm now what would

933
00:35:33,510 --> 00:35:32,160
happen is she would tweet i broke my arm

934
00:35:35,750 --> 00:35:33,520
i banded it up it's to the side i'm

935
00:35:36,870 --> 00:35:35,760
ready to go yep headed for mars what we

936
00:35:39,030 --> 00:35:36,880
would be like

937
00:35:40,470 --> 00:35:39,040
what do you broke your arm did you fall

938
00:35:42,230 --> 00:35:40,480

down how about the other arm is the

939

00:35:45,270 --> 00:35:42,240

other arm like we want to ask all these

940

00:35:46,870 --> 00:35:45,280

questions but 14 minutes up 14 minutes

941

00:35:48,310 --> 00:35:46,880

back plus we have to craft the questions

942

00:35:49,510 --> 00:35:48,320

we want to ask plus she's doing a lot of

943

00:35:52,550 --> 00:35:49,520

other stuff she's really busy she's

944

00:35:54,790 --> 00:35:52,560

hurtling toward mars and so it was that

945

00:35:56,870 --> 00:35:54,800

you know the normal human uh instinct

946

00:35:57,990 --> 00:35:56,880

would be to to to you know well what are

947

00:35:59,109 --> 00:35:58,000

you doing now what are you doing now

948

00:36:02,470 --> 00:35:59,119

well i'm going to tweak this and tweak

949

00:36:04,950 --> 00:36:02,480

that and we really had to balance that

950

00:36:07,670 --> 00:36:04,960

against hey she knows what she's doing

951
00:36:09,670 --> 00:36:07,680
you can just let her go but you only get

952
00:36:12,310 --> 00:36:09,680
the information that she sends you and

953
00:36:14,310 --> 00:36:12,320
you only get it because you know we have

954
00:36:16,310 --> 00:36:14,320
the links to the dsn

955
00:36:18,790 --> 00:36:16,320
and you know the relay links which is

956
00:36:20,470 --> 00:36:18,800
you know kind of one step on the way

957
00:36:23,829 --> 00:36:20,480
so it's very interesting for me actually

958
00:36:26,069 --> 00:36:23,839
now i'm working on the next rover the

959
00:36:28,550 --> 00:36:26,079
2020 rover so this is going to be

960
00:36:30,390 --> 00:36:28,560
curiosity's i don't know fraternal twin

961
00:36:32,710 --> 00:36:30,400
uh perhaps we're hoping to reuse a lot

962
00:36:35,430 --> 00:36:32,720
of the same systems and it's interesting

963
00:36:37,109 --> 00:36:35,440

looking back on you know usually at jpl

964

00:36:38,870 --> 00:36:37,119

you know we we do one thing and you move

965

00:36:40,710 --> 00:36:38,880

on you're like wow i'm really glad that

966

00:36:42,150 --> 00:36:40,720

worked yeah let's let's move on and do

967

00:36:43,750 --> 00:36:42,160

something different but now we have this

968

00:36:45,349 --> 00:36:43,760

opportunity to sit and think well you

969

00:36:46,870 --> 00:36:45,359

know was that the right thing you know

970

00:36:48,390 --> 00:36:46,880

maybe we should have thought about

971

00:36:50,230 --> 00:36:48,400

intervening if something happened maybe

972

00:36:52,950 --> 00:36:50,240

we should have done this maybe you know

973

00:36:55,430 --> 00:36:52,960

for for telecommunications for example

974

00:36:56,950 --> 00:36:55,440

um you know we had the the we're so

975

00:36:59,030 --> 00:36:56,960

lucky to have the the good relays

976
00:37:01,589 --> 00:36:59,040
through odyssey and mro mars

977
00:37:04,630 --> 00:37:01,599
reconnaissance orbiter and still now a

978
00:37:07,990 --> 00:37:04,640
basic cadence of curiosity's daily life

979
00:37:09,670 --> 00:37:08,000
is that uh you know odyssey or uh mro

980
00:37:11,030 --> 00:37:09,680
comes up they get all the data you know

981
00:37:12,150 --> 00:37:11,040
she dumps the pictures that sort of

982
00:37:13,829 --> 00:37:12,160
thing

983
00:37:16,150 --> 00:37:13,839
um but you know those orbiters are

984
00:37:17,670 --> 00:37:16,160
getting really old like we actually my

985
00:37:20,310 --> 00:37:17,680
group built the radios which means i'm

986
00:37:22,470 --> 00:37:20,320
getting really old uh that are on mars

987
00:37:26,710 --> 00:37:22,480
reconnaissance orbiter so it launched in

988
00:37:28,310 --> 00:37:26,720

2005. that's like a long time ago so by

989

00:37:31,030 --> 00:37:28,320

the time that we get

990

00:37:33,349 --> 00:37:31,040

to to to mars with 2020 those orbiters

991

00:37:34,790 --> 00:37:33,359

are going to be are going to be very old

992

00:37:36,790 --> 00:37:34,800

and you know we have to think about you

993

00:37:38,230 --> 00:37:36,800

know the dsn has been adding new

994

00:37:40,390 --> 00:37:38,240

capability we're looking at putting on

995

00:37:42,230 --> 00:37:40,400

optical communications and this would be

996

00:37:44,150 --> 00:37:42,240

a new feature of the interplanetary

997

00:37:46,390 --> 00:37:44,160

network that they could receive optical

998

00:37:48,470 --> 00:37:46,400

so we have options like that but only

999

00:37:50,310 --> 00:37:48,480

because you know the evolution of this

1000

00:37:52,950 --> 00:37:50,320

ground system has meant that it can

1001
00:37:55,510 --> 00:37:52,960
adapt you know to what projects need as

1002
00:37:58,150 --> 00:37:55,520
as we go along so oh i have my one

1003
00:37:59,910 --> 00:37:58,160
picture um i just wanted to show so this

1004
00:38:01,510 --> 00:37:59,920
is don't ask me why it's my it's my

1005
00:38:03,430 --> 00:38:01,520
favorite you look at you're like i don't

1006
00:38:05,829 --> 00:38:03,440
even actually know what this is so what

1007
00:38:08,550 --> 00:38:05,839
it is it's it's a picture of her arm

1008
00:38:10,230 --> 00:38:08,560
and it's it's got her name on it and

1009
00:38:11,430 --> 00:38:10,240
there's no one there to see it i mean no

1010
00:38:13,190 --> 00:38:11,440
matter what you see

1011
00:38:15,430 --> 00:38:13,200
in the twitter verse there truly is no

1012
00:38:17,430 --> 00:38:15,440
one to see it it's just her she's by

1013
00:38:18,630 --> 00:38:17,440

herself um and it always has kind of

1014

00:38:20,310 --> 00:38:18,640

struck me like i said you know i have

1015

00:38:21,109 --> 00:38:20,320

this sense of autonomy i have this sense

1016

00:38:23,109 --> 00:38:21,119

of

1017

00:38:24,870 --> 00:38:23,119

her being a person and a personality how

1018

00:38:27,030 --> 00:38:24,880

does she react to things how does she

1019

00:38:29,190 --> 00:38:27,040

like things how does she know how to do

1020

00:38:31,430 --> 00:38:29,200

things um and so i just kind of imagine

1021

00:38:33,510 --> 00:38:31,440

her sitting there you know um and just

1022

00:38:35,109 --> 00:38:33,520

going like what am i doing here what

1023

00:38:37,430 --> 00:38:35,119

curiosity oh yeah

1024

00:38:39,030 --> 00:38:37,440

uh curiosity yeah oh okay again i gotta

1025

00:38:40,390 --> 00:38:39,040

get it you know and sending back her

1026

00:38:45,109 --> 00:38:40,400

tweets oh yeah by the way i took a

1027

00:38:49,990 --> 00:38:46,950

all right we're going to open it up to

1028

00:38:52,310 --> 00:38:50,000

questions and um again you know wait for

1029

00:38:53,910 --> 00:38:52,320

a microphone to come your way and where

1030

00:38:54,870 --> 00:38:53,920

are our two mic runners by the way let

1031

00:38:59,190 --> 00:38:54,880

me see alice is here we're going to

1032

00:39:03,109 --> 00:39:01,430

go ahead hi uh you mentioned that you've

1033

00:39:04,870 --> 00:39:03,119

been working this for about eight years

1034

00:39:06,630 --> 00:39:04,880

or so uh what kind of things have you

1035

00:39:08,870 --> 00:39:06,640

learned about yourself

1036

00:39:11,670 --> 00:39:08,880

that you learned while working here and

1037

00:39:13,030 --> 00:39:11,680

uh what you know how does it feel being

1038

00:39:14,790 --> 00:39:13,040

part of history or creating something

1039

00:39:17,430 --> 00:39:14,800

like this so this yeah this was my first

1040

00:39:19,589 --> 00:39:17,440

job out of college um

1041

00:39:22,150 --> 00:39:19,599

you know i liked engineering i thought

1042

00:39:24,630 --> 00:39:22,160

it was cool i wanted to do what i saw

1043

00:39:26,950 --> 00:39:24,640

people had done before with pathfinder

1044

00:39:28,230 --> 00:39:26,960

in like 97 and then the i got here just

1045

00:39:31,109 --> 00:39:28,240

as the mars exploration rovers were

1046

00:39:32,870 --> 00:39:31,119

landing um

1047

00:39:34,230 --> 00:39:32,880

for me i learned a lot about what i like

1048

00:39:35,510 --> 00:39:34,240

as an engineer and what i don't like as

1049

00:39:37,190 --> 00:39:35,520

an engineer i also learned the

1050

00:39:39,030 --> 00:39:37,200

importance of actually working with

1051
00:39:41,030 --> 00:39:39,040
incredibly talented and awesome people

1052
00:39:42,870 --> 00:39:41,040
who make your job fun

1053
00:39:45,109 --> 00:39:42,880
um

1054
00:39:46,470 --> 00:39:45,119
yeah other people other people no uh

1055
00:39:48,150 --> 00:39:46,480
actually absolutely these guys and and

1056
00:39:50,150 --> 00:39:48,160
many other people on this team it's it's

1057
00:39:52,390 --> 00:39:50,160
been an incredible uh journey

1058
00:39:54,390 --> 00:39:52,400
um of kind of just learning

1059
00:39:55,910 --> 00:39:54,400
everything i think i i was lucky enough

1060
00:39:57,349 --> 00:39:55,920
to have some really great mentors on

1061
00:39:59,270 --> 00:39:57,359
this project like charles wetzel and

1062
00:40:00,470 --> 00:39:59,280
people like that who kind of allowed me

1063
00:40:01,750 --> 00:40:00,480

to apprentice i guess a little bit in

1064

00:40:03,349 --> 00:40:01,760

different roles throughout the the

1065

00:40:05,510 --> 00:40:03,359

course of that that time

1066

00:40:07,030 --> 00:40:05,520

um and it's really fun for me i think

1067

00:40:10,230 --> 00:40:07,040

one of the most amazing things is to see

1068

00:40:12,550 --> 00:40:10,240

this project go from really sketches on

1069

00:40:14,470 --> 00:40:12,560

you know paper and powerpoint to

1070

00:40:15,990 --> 00:40:14,480

actually you know those pictures on the

1071

00:40:18,230 --> 00:40:16,000

surface of another planet

1072

00:40:19,990 --> 00:40:18,240

um and i think that you know

1073

00:40:22,309 --> 00:40:20,000

uh people ask is

1074

00:40:24,470 --> 00:40:22,319

10 years is a really long time to get

1075

00:40:25,670 --> 00:40:24,480

that sort of like satisfaction but i'm

1076

00:40:27,430 --> 00:40:25,680

sure everybody who's worked on this

1077

00:40:29,190 --> 00:40:27,440

project for many years would say that

1078

00:40:31,750 --> 00:40:29,200

that investment is totally worth it when

1079

00:40:33,190 --> 00:40:31,760

you see the end results um so i would

1080

00:40:35,109 --> 00:40:33,200

say that despite the fact that sometimes

1081

00:40:35,990 --> 00:40:35,119

this job takes a lot of patience

1082

00:40:37,270 --> 00:40:36,000

um

1083

00:40:39,349 --> 00:40:37,280

you know maybe maybe you would love to

1084

00:40:41,510 --> 00:40:39,359

be on mars every couple years

1085

00:40:42,950 --> 00:40:41,520

uh it it really is tremendously

1086

00:40:44,550 --> 00:40:42,960

rewarding and i think that was that was

1087

00:40:45,270 --> 00:40:44,560

the best thing and i had i mean honestly

1088

00:40:47,910 --> 00:40:45,280

like

1089

00:40:48,950 --> 00:40:47,920

so from a very personal standpoint um

1090

00:40:50,630 --> 00:40:48,960

you know

1091

00:40:51,589 --> 00:40:50,640

there were definitely i think moments

1092

00:40:52,710 --> 00:40:51,599

where i was like

1093

00:40:55,030 --> 00:40:52,720

is it a little ridiculous for me to have

1094

00:40:57,670 --> 00:40:55,040

a mohawk at work or color it

1095

00:40:59,030 --> 00:40:57,680

um and and you know what i i never i

1096

00:41:00,710 --> 00:40:59,040

would say this the one of the greatest

1097

00:41:02,150 --> 00:41:00,720

things i learned about being a part of

1098

00:41:03,589 --> 00:41:02,160

this group was that we were always

1099

00:41:05,430 --> 00:41:03,599

judging the quality of our work and not

1100

00:41:07,030 --> 00:41:05,440

our presentation and how we were as

1101
00:41:08,710 --> 00:41:07,040
people i mean of course being having a

1102
00:41:09,829 --> 00:41:08,720
good team dynamic and

1103
00:41:11,190 --> 00:41:09,839
everything is really important you saw

1104
00:41:12,790 --> 00:41:11,200
us all hugging and high-fiving it's not

1105
00:41:14,230 --> 00:41:12,800
just for show it's because we really you

1106
00:41:16,630 --> 00:41:14,240
know we bonded over the the years

1107
00:41:18,390 --> 00:41:16,640
together so it's been really awesome

1108
00:41:20,390 --> 00:41:18,400
anybody else want to

1109
00:41:21,589 --> 00:41:20,400
answer that while we

1110
00:41:23,589 --> 00:41:21,599
go next

1111
00:41:26,390 --> 00:41:23,599
nope okay let me um

1112
00:41:28,309 --> 00:41:26,400
look for another exactly i agree

1113
00:41:30,230 --> 00:41:28,319

oh we have a microphone right here go

1114

00:41:32,390 --> 00:41:30,240

ahead so um because we're kind of

1115

00:41:34,309 --> 00:41:32,400

talking about a 50-year anniversary like

1116

00:41:35,829 --> 00:41:34,319

my mind is seeing 50 years ago these

1117

00:41:37,910 --> 00:41:35,839

images of just like

1118

00:41:39,670 --> 00:41:37,920

kind of generic balding white guy with

1119

00:41:41,750 --> 00:41:39,680

slick back hair pocket protector big

1120

00:41:44,870 --> 00:41:41,760

thick glasses to now

1121

00:41:47,109 --> 00:41:44,880

like just so much diversity and you guys

1122

00:41:49,349 --> 00:41:47,119

are like literally you three people are

1123

00:41:51,910 --> 00:41:49,359

famous like people millions of people

1124

00:41:52,790 --> 00:41:51,920

know who you are and i just kind of want

1125

00:41:54,390 --> 00:41:52,800

to like

1126
00:41:57,430 --> 00:41:54,400
ask you guys what do you think about

1127
00:41:59,430 --> 00:41:57,440
that like nasa going from this kind of

1128
00:42:00,630 --> 00:41:59,440
kind of elitist club to just like it

1129
00:42:04,069 --> 00:42:00,640
feels like

1130
00:42:06,150 --> 00:42:04,079
like these images like i'm gonna cry but

1131
00:42:08,470 --> 00:42:06,160
like all these images of everybody

1132
00:42:11,190 --> 00:42:08,480
cheering for these spacecraft like what

1133
00:42:12,550 --> 00:42:11,200
do you guys what do you feel about that

1134
00:42:16,550 --> 00:42:12,560
so they handed the microphone to the

1135
00:42:20,710 --> 00:42:18,150
now actually it's interesting so i've

1136
00:42:21,670 --> 00:42:20,720
worked at jpl for 20 years um

1137
00:42:24,470 --> 00:42:21,680
and

1138
00:42:27,750 --> 00:42:24,480

actually i started out uh uh doing some

1139

00:42:30,470 --> 00:42:27,760

work in the dsn and i was like yeah jpm

1140

00:42:33,109 --> 00:42:30,480

dsn oh yeah but i have a job at jpl and

1141

00:42:35,430 --> 00:42:33,119

i don't actually care what it is um but

1142

00:42:36,950 --> 00:42:35,440

i remember seeing safety videos you know

1143

00:42:38,470 --> 00:42:36,960

at the time like oh you know watch how

1144

00:42:41,349 --> 00:42:38,480

to take care of hardware you know

1145

00:42:42,870 --> 00:42:41,359

whatever and i am not kidding it was a

1146

00:42:44,790 --> 00:42:42,880

guy like with a white shirt pocket

1147

00:42:47,349 --> 00:42:44,800

protector black pants i mean this wasn't

1148

00:42:49,270 --> 00:42:47,359

ironic either this was the video and

1149

00:42:51,750 --> 00:42:49,280

he's wearing a coat and it's funny at

1150

00:42:53,589 --> 00:42:51,760

the time so he's got a pipe in his

1151

00:42:55,190 --> 00:42:53,599

pocket

1152

00:42:56,710 --> 00:42:55,200

you do and one of the things that

1153

00:42:58,069 --> 00:42:56,720

they're showing like you know be careful

1154

00:43:00,309 --> 00:42:58,079

that you don't have i mean now we wear

1155

00:43:02,069 --> 00:43:00,319

badges on on on chain and

1156

00:43:03,589 --> 00:43:02,079

i've never done this but you could

1157

00:43:05,270 --> 00:43:03,599

certainly lean over and you know crack

1158

00:43:06,950 --> 00:43:05,280

something with your badge but they show

1159

00:43:08,790 --> 00:43:06,960

this guy leaning over and the pipe's

1160

00:43:10,470 --> 00:43:08,800

coming out and it's like dark and they

1161

00:43:12,710 --> 00:43:10,480

stop him like this and you're like are

1162

00:43:14,950 --> 00:43:12,720

you kidding me are you but it was funny

1163

00:43:16,870 --> 00:43:14,960

when i came actually i mean you know

1164

00:43:18,710 --> 00:43:16,880

back in the day there weren't that many

1165

00:43:21,190 --> 00:43:18,720

women engineers mostly it was the

1166

00:43:23,349 --> 00:43:21,200

administrative staff um and it was an

1167

00:43:25,109 --> 00:43:23,359

interesting uh dynamic for me like every

1168

00:43:26,550 --> 00:43:25,119

once in a while actually still

1169

00:43:28,630 --> 00:43:26,560

i sit in a meeting and i might be the

1170

00:43:30,550 --> 00:43:28,640

one woman and there's 20 guys and it

1171

00:43:32,309 --> 00:43:30,560

just happens to be because that's the

1172

00:43:34,630 --> 00:43:32,319

balance but i think kind of like bobik

1173

00:43:36,470 --> 00:43:34,640

was saying um one of the great things

1174

00:43:39,910 --> 00:43:36,480

about working for nasa is it is about

1175

00:43:42,390 --> 00:43:39,920

your ideas so if i have good ideas i'm

1176

00:43:45,190 --> 00:43:42,400

in the center of the room i can be chief

1177

00:43:46,790 --> 00:43:45,200

engineer not this project maybe but i

1178

00:43:48,150 --> 00:43:46,800

can be chief engineer i can be whatever

1179

00:43:50,230 --> 00:43:48,160

and i know that kind of sounds like a

1180

00:43:52,710 --> 00:43:50,240

platitude but i think certainly my

1181

00:43:54,630 --> 00:43:52,720

experience has been that way and you

1182

00:43:56,230 --> 00:43:54,640

know we have more and more people coming

1183

00:43:58,150 --> 00:43:56,240

in i mean part of it is just education

1184

00:44:00,630 --> 00:43:58,160

right i mean back in the day i had to

1185

00:44:02,550 --> 00:44:00,640

keep saying that you know it wasn't

1186

00:44:03,990 --> 00:44:02,560

a good career path for a woman to go

1187

00:44:06,470 --> 00:44:04,000

into engineering why would you want to

1188

00:44:08,390 --> 00:44:06,480

do that um you didn't see people that

1189

00:44:09,829 --> 00:44:08,400

looked like you whether you were a woman

1190

00:44:11,589 --> 00:44:09,839

whether you were black whether you were

1191

00:44:13,030 --> 00:44:11,599

indian you just didn't see people like

1192

00:44:14,870 --> 00:44:13,040

that so why would you think that that

1193

00:44:16,950 --> 00:44:14,880

was something that you would do and i

1194

00:44:18,790 --> 00:44:16,960

think now there's there's so much less

1195

00:44:20,390 --> 00:44:18,800

of that there's no reason

1196

00:44:21,750 --> 00:44:20,400

you know for people not to understand

1197

00:44:23,990 --> 00:44:21,760

that they can have opportunities in

1198

00:44:26,069 --> 00:44:24,000

science and engineering jpl and

1199

00:44:27,670 --> 00:44:26,079

certainly stephen and bobik and i have

1200

00:44:29,990 --> 00:44:27,680

been very involved in you know getting

1201
00:44:31,349 --> 00:44:30,000
out and doing lectures on science and

1202
00:44:32,950 --> 00:44:31,359
engineering and why it's okay i actually

1203
00:44:34,630 --> 00:44:32,960
get to go to morocco

1204
00:44:36,790 --> 00:44:34,640
last year to give some talks for the

1205
00:44:39,030 --> 00:44:36,800
state department and i tell you the kids

1206
00:44:40,390 --> 00:44:39,040
were looking at me you know blonde white

1207
00:44:42,950 --> 00:44:40,400
woman

1208
00:44:44,390 --> 00:44:42,960
you know like i was from outer space so

1209
00:44:45,750 --> 00:44:44,400
it's very satisfying you know it's just

1210
00:44:47,670 --> 00:44:45,760
a matter of getting the word out that's

1211
00:44:49,510 --> 00:44:47,680
that's the way i feel about it

1212
00:44:50,870 --> 00:44:49,520
um you know i'll actually add something

1213
00:44:52,550 --> 00:44:50,880

to that getting the word out you know

1214

00:44:54,870 --> 00:44:52,560

really what has made these missions so

1215

00:44:57,670 --> 00:44:54,880

popular and them so well known

1216

00:44:59,829 --> 00:44:57,680

is that you all are on social media and

1217

00:45:02,390 --> 00:44:59,839

you have made this kind of work really

1218

00:45:04,790 --> 00:45:02,400

cool again um you know

1219

00:45:06,630 --> 00:45:04,800

in the last five years with twitter and

1220

00:45:08,230 --> 00:45:06,640

all the other social media platforms and

1221

00:45:10,390 --> 00:45:08,240

obviously you guys are following nasa in

1222

00:45:12,390 --> 00:45:10,400

some capacity and maybe on landing night

1223

00:45:14,550 --> 00:45:12,400

you were retweeting the landing but you

1224

00:45:16,630 --> 00:45:14,560

know we have done mission commentary

1225

00:45:18,630 --> 00:45:16,640

like what you saw in that video for

1226

00:45:21,349 --> 00:45:18,640

every single mission going back for

1227

00:45:23,109 --> 00:45:21,359

decades it just didn't get out very well

1228

00:45:24,950 --> 00:45:23,119

it only went to the news media and they

1229

00:45:26,710 --> 00:45:24,960

take you know the 30 minute or 20 sec a

1230

00:45:27,990 --> 00:45:26,720

30-second chunk of it to play in the

1231

00:45:29,990 --> 00:45:28,000

evening news you didn't see all the

1232

00:45:31,510 --> 00:45:30,000

build up in the drama and more in more

1233

00:45:33,990 --> 00:45:31,520

recent years we've been able to stream

1234

00:45:36,390 --> 00:45:34,000

it live uh the entire the entire show

1235

00:45:38,150 --> 00:45:36,400

the entire few hours of commentary and i

1236

00:45:40,230 --> 00:45:38,160

think that has made you have made all

1237

00:45:41,670 --> 00:45:40,240

the difference in the world in terms of

1238

00:45:43,190 --> 00:45:41,680

getting people more familiar with our

1239

00:45:45,109 --> 00:45:43,200

missions and and more familiar with the

1240

00:45:47,430 --> 00:45:45,119

people who are behind them so

1241

00:45:49,589 --> 00:45:47,440

it's thank you guys for doing that

1242

00:45:51,750 --> 00:45:49,599

there's a lot more channels of

1243

00:45:54,150 --> 00:45:51,760

communication now and a lot more options

1244

00:45:56,470 --> 00:45:54,160

for how we can tell the story of how we

1245

00:45:58,550 --> 00:45:56,480

do our stuff

1246

00:46:00,950 --> 00:45:58,560

just to touch on anne's

1247

00:46:04,710 --> 00:46:00,960

comment uh a little bit i was sitting in

1248

00:46:06,710 --> 00:46:04,720

a meeting for mars uh 2020 uh talking

1249

00:46:09,750 --> 00:46:06,720

about propulsion system stuff for that

1250

00:46:13,030 --> 00:46:09,760

mission the other day and it slowly

1251
00:46:15,510 --> 00:46:13,040
dawned on me that i was the only guy

1252
00:46:18,470 --> 00:46:15,520
in the meeting and i was like

1253
00:46:21,829 --> 00:46:18,480
that's that's good you know we we are

1254
00:46:23,829 --> 00:46:21,839
making progress there um and and jpl is

1255
00:46:26,630 --> 00:46:23,839
just an amazing place because of the

1256
00:46:28,710 --> 00:46:26,640
diversity of of people that uh that get

1257
00:46:31,750 --> 00:46:28,720
to work on it

1258
00:46:34,630 --> 00:46:31,760
we are super super lucky to be able to

1259
00:46:36,230 --> 00:46:34,640
do this fun technical stuff

1260
00:46:38,470 --> 00:46:36,240
be given these very challenging

1261
00:46:41,270 --> 00:46:38,480
technical problems and be able to share

1262
00:46:43,750 --> 00:46:41,280
it with the whole world basically uh

1263
00:46:45,990 --> 00:46:43,760

that they can uh you know ride along and

1264

00:46:47,670 --> 00:46:46,000

uh and see the amazing stuff that we're

1265

00:46:49,030 --> 00:46:47,680

doing so

1266

00:46:50,870 --> 00:46:49,040

all right let me go to another question

1267

00:46:52,870 --> 00:46:50,880

to someone already have the microphone

1268

00:46:54,829 --> 00:46:52,880

uh let's see if we go to the very back

1269

00:46:57,589 --> 00:46:54,839

row there

1270

00:46:59,829 --> 00:46:57,599

thanks hi there um

1271

00:47:02,790 --> 00:46:59,839

my name is jason major i i'm at twitter

1272

00:47:05,430 --> 00:47:02,800

at jp major and i love tweeting about

1273

00:47:07,510 --> 00:47:05,440

all of the space news that's happening i

1274

00:47:09,030 --> 00:47:07,520

remember live tweeting the the landing

1275

00:47:10,790 --> 00:47:09,040

it was one of the most exciting things

1276

00:47:13,349 --> 00:47:10,800

i've ever seen and the excitement that

1277

00:47:15,109 --> 00:47:13,359

was in the room was was palpable across

1278

00:47:17,270 --> 00:47:15,119

the internet which was really really

1279

00:47:20,309 --> 00:47:17,280

amazing um

1280

00:47:22,549 --> 00:47:20,319

now because this social is all about

1281

00:47:25,349 --> 00:47:22,559

communication with spacecraft and with

1282

00:47:27,030 --> 00:47:25,359

curiosity um and of course other

1283

00:47:28,309 --> 00:47:27,040

missions as well

1284

00:47:30,150 --> 00:47:28,319

what

1285

00:47:31,589 --> 00:47:30,160

and i'll say this for for all three of

1286

00:47:34,150 --> 00:47:31,599

you um

1287

00:47:37,349 --> 00:47:34,160

what what's your favorite information

1288

00:47:38,549 --> 00:47:37,359

that's come back from curiosity uh of

1289

00:47:40,549 --> 00:47:38,559

course other than you know hey i've

1290

00:47:43,990 --> 00:47:40,559

landed safely on mars everything's good

1291

00:47:46,549 --> 00:47:44,000

i like the quaternions a lot

1292

00:47:47,829 --> 00:47:46,559

but i'm an attitude control guy

1293

00:47:49,910 --> 00:47:47,839

uh

1294

00:47:52,150 --> 00:47:49,920

just so you get the joke the quaternions

1295

00:47:55,829 --> 00:47:52,160

are four numbers that we use to express

1296

00:47:58,630 --> 00:47:55,839

how the spacecraft is oriented in space

1297

00:48:01,190 --> 00:47:58,640

i spend a lot of my time

1298

00:48:03,430 --> 00:48:01,200

looking at telemetry and

1299

00:48:05,190 --> 00:48:03,440

the dsn streams me

1300

00:48:06,710 --> 00:48:05,200

thousands of numbers that show up on

1301
00:48:07,589 --> 00:48:06,720
these screens that are in front of you

1302
00:48:08,309 --> 00:48:07,599
guys

1303
00:48:13,109 --> 00:48:08,319
and

1304
00:48:15,030 --> 00:48:13,119
we in each of our different subsystems

1305
00:48:17,430 --> 00:48:15,040
make a picture in our mind of what the

1306
00:48:20,549 --> 00:48:17,440
spacecraft is doing out there

1307
00:48:22,470 --> 00:48:20,559
um and so that's the day-to-day thing i

1308
00:48:24,630 --> 00:48:22,480
mean that's what we you know when we're

1309
00:48:26,630 --> 00:48:24,640
not on tv we come in here every day and

1310
00:48:28,549 --> 00:48:26,640
look at our telemetry and figure out is

1311
00:48:30,309 --> 00:48:28,559
the spacecraft okay today that's weird

1312
00:48:31,190 --> 00:48:30,319
what is that little wiggle why did it do

1313
00:48:32,470 --> 00:48:31,200

that

1314

00:48:34,390 --> 00:48:32,480

um

1315

00:48:36,230 --> 00:48:34,400

that that may not be what

1316

00:48:39,190 --> 00:48:36,240

quite you were asking about what's the

1317

00:48:41,670 --> 00:48:39,200

most fascinating science

1318

00:48:44,390 --> 00:48:41,680

uh information from uh from curiosity

1319

00:48:49,589 --> 00:48:44,400

but but that's sort of my day-to-day

1320

00:48:52,870 --> 00:48:51,430

obviously the pictures are amazing i

1321

00:48:54,470 --> 00:48:52,880

think they're very tangible like when

1322

00:48:56,309 --> 00:48:54,480

you see like where we are at kimberly

1323

00:48:57,430 --> 00:48:56,319

these big you know beautiful rocks right

1324

00:48:59,910 --> 00:48:57,440

in front of us mountain shark is in the

1325

00:49:01,670 --> 00:48:59,920

distance it's it's all like and it's for

1326

00:49:03,750 --> 00:49:01,680

me it was very powerful i think to see

1327

00:49:05,510 --> 00:49:03,760

for example pathfinder in 97 to see the

1328

00:49:07,109 --> 00:49:05,520

fact that there's this human-built

1329

00:49:08,790 --> 00:49:07,119

object on a surface another planet makes

1330

00:49:10,069 --> 00:49:08,800

it very just kind of like an experience

1331

00:49:12,309 --> 00:49:10,079

that i feel like i could

1332

00:49:14,150 --> 00:49:12,319

share in um the things that i think i i

1333

00:49:15,750 --> 00:49:14,160

love now i really enjoy the weather

1334

00:49:17,589 --> 00:49:15,760

report and just i don't know why but

1335

00:49:18,790 --> 00:49:17,599

kind of knowing like mars has weather

1336

00:49:21,109 --> 00:49:18,800

and there's temperatures and oh yeah i

1337

00:49:22,309 --> 00:49:21,119

know oh it was cold day on mars today um

1338

00:49:23,750 --> 00:49:22,319

that kind of stuff is actually really

1339

00:49:24,710 --> 00:49:23,760

awesome i know when the sun sets you

1340

00:49:25,990 --> 00:49:24,720

know

1341

00:49:28,470 --> 00:49:26,000

one of the things early on that i

1342

00:49:30,630 --> 00:49:28,480

remember just loving more than anything

1343

00:49:32,950 --> 00:49:30,640

was the way the rover works is every

1344

00:49:35,030 --> 00:49:32,960

morning roughly uh you know 9 30 10 ish

1345

00:49:37,990 --> 00:49:35,040

we send in the the commands for the

1346

00:49:39,750 --> 00:49:38,000

entire day and then in order uh to

1347

00:49:41,349 --> 00:49:39,760

acknowledge that the rover just sends

1348

00:49:43,510 --> 00:49:41,359

out this little beep and it's just a

1349

00:49:45,109 --> 00:49:43,520

tone all is a little tone at the right

1350

00:49:47,109 --> 00:49:45,119

time that tells you hey i got the

1351

00:49:48,309 --> 00:49:47,119

commands today i'm gonna go do this now

1352

00:49:49,829 --> 00:49:48,319

and i don't know why but that just made

1353

00:49:51,589 --> 00:49:49,839

me so happy i'm like oh there it is it's

1354

00:49:53,270 --> 00:49:51,599

just telling us oh i got this all right

1355

00:49:54,710 --> 00:49:53,280

and you know of course later on the data

1356

00:49:55,910 --> 00:49:54,720

comes back via the mro but that you know

1357

00:49:57,430 --> 00:49:55,920

through going through the deep says

1358

00:50:00,150 --> 00:49:57,440

network we get this little just little

1359

00:50:01,349 --> 00:50:00,160

chirp saying yeah everything is fine

1360

00:50:02,630 --> 00:50:01,359

and it's i don't know why but it just

1361

00:50:03,990 --> 00:50:02,640

made me really happy it was just like a

1362

00:50:06,710 --> 00:50:04,000

little like i felt like a very personal

1363

00:50:07,510 --> 00:50:06,720

connection to the rubber at that moment

1364

00:50:09,510 --> 00:50:07,520

um

1365

00:50:12,710 --> 00:50:09,520

so i'm gonna be extra nerdy and say that

1366

00:50:14,630 --> 00:50:12,720

i really like the health status stuff

1367

00:50:16,230 --> 00:50:14,640

um you know i made the comment about the

1368

00:50:17,349 --> 00:50:16,240

rover tweeting and you think oh i'm just

1369

00:50:19,510 --> 00:50:17,359

saying that because i'm in a social

1370

00:50:20,950 --> 00:50:19,520

media thing no it is actually exactly

1371

00:50:23,829 --> 00:50:20,960

like tweeting there's something called

1372

00:50:24,710 --> 00:50:23,839

evrs help me out uh

1373

00:50:26,790 --> 00:50:24,720

yeah

1374

00:50:28,309 --> 00:50:26,800

no idea we have no idea what it is but

1375

00:50:30,710 --> 00:50:28,319

it's basically so just like you know a

1376

00:50:33,589 --> 00:50:30,720

tweet is 142 characters so this is one

1377

00:50:36,390 --> 00:50:33,599

line it'll say evr activity high i

1378

00:50:38,390 --> 00:50:36,400

turned on a motor evr warning low i saw

1379

00:50:40,069 --> 00:50:38,400

a red light on a temperature gauge that

1380

00:50:42,790 --> 00:50:40,079

i'm not all that concerned about evr

1381

00:50:44,150 --> 00:50:42,800

etcetera and so uh as as babak was

1382

00:50:46,630 --> 00:50:44,160

saying you know there's only some times

1383

00:50:48,870 --> 00:50:46,640

that we um are talking to the to the dsn

1384

00:50:51,270 --> 00:50:48,880

or you know dumping stuff uh through the

1385

00:50:52,069 --> 00:50:51,280

rov through the the relay and so you

1386

00:50:53,589 --> 00:50:52,079

know you're kind of sitting there

1387

00:50:55,510 --> 00:50:53,599

sitting there nothing and then you just

1388

00:50:57,829 --> 00:50:55,520

see this stream of consciousness like

1389

00:50:59,349 --> 00:50:57,839

your super annoying friend who goes and

1390

00:51:00,710 --> 00:50:59,359

it's like i'm at the mall i'm going to

1391

00:51:02,630 --> 00:51:00,720

abercrombie and fidget oh my gosh

1392

00:51:04,230 --> 00:51:02,640

they're having a sale oh look this one's

1393

00:51:06,710 --> 00:51:04,240

blue i'm going to get the blue one wait

1394

00:51:09,190 --> 00:51:06,720

i'm going to call bob maybe i'll go

1395

00:51:11,349 --> 00:51:09,200

exactly but it just continues this

1396

00:51:14,309 --> 00:51:11,359

stream down and it's it is sort of like

1397

00:51:15,589 --> 00:51:14,319

it's live tweeting its day you know i

1398

00:51:16,950 --> 00:51:15,599

did this i did this and you know most of

1399

00:51:18,470 --> 00:51:16,960

the stuff isn't all that interesting the

1400

00:51:20,230 --> 00:51:18,480

pictures are interesting you know some

1401
00:51:21,670 --> 00:51:20,240
of this technical data is interesting

1402
00:51:23,990 --> 00:51:21,680
but most of the stuff that it does

1403
00:51:25,589 --> 00:51:24,000
during the day just like us um is not

1404
00:51:27,589 --> 00:51:25,599
really all that interesting and kind of

1405
00:51:29,750 --> 00:51:27,599
happens every day but that gives me this

1406
00:51:31,430 --> 00:51:29,760
warm sense of normality like this is

1407
00:51:32,630 --> 00:51:31,440
just another day on the surface tick

1408
00:51:34,470 --> 00:51:32,640
tick tick tick tick i did all these

1409
00:51:37,109 --> 00:51:34,480
things bye-bye signed off i'll talk to

1410
00:51:40,230 --> 00:51:37,119
you tomorrow mom

1411
00:51:42,950 --> 00:51:40,240
before we let you guys go i wanted to

1412
00:51:44,870 --> 00:51:42,960
bring up the peanuts and uh does any one

1413
00:51:46,470 --> 00:51:44,880

of you want to tell the story of peanuts

1414

00:51:49,990 --> 00:51:46,480

steve i'm wondering you you have been in

1415

00:51:53,030 --> 00:51:50,000

this room for so many mission events

1416

00:51:55,190 --> 00:51:53,040

yeah and there always seem to be peanuts

1417

00:51:56,230 --> 00:51:55,200

for some reason

1418

00:51:57,270 --> 00:51:56,240

i i

1419

00:51:59,430 --> 00:51:57,280

i'm

1420

00:52:01,670 --> 00:51:59,440

i may have trouble with knowing the

1421

00:52:02,950 --> 00:52:01,680

whole story but there's a long tradition

1422

00:52:05,510 --> 00:52:02,960

at jpl

1423

00:52:07,109 --> 00:52:05,520

of of having um

1424

00:52:09,510 --> 00:52:07,119

peanuts for

1425

00:52:12,150 --> 00:52:09,520

i think it started with launches and

1426

00:52:14,470 --> 00:52:12,160

then later became kind of any big

1427

00:52:17,270 --> 00:52:14,480

critical event uh that we're doing with

1428

00:52:19,990 --> 00:52:17,280

the spacecraft that for good luck we

1429

00:52:21,589 --> 00:52:20,000

would get out a a bunch of peanuts and

1430

00:52:23,430 --> 00:52:21,599

we'd pass them up and down the rows and

1431

00:52:24,630 --> 00:52:23,440

everybody would eat a couple of peanuts

1432

00:52:27,750 --> 00:52:24,640

yeah i'll tell you a little more about

1433

00:52:30,470 --> 00:52:27,760

the story it was dates back to 1957 and

1434

00:52:33,270 --> 00:52:30,480

uh we were launching a series of

1435

00:52:35,829 --> 00:52:33,280

spacecraft ranger spacecraft at the time

1436

00:52:38,950 --> 00:52:35,839

rangers one through six failed

1437

00:52:40,470 --> 00:52:38,960

ranger seven was a success and everyone

1438

00:52:41,589 --> 00:52:40,480

said well what did we do differently and

1439

00:52:42,710 --> 00:52:41,599

the only thing they could think of that

1440

00:52:44,470 --> 00:52:42,720

had been done differently is someone who

1441

00:52:45,430 --> 00:52:44,480

brought peanuts to mission control that

1442

00:52:47,030 --> 00:52:45,440

day

1443

00:52:48,150 --> 00:52:47,040

just to help people stop being so

1444

00:52:51,030 --> 00:52:48,160

nervous and they had passed around the

1445

00:52:53,030 --> 00:52:51,040

peanuts now so this since 1957 it's been

1446

00:52:54,390 --> 00:52:53,040

a tradition here at jpl as someone else

1447

00:52:57,109 --> 00:52:54,400

will stay say here it's not a

1448

00:53:03,349 --> 00:52:57,119

superstition it's a tradition

1449

00:53:06,390 --> 00:53:04,870

anyways we've got peanuts for each row

1450

00:53:07,670 --> 00:53:06,400

so we're going to put some peanuts on

1451
00:53:09,349 --> 00:53:07,680
the end of each row so you guys can do

1452
00:53:11,589 --> 00:53:09,359
what they do and pass down the peanuts

1453
00:53:13,510 --> 00:53:11,599
during the rest of today thank you all

1454
00:53:15,030 --> 00:53:13,520
so much for coming in and spending time

1455
00:53:16,950 --> 00:53:15,040
talking with them today really

1456
00:53:18,069 --> 00:53:16,960
appreciate it and appreciate all your

1457
00:53:26,309 --> 00:53:18,079
great work

1458
00:53:30,950 --> 00:53:28,870
okay so you've seen this visualization

1459
00:53:33,349 --> 00:53:30,960
going on over here all morning and doug

1460
00:53:34,870 --> 00:53:33,359
ellison was uh instrumental in in

1461
00:53:37,670 --> 00:53:34,880
getting this created and then because it

1462
00:53:39,109 --> 00:53:37,680
used to only be available inside uh jpl

1463
00:53:40,549 --> 00:53:39,119

and now it is available on the internet

1464

00:53:41,990 --> 00:53:40,559

just recently in the last couple of

1465

00:53:43,030 --> 00:53:42,000

weeks right three weeks ago all right

1466

00:53:45,510 --> 00:53:43,040

let you explain it so thank you very

1467

00:53:46,950 --> 00:53:45,520

much so uh welcome everybody the uh the

1468

00:53:48,390 --> 00:53:46,960

the traditional way the deep space

1469

00:53:50,309 --> 00:53:48,400

network would share with the world what

1470

00:53:51,750 --> 00:53:50,319

it was up to and up until about 18

1471

00:53:53,349 --> 00:53:51,760

months two years ago

1472

00:53:54,950 --> 00:53:53,359

was um very much like the gantt chart

1473

00:53:56,470 --> 00:53:54,960

behind that cameraman

1474

00:53:58,309 --> 00:53:56,480

and it's it tells you exactly what the

1475

00:53:59,270 --> 00:53:58,319

network is doing but it takes a while to

1476
00:54:01,349 --> 00:53:59,280
figure out what it's you know what does

1477
00:54:03,190 --> 00:54:01,359
it look like what what what is each line

1478
00:54:04,309 --> 00:54:03,200
what are the colors mean and it's it's a

1479
00:54:06,549 --> 00:54:04,319
glorious way of showing people what the

1480
00:54:09,109 --> 00:54:06,559
network is doing but it's not

1481
00:54:10,630 --> 00:54:09,119
particularly kind of uh intuitive right

1482
00:54:11,910 --> 00:54:10,640
it's not it's not easy to grasp a hold

1483
00:54:13,510 --> 00:54:11,920
of and so

1484
00:54:14,790 --> 00:54:13,520
our team the visualization technology

1485
00:54:16,390 --> 00:54:14,800
application and developments team uh

1486
00:54:18,069 --> 00:54:16,400
here at jpl we worked with some of the

1487
00:54:19,829 --> 00:54:18,079
uh the engineers behind the dsm

1488
00:54:21,109 --> 00:54:19,839

particularly a guy called bark bowie who

1489

00:54:22,549 --> 00:54:21,119

set up some

1490

00:54:24,230 --> 00:54:22,559

some pretty cool pipelines as you can

1491

00:54:25,990 --> 00:54:24,240

imagine getting data about what the

1492

00:54:26,870 --> 00:54:26,000

network itself is doing out to the

1493

00:54:28,309 --> 00:54:26,880

public

1494

00:54:29,750 --> 00:54:28,319

is pretty tricky you've got a lot of

1495

00:54:31,670 --> 00:54:29,760

firewalls to jump through but we've

1496

00:54:32,950 --> 00:54:31,680

managed to make it work now the first

1497

00:54:34,150 --> 00:54:32,960

step was what you've already seen this

1498

00:54:35,430 --> 00:54:34,160

morning we've got this thing working

1499

00:54:36,710 --> 00:54:35,440

here and you'll have seen it up in the

1500

00:54:38,309 --> 00:54:36,720

dark room as well we have these three

1501
00:54:39,829 --> 00:54:38,319
screens that show you all the different

1502
00:54:41,349 --> 00:54:39,839
connections between the antenna and the

1503
00:54:42,870 --> 00:54:41,359
spacecraft and you can see the whole

1504
00:54:44,230 --> 00:54:42,880
different bunch of spacecraft here some

1505
00:54:45,750 --> 00:54:44,240
are gray some are lit up because they're

1506
00:54:47,270 --> 00:54:45,760
actually live connections some are green

1507
00:54:48,870 --> 00:54:47,280
that's the one that's reflected over in

1508
00:54:51,190 --> 00:54:48,880
the co in the big screen at the front of

1509
00:54:53,109 --> 00:54:51,200
the dark room there what we've now done

1510
00:54:54,710 --> 00:54:53,119
is take that and put it online for

1511
00:54:57,030 --> 00:54:54,720
anybody to look at anywhere around the

1512
00:54:57,829 --> 00:54:57,040
world right inside a browser and that's

1513
00:54:59,270 --> 00:54:57,839

what

1514

00:55:01,710 --> 00:54:59,280

the screen is right here so you can get

1515

00:55:03,670 --> 00:55:01,720

to it from the new dsn website at

1516

00:55:04,829 --> 00:55:03,680

deepspace.jpl.nasa.gov or there's a

1517

00:55:07,750 --> 00:55:04,839

quick shortcut for you can go to

1518

00:55:09,510 --> 00:55:07,760

eyes.nasa.gov forward slash dsm i'm sure

1519

00:55:10,549 --> 00:55:09,520

those of you tuning in uh value stream

1520

00:55:11,750 --> 00:55:10,559

and so on and so forth and many of you

1521

00:55:13,270 --> 00:55:11,760

here will have heard about eyes on the

1522

00:55:15,270 --> 00:55:13,280

solar system eyes on the earth eyes on

1523

00:55:17,349 --> 00:55:15,280

exoplanets they all have eyes.nasa.gov

1524

00:55:19,910 --> 00:55:17,359

we'll put a slash dsn on it and you get

1525

00:55:22,230 --> 00:55:19,920

this web page right here and lo and

1526
00:55:23,750 --> 00:55:22,240
behold we hit enter dsn now and we get

1527
00:55:26,069 --> 00:55:23,760
the current view notice they're kind of

1528
00:55:28,069 --> 00:55:26,079
the same right we're now sharing this

1529
00:55:29,510 --> 00:55:28,079
internal dsn view with the general

1530
00:55:30,950 --> 00:55:29,520
public around the globe and you can see

1531
00:55:32,549 --> 00:55:30,960
you've got the dishes at madrid at

1532
00:55:33,510 --> 00:55:32,559
goldstone at canberra in fact this

1533
00:55:35,750 --> 00:55:33,520
version has even got the under

1534
00:55:37,270 --> 00:55:35,760
construction dish 35 down in canberra

1535
00:55:39,510 --> 00:55:37,280
right which will be starting work later

1536
00:55:41,349 --> 00:55:39,520
this year now this is kind of the the 10

1537
00:55:43,349 --> 00:55:41,359
000 view you can see all the different

1538
00:55:45,109 --> 00:55:43,359

connections in real time we can bring up

1539

00:55:46,950 --> 00:55:45,119

the world map that shows you where these

1540

00:55:48,870 --> 00:55:46,960

space these these complexes are around

1541

00:55:50,309 --> 00:55:48,880

the globe in real time with proper

1542

00:55:51,510 --> 00:55:50,319

shading and daytime and night time and

1543

00:55:54,230 --> 00:55:51,520

so on and so forth the different time

1544

00:55:55,990 --> 00:55:54,240

zones for these three complexes but

1545

00:55:57,589 --> 00:55:56,000

where this thing really gets cool is

1546

00:55:58,870 --> 00:55:57,599

kind of the really nerdy detail as far

1547

00:55:59,990 --> 00:55:58,880

as i'm concerned so let's take one

1548

00:56:01,750 --> 00:56:00,000

spacecraft and trigger we've already

1549

00:56:04,549 --> 00:56:01,760

selected up here we can click on soho

1550

00:56:05,750 --> 00:56:04,559

right here soho is a solar observatory

1551

00:56:07,510 --> 00:56:05,760

that lives out

1552

00:56:09,109 --> 00:56:07,520

where the gravity of the sun and the

1553

00:56:13,190 --> 00:56:09,119

earth cancel out so it can observe the

1554

00:56:15,270 --> 00:56:13,200

sun 24 7 365. and this is a simulated

1555

00:56:17,829 --> 00:56:15,280

view of that particular dish pointing in

1556

00:56:19,270 --> 00:56:17,839

that direction at that time of day okay

1557

00:56:22,630 --> 00:56:19,280

we generated the library of something

1558

00:56:24,470 --> 00:56:22,640

like 280 000 images to feed that little

1559

00:56:25,910 --> 00:56:24,480

image in the corner okay

1560

00:56:28,309 --> 00:56:25,920

and we've got some information down here

1561

00:56:29,990 --> 00:56:28,319

soho is 1.29 million k from the earth

1562

00:56:31,270 --> 00:56:30,000

the round trip light time the time it

1563

00:56:34,870 --> 00:56:31,280

takes for radio signal to get to the

1564

00:56:36,870 --> 00:56:34,880

spacecraft and back again is 8.6 seconds

1565

00:56:39,990 --> 00:56:36,880

and you can see it's station 54 it's

1566

00:56:41,670 --> 00:56:40,000

pointing at 264 degrees azimuth and 26.3

1567

00:56:43,510 --> 00:56:41,680

degrees above the horizon you can see

1568

00:56:45,510 --> 00:56:43,520

the weather at the site it's 9.8 sorry

1569

00:56:47,270 --> 00:56:45,520

10.5 it updates every five seconds at

1570

00:56:48,630 --> 00:56:47,280

kilometers per hour where this thing

1571

00:56:50,309 --> 00:56:48,640

gets really cool is when you hit more

1572

00:56:51,750 --> 00:56:50,319

details this is why i really really like

1573

00:56:53,109 --> 00:56:51,760

this tool because you can then start to

1574

00:56:54,390 --> 00:56:53,119

see stuff like

1575

00:56:56,150 --> 00:56:54,400

what sort of data we're getting back

1576

00:56:57,910 --> 00:56:56,160

what frequency it is what power we're

1577

00:56:59,750 --> 00:56:57,920

using so right now so you can see right

1578

00:57:03,109 --> 00:56:59,760

now the soho spacecraft is sending data

1579

00:57:05,750 --> 00:57:03,119

back at 245.7 kilobits per second okay

1580

00:57:07,270 --> 00:57:05,760

that's like isdn speeds early adsl

1581

00:57:08,630 --> 00:57:07,280

speeds let's find something that might

1582

00:57:09,990 --> 00:57:08,640

be talking to us a little bit quicker

1583

00:57:12,150 --> 00:57:10,000

let's find

1584

00:57:13,349 --> 00:57:12,160

uh hopefully mars honestly the mars

1585

00:57:14,630 --> 00:57:13,359

odyssey orbiter may be doing actually a

1586

00:57:16,710 --> 00:57:14,640

little bit slower i'd expect let's see

1587

00:57:19,109 --> 00:57:16,720

what we're getting here 124 kilobits per

1588

00:57:20,069 --> 00:57:19,119

second from mars right now okay

1589

00:57:21,910 --> 00:57:20,079

and

1590

00:57:23,589 --> 00:57:21,920

everyone's favorite without fail is of

1591

00:57:25,829 --> 00:57:23,599

course this guy right down here voyager

1592

00:57:27,109 --> 00:57:25,839

1 has been speaking to us all morning

1593

00:57:28,789 --> 00:57:27,119

and

1594

00:57:31,430 --> 00:57:28,799

you may see some spacecraft in here you

1595

00:57:32,789 --> 00:57:31,440

know 100 kilobits per second 200

1596

00:57:34,549 --> 00:57:32,799

kilobits per second in some cases like

1597

00:57:36,069 --> 00:57:34,559

the miles reconnaissance orbiter 4

1598

00:57:38,390 --> 00:57:36,079

megabits per second you know pretty

1599

00:57:40,549 --> 00:57:38,400

decent communication rates uh voyager

1600

00:57:42,430 --> 00:57:40,559

because it's so far away talks it's a

1601
00:57:45,910 --> 00:57:42,440
little bit slower than that look at this

1602
00:57:47,270 --> 00:57:45,920
18.99 billion kilometers from earth

1603
00:57:48,710 --> 00:57:47,280
the universal is constant to the speed

1604
00:57:50,630 --> 00:57:48,720
of light it takes almost one and a half

1605
00:57:52,150 --> 00:57:50,640
days for a signal to get to and from

1606
00:57:54,230 --> 00:57:52,160
voyages so if we were to send a signal

1607
00:57:56,549 --> 00:57:54,240
to voyager right now we wouldn't get it

1608
00:57:58,309 --> 00:57:56,559
back until about 12 hours from now

1609
00:57:59,430 --> 00:57:58,319
tomorrow okay

1610
00:58:00,470 --> 00:57:59,440
but here's where it gets really

1611
00:58:02,230 --> 00:58:00,480
interesting

1612
00:58:06,150 --> 00:58:02,240
the data rate right down here somewhere

1613
00:58:07,670 --> 00:58:06,160

there it is 160 bits per second

1614

00:58:10,470 --> 00:58:07,680

okay

1615

00:58:12,150 --> 00:58:10,480

um to get a sense of scale it would take

1616

00:58:14,870 --> 00:58:12,160

what we get from kind of some of our

1617

00:58:17,430 --> 00:58:14,880

mars missions it would take voyager 1 a

1618

00:58:19,190 --> 00:58:17,440

couple of thousand years to send back

1619

00:58:20,829 --> 00:58:19,200

what kind of mro has sent back in a year

1620

00:58:23,750 --> 00:58:20,839

or so you know it's incredible data

1621

00:58:25,829 --> 00:58:23,760

rates all of this it's available online

1622

00:58:28,710 --> 00:58:25,839

at is.nasa.gov for sorry yes i used

1623

00:58:30,870 --> 00:58:28,720

master forward slash dsn it's just a web

1624

00:58:33,829 --> 00:58:30,880

page and it's agile design so it works

1625

00:58:35,030 --> 00:58:33,839

on ipads iphones uh android phones and

1626
00:58:36,390 --> 00:58:35,040
so on and so forth works across all

1627
00:58:37,670 --> 00:58:36,400
those different platforms

1628
00:58:38,870 --> 00:58:37,680
and if you've got any time i'll just

1629
00:58:40,390 --> 00:58:38,880
take if anyone got any questions about

1630
00:58:41,910 --> 00:58:40,400
either this screen right here or that

1631
00:58:43,349 --> 00:58:41,920
screen right there or how we made this

1632
00:58:49,030 --> 00:58:43,359
work i'll be happy to take a question or

1633
00:58:51,829 --> 00:58:50,710
i'm just wondering for the classroom

1634
00:58:53,990 --> 00:58:51,839
like if i want to get some of the

1635
00:58:55,510 --> 00:58:54,000
students to plot any data do you have

1636
00:58:57,349 --> 00:58:55,520
data that's available that they could

1637
00:58:58,710 --> 00:58:57,359
bring up so they could plot something

1638
00:58:59,910 --> 00:58:58,720

like an archive of it sort of thing

1639

00:59:01,510 --> 00:58:59,920

right it's something we're looking at

1640

00:59:03,030 --> 00:59:01,520

this is very much a version one and what

1641

00:59:04,950 --> 00:59:03,040

we'd like is people to be able to wind

1642

00:59:06,630 --> 00:59:04,960

back time and say what was it doing five

1643

00:59:08,710 --> 00:59:06,640

minutes ago or an hour ago or so on and

1644

00:59:10,069 --> 00:59:08,720

so forth so uh i hadn't actually with

1645

00:59:11,910 --> 00:59:10,079

our eyes on the earth tool we often get

1646

00:59:12,950 --> 00:59:11,920

questions about can i plot this data

1647

00:59:13,910 --> 00:59:12,960

over time but i hadn't thought about it

1648

00:59:15,750 --> 00:59:13,920

with the dsm that would be pretty

1649

00:59:17,510 --> 00:59:15,760

interesting plotting things like

1650

00:59:18,470 --> 00:59:17,520

frequency or round trip light time and

1651

00:59:19,829 --> 00:59:18,480

so on and so forth that'd be a pretty

1652

00:59:23,430 --> 00:59:19,839

cool thing so we'll definitely keep that

1653

00:59:26,870 --> 00:59:25,430

what does it mean when they turn green

1654

00:59:29,510 --> 00:59:26,880

is that just is that just somebody's

1655

00:59:30,870 --> 00:59:29,520

looking at the data so so this screen is

1656

00:59:32,150 --> 00:59:30,880

actually a mirror of a touch screen

1657

00:59:34,950 --> 00:59:32,160

that's in there and up in the gallery

1658

00:59:36,150 --> 00:59:34,960

where our visitors go and the green one

1659

00:59:37,910 --> 00:59:36,160

is the one that's featured on the other

1660

00:59:39,829 --> 00:59:37,920

two screens in the dark room just over

1661

00:59:41,190 --> 00:59:39,839

there so for example right now we've got

1662

00:59:42,870 --> 00:59:41,200

messenger highlighted here and if you

1663

00:59:43,990 --> 00:59:42,880

look through there the middle screen is

1664

00:59:45,349 --> 00:59:44,000

showing you the dish that's talking to

1665

00:59:46,390 --> 00:59:45,359

messenger and the screen on the right is

1666

00:59:47,910 --> 00:59:46,400

showing you where the messenger

1667

00:59:49,349 --> 00:59:47,920

spacecraft is it's now switched over to

1668

00:59:51,190 --> 00:59:49,359

the european space agency's red desert

1669

00:59:55,270 --> 00:59:51,200

spacecraft just which one is selected

1670

01:00:00,069 --> 00:59:57,190

okay thank you doug thanks so much for

1671

01:00:01,349 --> 01:00:00,079

showing us

1672

01:00:03,109 --> 01:00:01,359

that's the kind of thing i want to have

1673

01:00:04,470 --> 01:00:03,119

on my computer screen all day long just

1674

01:00:06,470 --> 01:00:04,480

up in that top corner i think it's so

1675

01:00:08,470 --> 01:00:06,480

cool uh to know what spacecraft are

1676
01:00:09,910 --> 01:00:08,480
communicating right now all right so now

1677
01:00:11,910 --> 01:00:09,920
we have a very special guest from nasa

1678
01:00:15,750 --> 01:00:11,920
headquarters joining us today this is

1679
01:00:17,750 --> 01:00:15,760
badre eunice and he is nasa's associate

1680
01:00:20,789 --> 01:00:17,760
administrator for space communications

1681
01:00:22,230 --> 01:00:20,799
and navigation and he wanted to uh greet

1682
01:00:25,910 --> 01:00:22,240
you all and and tell you a little more

1683
01:00:27,589 --> 01:00:25,920
about the dsn go ahead yeah

1684
01:00:30,069 --> 01:00:27,599
yeah it's on it's a minor correction i'm

1685
01:00:30,870 --> 01:00:30,079
a deputy associate administrator but i

1686
01:00:33,190 --> 01:00:30,880
have

1687
01:00:35,030 --> 01:00:33,200
the overall responsibility for all space

1688
01:00:38,230 --> 01:00:35,040

calm and navigations

1689

01:00:39,430 --> 01:00:38,240

um behind all of what you have seen are

1690

01:00:41,349 --> 01:00:39,440

people

1691

01:00:44,470 --> 01:00:41,359

dedicated team

1692

01:00:47,190 --> 01:00:44,480

of technicians engineers scientists who

1693

01:00:48,069 --> 01:00:47,200

made all all this possible

1694

01:00:49,349 --> 01:00:48,079

you know

1695

01:00:51,670 --> 01:00:49,359

what

1696

01:00:54,710 --> 01:00:51,680

they've done is enabling science to take

1697

01:00:57,829 --> 01:00:54,720

place exploration to proceed

1698

01:01:00,710 --> 01:00:57,839

return the kind of data from all of our

1699

01:01:02,789 --> 01:01:00,720

planets in our solar systems

1700

01:01:05,030 --> 01:01:02,799

and with our radar capability we're able

1701

01:01:08,390 --> 01:01:05,040

to image most of them

1702

01:01:10,870 --> 01:01:08,400

we have a super duper team here at jpl

1703

01:01:12,950 --> 01:01:10,880

and we are very proud of them so this

1704

01:01:14,630 --> 01:01:12,960

50th anniversary is a celebration of

1705

01:01:17,190 --> 01:01:14,640

their achievement

1706

01:01:20,069 --> 01:01:17,200

it's a something to be proud of not only

1707

01:01:21,589 --> 01:01:20,079

from a nasa perspective from uh from a

1708

01:01:23,990 --> 01:01:21,599

nation perspective

1709

01:01:26,630 --> 01:01:24,000

the united states ought to be proud of

1710

01:01:28,549 --> 01:01:26,640

their dedication and their achievement

1711

01:01:30,870 --> 01:01:28,559

and we have a lot

1712

01:01:33,349 --> 01:01:30,880

to look forward to we are celebrating

1713

01:01:34,789 --> 01:01:33,359

the past 50 years but the next 50 years

1714

01:01:37,430 --> 01:01:34,799

hopefully

1715

01:01:39,589 --> 01:01:37,440

will be much better

1716

01:01:42,470 --> 01:01:39,599

there was a question do you remember

1717

01:01:45,270 --> 01:01:42,480

where uh where were you when the msl

1718

01:01:46,789 --> 01:01:45,280

landed on on mars

1719

01:01:49,990 --> 01:01:46,799

do you remember these pictures that

1720

01:01:53,109 --> 01:01:50,000

you've seen you know streaming down

1721

01:01:54,789 --> 01:01:53,119

what was missing

1722

01:01:57,430 --> 01:01:54,799

streaming video

1723

01:01:59,430 --> 01:01:57,440

we want real high definition

1724

01:02:02,230 --> 01:01:59,440

signals to be coming down from mars to

1725

01:02:05,750 --> 01:02:02,240

see it the way we are used to like now

1726
01:02:06,710 --> 01:02:05,760
in our day to day high definition tv and

1727
01:02:08,390 --> 01:02:06,720
high

1728
01:02:11,750 --> 01:02:08,400
definition everything

1729
01:02:13,430 --> 01:02:11,760
our appetite for data eight has grown

1730
01:02:16,549 --> 01:02:13,440
tremendously

1731
01:02:19,430 --> 01:02:16,559
uh and the same for nasa you know our

1732
01:02:21,349 --> 01:02:19,440
scientists want the high data rate want

1733
01:02:23,750 --> 01:02:21,359
better capabilities

1734
01:02:25,029 --> 01:02:23,760
most of our sensors

1735
01:02:26,789 --> 01:02:25,039
and

1736
01:02:29,829 --> 01:02:26,799
payload that we put on spacecraft they

1737
01:02:32,950 --> 01:02:29,839
are taking more and more bandwidth

1738
01:02:34,549 --> 01:02:32,960

the radio frequency especially now the

1739

01:02:36,470 --> 01:02:34,559

portion of it that we use is in

1740

01:02:40,630 --> 01:02:36,480

contention

1741

01:02:42,789 --> 01:02:40,640

you know like the seller phone that you

1742

01:02:44,549 --> 01:02:42,799

have these they do use

1743

01:02:46,710 --> 01:02:44,559

portion of the spectrum

1744

01:02:49,190 --> 01:02:46,720

so we made the decision

1745

01:02:51,270 --> 01:02:49,200

to go up in frequency

1746

01:02:52,630 --> 01:02:51,280

and going up in frequency we had to look

1747

01:02:54,230 --> 01:02:52,640

at the architecture of our

1748

01:02:57,349 --> 01:02:54,240

infrastructure

1749

01:02:59,750 --> 01:02:57,359

and we've decided that the 70 meters

1750

01:03:01,589 --> 01:02:59,760

served us for a long time they are not

1751

01:03:04,069 --> 01:03:01,599

suitable to support users at high

1752

01:03:05,750 --> 01:03:04,079

frequencies so we are trying to build

1753

01:03:08,150 --> 01:03:05,760

equivalent

1754

01:03:10,390 --> 01:03:08,160

you know set of antennas

1755

01:03:12,390 --> 01:03:10,400

that are comparable in terms of

1756

01:03:13,430 --> 01:03:12,400

performance in meeting the

1757

01:03:17,029 --> 01:03:13,440

present

1758

01:03:19,430 --> 01:03:17,039

commitment to our customers but

1759

01:03:21,430 --> 01:03:19,440

allow us to go higher up in frequency

1760

01:03:22,870 --> 01:03:21,440

and support a new generation

1761

01:03:25,109 --> 01:03:22,880

of missions

1762

01:03:26,630 --> 01:03:25,119

and this is ongoing

1763

01:03:29,750 --> 01:03:26,640

this uh

1764

01:03:33,109 --> 01:03:29,760

this september we are going to celebrate

1765

01:03:34,630 --> 01:03:33,119

uh the uh introduction to operation of

1766

01:03:35,589 --> 01:03:34,640

one of the first antennas we are

1767

01:03:37,750 --> 01:03:35,599

building

1768

01:03:40,390 --> 01:03:37,760

we are also forging ahead

1769

01:03:42,630 --> 01:03:40,400

with optical communications

1770

01:03:44,950 --> 01:03:42,640

you know communicating through light

1771

01:03:47,190 --> 01:03:44,960

we at nasa have seen the light

1772

01:03:48,950 --> 01:03:47,200

and the light is wonderful you know just

1773

01:03:49,990 --> 01:03:48,960

it allows you to do so many wonderful

1774

01:03:51,349 --> 01:03:50,000

things

1775

01:03:59,510 --> 01:03:51,359

and

1776
01:04:01,109 --> 01:03:59,520
infinite compared to what we have today

1777
01:04:04,390 --> 01:04:01,119
so we are

1778
01:04:06,549 --> 01:04:04,400
we started by building the technology

1779
01:04:08,789 --> 01:04:06,559
and we recently demo uh demo this

1780
01:04:11,349 --> 01:04:08,799
technology we had a payload

1781
01:04:14,549 --> 01:04:11,359
on board the mission to the to the moon

1782
01:04:16,390 --> 01:04:14,559
you all heard about lady and the lrcd

1783
01:04:18,069 --> 01:04:16,400
and the support we provided from the

1784
01:04:21,270 --> 01:04:18,079
moon down to earth

1785
01:04:24,870 --> 01:04:21,280
622 megabit per second

1786
01:04:26,390 --> 01:04:24,880
you know at a distance 10 times that of

1787
01:04:29,190 --> 01:04:26,400
you know the distance from here to a

1788
01:04:31,029 --> 01:04:29,200

geosynchronous satellite so if you

1789

01:04:34,230 --> 01:04:31,039

translate that into

1790

01:04:35,510 --> 01:04:34,240

you know the distance into a data rate

1791

01:04:37,829 --> 01:04:35,520

uh

1792

01:04:40,390 --> 01:04:37,839

mapping you'll be able to get

1793

01:04:42,390 --> 01:04:40,400

tens of gigabits per second from a

1794

01:04:44,390 --> 01:04:42,400

geosynchronous orbit

1795

01:04:47,430 --> 01:04:44,400

from a deep space we are looking at

1796

01:04:49,109 --> 01:04:47,440

building much wider aperture because as

1797

01:04:50,309 --> 01:04:49,119

you go further

1798

01:04:52,470 --> 01:04:50,319

you know

1799

01:04:54,630 --> 01:04:52,480

you need a bigger and bigger ear or

1800

01:04:56,230 --> 01:04:54,640

bigger eye to see the light

1801
01:04:57,990 --> 01:04:56,240
and that's what we are working working

1802
01:05:00,950 --> 01:04:58,000
on much bigger

1803
01:05:03,510 --> 01:05:00,960
telescopes that will allow us to support

1804
01:05:05,109 --> 01:05:03,520
deep space missions in addition to that

1805
01:05:08,230 --> 01:05:05,119
because of the competence of the

1806
01:05:10,390 --> 01:05:08,240
technical team that we have in here we

1807
01:05:13,829 --> 01:05:10,400
have entrusted jpl

1808
01:05:17,430 --> 01:05:13,839
to build our future integrated network

1809
01:05:19,430 --> 01:05:17,440
the dsn is one single network among many

1810
01:05:22,549 --> 01:05:19,440
we have the nearest network

1811
01:05:24,549 --> 01:05:22,559
the data relay satellite network and all

1812
01:05:25,510 --> 01:05:24,559
together we support over 100 missions a

1813
01:05:28,470 --> 01:05:25,520

day

1814

01:05:30,470 --> 01:05:28,480

we transmit through our system a tera

1815

01:05:32,069 --> 01:05:30,480

byte every day there are actually

1816

01:05:34,230 --> 01:05:32,079

hundreds of terabytes

1817

01:05:36,630 --> 01:05:34,240

you know an entire library of congress

1818

01:05:37,589 --> 01:05:36,640

on a daily basis so we manage a lot of

1819

01:05:39,589 --> 01:05:37,599

data

1820

01:05:42,230 --> 01:05:39,599

but because of the technical competence

1821

01:05:44,630 --> 01:05:42,240

and competence we have in here and

1822

01:05:46,789 --> 01:05:44,640

much of the changes will occur is

1823

01:05:49,029 --> 01:05:46,799

you know in the dsn

1824

01:05:51,750 --> 01:05:49,039

hardware and software so they have been

1825

01:05:53,270 --> 01:05:51,760

entrusted to lead the nasa team toward a

1826

01:05:54,309 --> 01:05:53,280

fully integrated network that will

1827

01:05:55,270 --> 01:05:54,319

provide

1828

01:05:57,190 --> 01:05:55,280

you know

1829

01:05:59,910 --> 01:05:57,200

at least two order magnitude better

1830

01:06:02,390 --> 01:05:59,920

performance that we have today

1831

01:06:04,950 --> 01:06:02,400

i don't know how many uh met with me in

1832

01:06:06,549 --> 01:06:04,960

the past in a similar setting and i

1833

01:06:10,789 --> 01:06:06,559

promised we'll have

1834

01:06:13,829 --> 01:06:10,799

streaming video from march by 2025.

1835

01:06:15,349 --> 01:06:13,839

i still mean it i intend to do it

1836

01:06:17,670 --> 01:06:15,359

and definitely with the dedication of

1837

01:06:20,150 --> 01:06:17,680

the team here at jpl we realize that

1838

01:06:21,190 --> 01:06:20,160

pretty soon even sooner than 2025 that's

1839

01:06:22,950 --> 01:06:21,200

a promise

1840

01:06:25,670 --> 01:06:22,960

that's great and i'm hoping for any

1841

01:06:26,549 --> 01:06:25,680

questions that you may have

1842

01:06:29,109 --> 01:06:26,559

go ahead

1843

01:06:32,950 --> 01:06:29,119

let me hand you a microphone alice can

1844

01:06:35,589 --> 01:06:32,960

you get there fast yeah we'll toss them

1845

01:06:39,829 --> 01:06:35,599

um let's see i was wondering if um you

1846

01:06:44,470 --> 01:06:41,750

antenna is not suitable for the higher

1847

01:06:45,430 --> 01:06:44,480

frequencies oh why is that yeah as you

1848

01:06:48,150 --> 01:06:45,440

see

1849

01:06:50,309 --> 01:06:48,160

as you go up in frequency the

1850

01:06:52,069 --> 01:06:50,319

wavelengths start to get smaller and

1851
01:06:52,870 --> 01:06:52,079
smaller and smaller

1852
01:06:54,950 --> 01:06:52,880
then

1853
01:06:57,270 --> 01:06:54,960
the panels the lining of the panel on

1854
01:06:59,990 --> 01:06:57,280
the surface of the antenna if they are

1855
01:07:02,470 --> 01:07:00,000
not lined perfectly it can eat up from

1856
01:07:05,190 --> 01:07:02,480
the efficiency of the antenna so the

1857
01:07:07,990 --> 01:07:05,200
antenna can become less efficient

1858
01:07:10,309 --> 01:07:08,000
at high frequency especially with big

1859
01:07:13,190 --> 01:07:10,319
mechanical structures subject to you

1860
01:07:15,750 --> 01:07:13,200
know a higher wind wind load and was

1861
01:07:19,029 --> 01:07:15,760
designed early on you know that the

1862
01:07:21,829 --> 01:07:19,039
metal has started to show some fatigue

1863
01:07:24,630 --> 01:07:21,839

and it's not you know in a robust state

1864

01:07:25,349 --> 01:07:24,640

as when it was first introduced

1865

01:07:27,270 --> 01:07:25,359

uh

1866

01:07:29,190 --> 01:07:27,280

you know additionally we made a lot of

1867

01:07:30,789 --> 01:07:29,200

progress in iran

1868

01:07:34,150 --> 01:07:30,799

technology we can take a bunch of

1869

01:07:36,549 --> 01:07:34,160

smaller antennas and array them together

1870

01:07:37,670 --> 01:07:36,559

and in a way we resolve

1871

01:07:41,109 --> 01:07:37,680

the phase

1872

01:07:43,589 --> 01:07:41,119

between

1873

01:07:45,829 --> 01:07:43,599

the various antennas such that when we

1874

01:07:47,829 --> 01:07:45,839

put the you know collect the signal from

1875

01:07:49,829 --> 01:07:47,839

all of them will have a coherent

1876

01:07:51,750 --> 01:07:49,839

you know uh signal

1877

01:07:53,349 --> 01:07:51,760

thank you all right thank you so much

1878

01:07:55,829 --> 01:07:53,359

for coming in today i know you'll be out

1879

01:07:57,670 --> 01:07:55,839

at goldstone tomorrow by the way

1880

01:08:00,230 --> 01:07:57,680

tomorrow is going to be a wonderful day

1881

01:08:03,270 --> 01:08:00,240

we arranged it for you you know wayne

1882

01:08:04,390 --> 01:08:03,280

assures me and we have confirmation from

1883

01:08:07,029 --> 01:08:04,400

the weather

1884

01:08:09,109 --> 01:08:07,039

you know a person that tomorrow is going

1885

01:08:11,349 --> 01:08:09,119

to be a wonderful day and you are going

1886

01:08:13,589 --> 01:08:11,359

to enjoy you know talking about it is

1887

01:08:15,670 --> 01:08:13,599

different you know seeing is believing

1888

01:08:17,269 --> 01:08:15,680

you are going to see the 70 meter you

1889

01:08:19,749 --> 01:08:17,279

are going to see some of these engine

1890

01:08:21,749 --> 01:08:19,759

engineers running around doing some of

1891

01:08:23,749 --> 01:08:21,759

what they do best and these are the

1892

01:08:25,749 --> 01:08:23,759

people who are behind the curtain you

1893

01:08:26,950 --> 01:08:25,759

know when the msl landed

1894

01:08:28,630 --> 01:08:26,960

they were the first to know but they

1895

01:08:30,789 --> 01:08:28,640

were not authorized to the to make that

1896

01:08:34,070 --> 01:08:30,799

declaration

1897

01:08:35,829 --> 01:08:34,080

you know we but the navigators and the

1898

01:08:37,669 --> 01:08:35,839

calm people in here

1899

01:08:39,590 --> 01:08:37,679

are the kind of people that we ought all

1900

01:08:43,269 --> 01:08:39,600

to be proud of

1901

01:08:44,070 --> 01:08:43,279

and give them their recognition you know

1902

01:08:47,430 --> 01:08:44,080

very

1903

01:08:49,829 --> 01:08:47,440

londo or you know

1904

01:08:51,669 --> 01:08:49,839

recognition for all of the work they do

1905

01:08:53,349 --> 01:08:51,679

they are an enabling entity within the

1906

01:08:55,189 --> 01:08:53,359

agency without which

1907

01:08:57,349 --> 01:08:55,199

none of the discoveries none of this

1908

01:08:59,110 --> 01:08:57,359

science could have taken place

1909

01:09:03,110 --> 01:08:59,120

absolutely

1910

01:09:07,269 --> 01:09:04,870

that's so true they do they really do

1911

01:09:09,110 --> 01:09:07,279

work completely behind the scenes uh so

1912

01:09:10,470 --> 01:09:09,120

now um we're gonna have our final panel

1913

01:09:12,470 --> 01:09:10,480

for the day and and you've heard from

1914

01:09:13,910 --> 01:09:12,480

the engineers about how crucial it is

1915

01:09:15,590 --> 01:09:13,920

for the deep space network for them to

1916

01:09:17,430 --> 01:09:15,600

know where their spacecraft is and if

1917

01:09:18,550 --> 01:09:17,440

they're landing safely and now we want

1918

01:09:20,470 --> 01:09:18,560

to introduce you to some of the

1919

01:09:22,550 --> 01:09:20,480

scientists that then sit back and wait

1920

01:09:24,630 --> 01:09:22,560

for their science data and images to

1921

01:09:26,550 --> 01:09:24,640

come back to earth and how they use

1922

01:09:29,269 --> 01:09:26,560

those and so joining us

1923

01:09:31,990 --> 01:09:29,279

we have ashwin vasavada he is the deputy

1924

01:09:35,349 --> 01:09:32,000

project scientist for curiosity

1925

01:09:36,550 --> 01:09:35,359

and that's fine marina brasovich marina

1926

01:09:39,349 --> 01:09:36,560

is a

1927

01:09:42,149 --> 01:09:39,359

scientist with our near uh earth objects

1928

01:09:43,510 --> 01:09:42,159

office and uh uses the dsn to study

1929

01:09:45,510 --> 01:09:43,520

asteroids

1930

01:09:46,950 --> 01:09:45,520

and linda spelker who is the project

1931

01:09:50,149 --> 01:09:46,960

scientist for the cassini mission which

1932

01:09:57,350 --> 01:09:50,159

has been orbiting saturn since 2004 and

1933

01:10:00,950 --> 01:09:59,430

take it away all right excellent hey

1934

01:10:02,790 --> 01:10:00,960

how's everybody doing

1935

01:10:05,110 --> 01:10:02,800

all right you can talk to scientists but

1936

01:10:06,950 --> 01:10:05,120

we're not going to bore you i promise

1937

01:10:08,470 --> 01:10:06,960

we got great stuff to talk to you about

1938

01:10:09,750 --> 01:10:08,480

especially how it's all been enabled by

1939

01:10:10,870 --> 01:10:09,760

the dsn

1940

01:10:12,950 --> 01:10:10,880

i've been

1941

01:10:14,709 --> 01:10:12,960

a planetary scientist for um i don't

1942

01:10:16,950 --> 01:10:14,719

know about 20 years now and 10 years of

1943

01:10:19,590 --> 01:10:16,960

that has all been on curiosity it's been

1944

01:10:21,030 --> 01:10:19,600

a long road uh but it's paid off

1945

01:10:23,430 --> 01:10:21,040

immensely and we'll talk about some of

1946

01:10:24,709 --> 01:10:23,440

that um i think i was thinking about

1947

01:10:27,030 --> 01:10:24,719

what you know what i could share about

1948

01:10:28,950 --> 01:10:27,040

the dsm i think there was two moments

1949

01:10:30,870 --> 01:10:28,960

in my life

1950

01:10:32,390 --> 01:10:30,880

in planetary science that i really felt

1951

01:10:33,830 --> 01:10:32,400

like i was exploring

1952

01:10:35,590 --> 01:10:33,840

deep space

1953

01:10:37,830 --> 01:10:35,600

you know a lot of what i do is staring

1954

01:10:39,110 --> 01:10:37,840

at a computer and i see pictures come up

1955

01:10:40,630 --> 01:10:39,120

and it can feel you can kind of get

1956

01:10:42,310 --> 01:10:40,640

disconnected you forget that you're

1957

01:10:44,390 --> 01:10:42,320

actually doing something on another

1958

01:10:46,550 --> 01:10:44,400

planet and one of those experiences was

1959

01:10:48,229 --> 01:10:46,560

the launch of curiosity i know it's like

1960

01:10:50,149 --> 01:10:48,239

sacrilegious but the landing wasn't my

1961

01:10:51,750 --> 01:10:50,159

favorite part it was actually the launch

1962

01:10:53,350 --> 01:10:51,760

and i was standing there in florida

1963

01:10:55,189 --> 01:10:53,360

watching this rocket go up and hearing

1964

01:10:57,430 --> 01:10:55,199

the noise and seeing this huge you know

1965

01:10:59,110 --> 01:10:57,440

multi-story thing go up and thinking

1966

01:11:00,709 --> 01:10:59,120

okay you know we are actually human

1967

01:11:02,070 --> 01:11:00,719

beings just throwing something off of

1968

01:11:04,149 --> 01:11:02,080

our planet to another planet and it

1969

01:11:05,750 --> 01:11:04,159

takes that much energy to do that and

1970

01:11:08,149 --> 01:11:05,760

that much force and it was it was an

1971

01:11:10,310 --> 01:11:08,159

amazing kind of visceral moment

1972

01:11:12,470 --> 01:11:10,320

the other time was um really early when

1973

01:11:13,590 --> 01:11:12,480

i was in grad school and i went on a

1974

01:11:15,270 --> 01:11:13,600

field trip just like the one you're

1975

01:11:17,830 --> 01:11:15,280

going to go on tomorrow and got to stick

1976

01:11:20,310 --> 01:11:17,840

my head up into the 70 meter dish and

1977

01:11:22,310 --> 01:11:20,320

see what it takes to just even

1978

01:11:24,709 --> 01:11:22,320

send little ones and zeros to something

1979

01:11:26,550 --> 01:11:24,719

so far away and to think that you know

1980

01:11:28,229 --> 01:11:26,560

robots out there you know hundreds of

1981

01:11:30,709 --> 01:11:28,239

millions of miles away are receiving our

1982

01:11:32,709 --> 01:11:30,719

signals from earth that also was just a

1983

01:11:34,470 --> 01:11:32,719

mind-blowing moment to think wow we're

1984

01:11:36,550 --> 01:11:34,480

doing something pretty amazing and all

1985

01:11:38,550 --> 01:11:36,560

enabled by the dsn

1986

01:11:41,350 --> 01:11:38,560

um i'll show you one

1987

01:11:43,350 --> 01:11:41,360

picture which uh choosing of the

1988

01:11:45,990 --> 01:11:43,360

thousands and thousands of pictures that

1989

01:11:47,189 --> 01:11:46,000

we've gotten back from curiosity

1990

01:11:49,990 --> 01:11:47,199

turn your attention to this one over

1991

01:11:51,910 --> 01:11:50,000

here this was just from last week we

1992

01:11:54,390 --> 01:11:51,920

rolled up to a site called the kimberly

1993

01:11:56,550 --> 01:11:54,400

which is named after a geological region

1994

01:11:58,470 --> 01:11:56,560

in northern australia we tend to name

1995

01:11:59,990 --> 01:11:58,480

all of our sites on curiosity after

1996

01:12:02,709 --> 01:12:00,000

famous geological

1997

01:12:04,390 --> 01:12:02,719

formations on earth this site like we've

1998

01:12:07,910 --> 01:12:04,400

been finding all over the crater floor

1999

01:12:10,630 --> 01:12:07,920

around mount sharp is a place where a

2000

01:12:12,550 --> 01:12:10,640

river once flowed and water pooled maybe

2001

01:12:14,870 --> 01:12:12,560

in lakes or maybe a whole series of

2002

01:12:16,790 --> 01:12:14,880

lakes laying down what you see here is

2003

01:12:18,870 --> 01:12:16,800

finely bedded sandstones these

2004

01:12:21,110 --> 01:12:18,880

sandstones have grain sizes that are are

2005

01:12:23,590 --> 01:12:21,120

like beach sand and then all the way up

2006

01:12:25,669 --> 01:12:23,600

to things like pebbles and gravel

2007

01:12:27,750 --> 01:12:25,679

and that tends to mean that water flowed

2008

01:12:29,990 --> 01:12:27,760

at different rates um slower water

2009

01:12:32,470 --> 01:12:30,000

carrying the smaller particles more fast

2010

01:12:33,669 --> 01:12:32,480

water carrying the the gravel and things

2011

01:12:35,990 --> 01:12:33,679

have kind of come and gone maybe

2012

01:12:37,910 --> 01:12:36,000

shorelines have come and gone maybe uh

2013

01:12:40,470 --> 01:12:37,920

rivers emptied out into lakes that that

2014

01:12:42,470 --> 01:12:40,480

came and went and it's just amazing to

2015

01:12:44,229 --> 01:12:42,480

think that a few billion years ago mars

2016

01:12:46,229 --> 01:12:44,239

was so earth-like and that's what we're

2017

01:12:49,750 --> 01:12:46,239

really finding about uh with with

2018

01:12:51,910 --> 01:12:49,760

curiosity that uh this planet uh was a

2019

01:12:54,630 --> 01:12:51,920

place where rain probably fell from the

2020

01:12:57,110 --> 01:12:54,640

sky and and streams formed rivers and

2021

01:12:59,030 --> 01:12:57,120

rivers carried sand deposited them into

2022

01:13:00,390 --> 01:12:59,040

lakes all around this gorgeous mountain

2023

01:13:01,189 --> 01:13:00,400

that will be climbing in the next couple

2024

01:13:03,990 --> 01:13:01,199

years

2025

01:13:05,910 --> 01:13:04,000

so with that i'll turn it over to marina

2026

01:13:08,390 --> 01:13:05,920

thanks

2027

01:13:11,270 --> 01:13:08,400

hi everybody so um i'll be talking a

2028

01:13:13,910 --> 01:13:11,280

little bit how we use a dsn 70 meter

2029

01:13:17,030 --> 01:13:13,920

antenna so uh probably not many of you

2030

01:13:18,310 --> 01:13:17,040

know that 70 meter antenna the ss14

2031

01:13:20,229 --> 01:13:18,320

actually is equipped with a very

2032

01:13:21,910 --> 01:13:20,239

powerful transmitter it has a half a

2033

01:13:24,229 --> 01:13:21,920

megawatt transmitter

2034

01:13:26,709 --> 01:13:24,239

and it is the second it's world's second

2035

01:13:29,510 --> 01:13:26,719

most powerful radar right after our sibo

2036

01:13:32,550 --> 01:13:29,520

in puerto rico and what we use for we

2037

01:13:35,189 --> 01:13:32,560

use dss-14 to ping asteroids

2038

01:13:37,189 --> 01:13:35,199

and to learn about their exact locations

2039

01:13:39,669 --> 01:13:37,199

and line of sight velocities and that

2040

01:13:42,149 --> 01:13:39,679

allows us to calculate their orbits much

2041

01:13:43,990 --> 01:13:42,159

more precisely and then we also use it

2042

01:13:45,830 --> 01:13:44,000

to image asteroids

2043

01:13:49,350 --> 01:13:45,840

at dss14 we

2044

01:13:50,229 --> 01:13:49,360

observe about 25 to 30 asteroids every

2045

01:13:52,310 --> 01:13:50,239

year

2046

01:13:53,830 --> 01:13:52,320

and in some instances some of these

2047

01:13:55,189 --> 01:13:53,840

asteroids end up being really strong

2048

01:13:58,550 --> 01:13:55,199

radar targets

2049

01:14:00,630 --> 01:13:58,560

and the images that we get from them are

2050

01:14:03,590 --> 01:14:00,640

such a high quality that it can only be

2051

01:14:05,189 --> 01:14:03,600

compared to spacecraft flyby

2052

01:14:07,350 --> 01:14:05,199

so what i'm going to show you now is

2053

01:14:09,350 --> 01:14:07,360

example of something that we consider

2054

01:14:11,750 --> 01:14:09,360

spacecraft flyby and that is asteroid to

2055

01:14:13,590 --> 01:14:11,760

titus uh if we can have the video please

2056

01:14:14,870 --> 01:14:13,600

so this is what this is the asteroid

2057

01:14:17,590 --> 01:14:14,880

that we imaged

2058

01:14:19,350 --> 01:14:17,600

in december of 2012

2059

01:14:21,430 --> 01:14:19,360

uh these are radar images you'll notice

2060

01:14:23,669 --> 01:14:21,440

these are very different from the images

2061

01:14:26,149 --> 01:14:23,679

that you would take with your camera

2062

01:14:27,830 --> 01:14:26,159

because what what so radar images where

2063

01:14:29,669 --> 01:14:27,840

they're displaying on vertical axis

2064

01:14:32,470 --> 01:14:29,679

they're displaying the distance from the

2065

01:14:34,310 --> 01:14:32,480

radar so this is the depth if you will

2066

01:14:36,950 --> 01:14:34,320

and then on the horizontal axis what

2067

01:14:39,669 --> 01:14:36,960

you're seeing is how fast the parts of

2068

01:14:41,910 --> 01:14:39,679

the asteroid are moving toward the radar

2069

01:14:44,229 --> 01:14:41,920

away from radar and i know this is not

2070

01:14:46,149 --> 01:14:44,239

very intuitive but still if you look at

2071

01:14:48,070 --> 01:14:46,159

these videos

2072

01:14:50,470 --> 01:14:48,080

you know some things are obvious so

2073

01:14:52,229 --> 01:14:50,480

these two videos are taken these two

2074

01:14:54,310 --> 01:14:52,239

they are taken on two different days

2075

01:14:56,149 --> 01:14:54,320

that's why the radar echoes looks look

2076

01:14:59,110 --> 01:14:56,159

so different because the asteroid is

2077

01:15:01,350 --> 01:14:59,120

rotated is oriented differently in space

2078

01:15:04,310 --> 01:15:01,360

with respect to radar on the two days

2079

01:15:05,830 --> 01:15:04,320

and another obvious thing is that

2080

01:15:07,750 --> 01:15:05,840

when you image it with a radar for a

2081

01:15:09,750 --> 01:15:07,760

couple of hours you see it's rotating

2082

01:15:11,830 --> 01:15:09,760

the asteroid is actually rotating in

2083

01:15:12,870 --> 01:15:11,840

front of your eyes

2084

01:15:15,189 --> 01:15:12,880

and

2085

01:15:17,510 --> 01:15:15,199

the resolution the pixel vertical pixel

2086

01:15:18,310 --> 01:15:17,520

resolution on these images is only 12

2087

01:15:20,070 --> 01:15:18,320

feet

2088

01:15:23,270 --> 01:15:20,080

which is really impressive considering

2089

01:15:25,990 --> 01:15:23,280

this asteroid is 4.3 million miles away

2090

01:15:28,630 --> 01:15:26,000

from us and we are imaging it down to 12

2091

01:15:30,470 --> 01:15:28,640

feet and what this resolution is really

2092

01:15:32,149 --> 01:15:30,480

allowing you is you even see the

2093

01:15:34,310 --> 01:15:32,159

boulders that are lying on the surface

2094

01:15:36,870 --> 01:15:34,320

of asteroid and those little bright

2095

01:15:39,110 --> 01:15:36,880

specks that know to come in in you can

2096

01:15:41,189 --> 01:15:39,120

see them as the asteroid is rotating and

2097

01:15:43,430 --> 01:15:41,199

they persist those are actually the

2098

01:15:46,550 --> 01:15:43,440

boulders on the surface of asteroid that

2099

01:15:48,470 --> 01:15:46,560

is 4.3 million miles away

2100

01:15:51,030 --> 01:15:48,480

what we ultimately do with images like

2101
01:15:52,550 --> 01:15:51,040
this is we reconstructed how the object

2102
01:15:54,390 --> 01:15:52,560
how the asteroid really looks in

2103
01:15:57,030 --> 01:15:54,400
three-dimensional space

2104
01:15:59,270 --> 01:15:57,040
so uh we also reconstruct how it rotates

2105
01:16:01,510 --> 01:15:59,280
and this asteroid to tardis i'm showing

2106
01:16:04,149 --> 01:16:01,520
you here this is reconstruction of its

2107
01:16:05,990 --> 01:16:04,159
three-dimensional uh shape based on

2108
01:16:07,830 --> 01:16:06,000
radar images that we're taking actually

2109
01:16:10,229 --> 01:16:07,840
prior they're all these are older based

2110
01:16:13,870 --> 01:16:10,239
on all the radar data but it is very

2111
01:16:15,990 --> 01:16:13,880
very unusual asteroid um this is about

2112
01:16:17,350 --> 01:16:16,000
2.9 miles

2113
01:16:19,590 --> 01:16:17,360

long

2114

01:16:22,310 --> 01:16:19,600

it has this regular shape it looks like

2115

01:16:23,430 --> 01:16:22,320

these kind of two pieces in contact this

2116

01:16:25,110 --> 01:16:23,440

is something that we actually call

2117

01:16:27,350 --> 01:16:25,120

contact binaries

2118

01:16:30,310 --> 01:16:27,360

and even its rotation state is kind of

2119

01:16:33,510 --> 01:16:30,320

unusual because it it kind of rotates

2120

01:16:36,149 --> 01:16:33,520

like a poorly thrown football so it's

2121

01:16:38,310 --> 01:16:36,159

it's rotation around long axis is 5.4

2122

01:16:40,390 --> 01:16:38,320

days and at the same time it's executing

2123

01:16:42,070 --> 01:16:40,400

this precession with seven four in four

2124

01:16:44,470 --> 01:16:42,080

days so it kind of is it's really

2125

01:16:46,550 --> 01:16:44,480

tumbling it's tumbling through space

2126

01:16:48,310 --> 01:16:46,560

and this is not the

2127

01:16:50,070 --> 01:16:48,320

this is not the only one that we have

2128

01:16:52,550 --> 01:16:50,080

you know shape models of these are some

2129

01:16:54,790 --> 01:16:52,560

other examples you know for asteroids

2130

01:16:56,870 --> 01:16:54,800

that um we reconstructed their shape

2131

01:16:59,750 --> 01:16:56,880

based on the radar data so there is a

2132

01:17:01,910 --> 01:16:59,760

binary kw-4 there is this regularly

2133

01:17:05,270 --> 01:17:01,920

shaped asteroid called europe there's

2134

01:17:07,590 --> 01:17:05,280

another contact binary hw1 and then

2135

01:17:10,630 --> 01:17:07,600

there is the nereus as you can see this

2136

01:17:13,189 --> 01:17:10,640

is a we really see tremendous diversity

2137

01:17:16,630 --> 01:17:13,199

in near-earth asteroids among near-earth

2138

01:17:18,950 --> 01:17:16,640

asteroids every time we observe uh we

2139

01:17:20,950 --> 01:17:18,960

really are going in a completely kind of

2140

01:17:22,870 --> 01:17:20,960

we we usually know very little about

2141

01:17:24,470 --> 01:17:22,880

asteroid we'll be observing

2142

01:17:25,990 --> 01:17:24,480

and um

2143

01:17:28,470 --> 01:17:26,000

we you never know what you're going to

2144

01:17:31,430 --> 01:17:28,480

see and and the best thing in a life of

2145

01:17:33,990 --> 01:17:31,440

scientists is to be you know surprised

2146

01:17:36,149 --> 01:17:34,000

and we never cease to find you know we

2147

01:17:38,229 --> 01:17:36,159

always end up being surprised

2148

01:17:40,149 --> 01:17:38,239

because there is so much more things to

2149

01:17:43,030 --> 01:17:40,159

discover

2150

01:17:44,950 --> 01:17:43,040

so um thank you

2151

01:17:47,590 --> 01:17:44,960

okay i'm linda spilker and i've been

2152

01:17:48,550 --> 01:17:47,600

fortunate enough to work at jpl for 37

2153

01:17:50,470 --> 01:17:48,560

years

2154

01:17:52,790 --> 01:17:50,480

and that spans from just before the

2155

01:17:54,310 --> 01:17:52,800

launch of voyager through the cassini

2156

01:17:56,709 --> 01:17:54,320

mission and so i'm going to talk a

2157

01:17:58,070 --> 01:17:56,719

little bit about both of those missions

2158

01:18:00,630 --> 01:17:58,080

if you think about it voyager was

2159

01:18:02,870 --> 01:18:00,640

launched about 36 years ago two voyager

2160

01:18:05,030 --> 01:18:02,880

spacecraft and that's about three

2161

01:18:07,030 --> 01:18:05,040

quarters of this 50th anniversary we're

2162

01:18:08,790 --> 01:18:07,040

celebrating with the dsn

2163

01:18:10,229 --> 01:18:08,800

so the dsn has been listening to voyager

2164

01:18:12,630 --> 01:18:10,239

for a long time

2165

01:18:15,270 --> 01:18:12,640

there have been great flybys of jupiter

2166

01:18:17,830 --> 01:18:15,280

saturn uranus and neptune and their

2167

01:18:19,990 --> 01:18:17,840

incredible moons and rings and for me a

2168

01:18:22,149 --> 01:18:20,000

really exciting moment in just watching

2169

01:18:24,310 --> 01:18:22,159

those pictures come back from voyager

2170

01:18:28,310 --> 01:18:24,320

was actually realizing that there were

2171

01:18:31,189 --> 01:18:28,320

volcanoes on jupiter's moon io volcanoes

2172

01:18:33,510 --> 01:18:31,199

going off as we were watching those data

2173

01:18:35,430 --> 01:18:33,520

and just incredible what those ones and

2174

01:18:37,990 --> 01:18:35,440

zeroes can turn into

2175

01:18:40,630 --> 01:18:38,000

these very beautiful color images and it

2176

01:18:44,310 --> 01:18:40,640

turns out that voyager 1 in august of

2177

01:18:46,790 --> 01:18:44,320

2012 if we bring up the first video here

2178

01:18:48,390 --> 01:18:46,800

actually left our solar system and is in

2179

01:18:50,149 --> 01:18:48,400

interstellar space

2180

01:18:51,830 --> 01:18:50,159

here are the sounds first just before

2181

01:18:54,229 --> 01:18:51,840

interstellar space

2182

01:18:57,430 --> 01:18:54,239

the frequency goes up as the plasma

2183

01:18:58,790 --> 01:18:57,440

density increases until you hear a very

2184

01:19:00,790 --> 01:18:58,800

high tone

2185

01:19:03,590 --> 01:19:00,800

you're hearing what the wind between the

2186

01:19:05,750 --> 01:19:03,600

stars would sound like coming back from

2187

01:19:07,110 --> 01:19:05,760

voyager and there's a plasma wave

2188

01:19:09,430 --> 01:19:07,120

spectrometer

2189

01:19:12,470 --> 01:19:09,440

that recorded those data

2190

01:19:14,950 --> 01:19:12,480

now cassini was launched 17 years ago so

2191

01:19:16,709 --> 01:19:14,960

that's about one-third of the the 50

2192

01:19:18,790 --> 01:19:16,719

years from the dsn

2193

01:19:21,750 --> 01:19:18,800

and cassini has been sending back data

2194

01:19:23,910 --> 01:19:21,760

continuously and and for me probably the

2195

01:19:26,550 --> 01:19:23,920

one of the biggest most interesting

2196

01:19:28,950 --> 01:19:26,560

discoveries for cassini was actually

2197

01:19:31,590 --> 01:19:28,960

seeing this tiny moon enceladus

2198

01:19:34,870 --> 01:19:31,600

it's 300 miles across you could fit it

2199

01:19:37,030 --> 01:19:34,880

between los angeles and san francisco

2200

01:19:40,229 --> 01:19:37,040

and yet coming out of cracks at its

2201

01:19:42,870 --> 01:19:40,239

south pole were these jets of salt water

2202

01:19:45,510 --> 01:19:42,880

coming out and going out into space and

2203

01:19:47,350 --> 01:19:45,520

creating a very beautiful ring the

2204

01:19:48,229 --> 01:19:47,360

e-ring in fact if you look at the next

2205

01:19:50,229 --> 01:19:48,239

image

2206

01:19:52,310 --> 01:19:50,239

this is one of my very favorite pictures

2207

01:19:55,590 --> 01:19:52,320

it was taken last july

2208

01:19:57,430 --> 01:19:55,600

it's made up of 141 images and that very

2209

01:20:00,229 --> 01:19:57,440

outermost blue ring

2210

01:20:03,830 --> 01:20:00,239

that's the e-ring being supplied by the

2211

01:20:05,830 --> 01:20:03,840

water jets coming from tiny enceladus

2212

01:20:08,470 --> 01:20:05,840

and you'll notice there's a bright ring

2213

01:20:10,709 --> 01:20:08,480

around the outermost limb of saturn and

2214

01:20:14,149 --> 01:20:10,719

if you think about it that's every

2215

01:20:16,470 --> 01:20:14,159

sunrise and every sunset on saturn that

2216

01:20:18,470 --> 01:20:16,480

we can see at the same time

2217

01:20:20,070 --> 01:20:18,480

also in this image you have mars and

2218

01:20:22,790 --> 01:20:20,080

venus and the earth so you have four

2219

01:20:25,189 --> 01:20:22,800

planets in this particular mosaic and on

2220

01:20:26,709 --> 01:20:25,199

that day in july we asked everyone to

2221

01:20:29,270 --> 01:20:26,719

wave at saturn

2222

01:20:31,110 --> 01:20:29,280

while cassini was taking those pictures

2223

01:20:32,950 --> 01:20:31,120

and so there are little photons that had

2224

01:20:35,110 --> 01:20:32,960

come into the cassini cameras of all of

2225

01:20:37,669 --> 01:20:35,120

those people from around around the

2226

01:20:39,350 --> 01:20:37,679

world waving at saturn

2227

01:20:41,590 --> 01:20:39,360

and of course you can't do any of this

2228

01:20:43,350 --> 01:20:41,600

without the data from the dsn so it's

2229

01:20:45,189 --> 01:20:43,360

really pivotal in

2230

01:20:47,030 --> 01:20:45,199

getting our understanding

2231

01:20:48,950 --> 01:20:47,040

increased to actually have those data

2232

01:20:50,709 --> 01:20:48,960

come back and so

2233

01:20:53,830 --> 01:20:50,719

with that if there's any questions we'd

2234

01:20:58,229 --> 01:20:55,830

do we have any questions

2235

01:21:00,070 --> 01:20:58,239

okay alice we'll get to this one first

2236

01:21:01,590 --> 01:21:00,080

and then we'll go in the back there and

2237

01:21:03,430 --> 01:21:01,600

then over on this side

2238

01:21:05,270 --> 01:21:03,440

sorry it's probably an obvious question

2239

01:21:07,590 --> 01:21:05,280

based on what you said but

2240

01:21:09,270 --> 01:21:07,600

then with any of that stuff that your

2241

01:21:12,310 --> 01:21:09,280

your you all have been discussing been

2242

01:21:13,910 --> 01:21:12,320

possible without dsn

2243

01:21:15,510 --> 01:21:13,920

it would have been for the outer planet

2244

01:21:17,669 --> 01:21:15,520

missions especially if you didn't have

2245

01:21:19,030 --> 01:21:17,679

the dsn you think about what they did in

2246

01:21:21,510 --> 01:21:19,040

some of the early days where you would

2247

01:21:23,590 --> 01:21:21,520

take pictures put it on film and send

2248

01:21:25,990 --> 01:21:23,600

the film back and that certainly would

2249

01:21:29,110 --> 01:21:26,000

be a very long and tedious way so the

2250

01:21:30,390 --> 01:21:29,120

dsn is really key especially for

2251

01:21:32,950 --> 01:21:30,400

missions that are far away you know

2252

01:21:34,790 --> 01:21:32,960

voyager with one and a half days round

2253

01:21:37,830 --> 01:21:34,800

trip light time that's a long way to

2254

01:21:42,070 --> 01:21:39,990

so dss-14 is really unique instrument

2255

01:21:44,310 --> 01:21:42,080

for us there are only two planetary

2256

01:21:46,470 --> 01:21:44,320

radars in the world and this is one of

2257

01:21:47,510 --> 01:21:46,480

two so we are getting tremendous science

2258

01:21:49,270 --> 01:21:47,520

every time

2259

01:21:52,149 --> 01:21:49,280

uh you know when we observe asteroids

2260

01:21:54,629 --> 01:21:52,159

and uh definitely um

2261

01:21:56,390 --> 01:21:54,639

i really can't imagine um you know i

2262

01:21:57,990 --> 01:21:56,400

can't imagine you know kind of science

2263

01:21:59,030 --> 01:21:58,000

science productivity that we have

2264

01:22:01,910 --> 01:21:59,040

without

2265

01:22:03,510 --> 01:22:01,920

uh dss 14.

2266

01:22:06,550 --> 01:22:03,520

the only thing i'll add to that is um

2267

01:22:08,390 --> 01:22:06,560

you know it's the dsn is uh

2268

01:22:10,149 --> 01:22:08,400

it's completely enabling for curiosity

2269

01:22:11,430 --> 01:22:10,159

but we also need the orbiters the

2270

01:22:13,750 --> 01:22:11,440

amazing thing is we're building a whole

2271

01:22:15,750 --> 01:22:13,760

communications infrastructure out there

2272

01:22:18,550 --> 01:22:15,760

you know we send commands directly from

2273

01:22:19,990 --> 01:22:18,560

the dsn dishes to curiosity but that's

2274

01:22:21,830 --> 01:22:20,000

not that much data just a list of

2275

01:22:23,830 --> 01:22:21,840

instructions for the day but to get all

2276

01:22:25,270 --> 01:22:23,840

those gorgeous images back curiosity

2277

01:22:27,350 --> 01:22:25,280

first talks to the orbiters and the

2278

01:22:28,950 --> 01:22:27,360

orbiters relay at a much higher rate

2279

01:22:30,709 --> 01:22:28,960

that the dsn can

2280

01:22:33,270 --> 01:22:30,719

accept from the orbiters uh back to

2281

01:22:35,669 --> 01:22:33,280

earth so you know it's a it's a link in

2282

01:22:37,510 --> 01:22:35,679

a chain that we totally need to get all

2283

01:22:39,350 --> 01:22:37,520

these gorgeous pictures back and video

2284

01:22:40,550 --> 01:22:39,360

one day

2285

01:22:41,669 --> 01:22:40,560

okay we had a question right there on

2286

01:22:44,149 --> 01:22:41,679

the end

2287

01:22:46,070 --> 01:22:44,159

yeah hi uh marina i was wondering okay

2288

01:22:47,669 --> 01:22:46,080

you said those were replicas of the

2289

01:22:49,350 --> 01:22:47,679

asteroids

2290

01:22:50,629 --> 01:22:49,360

their reconstruction of the shapes

2291

01:22:53,430 --> 01:22:50,639

because

2292

01:22:55,510 --> 01:22:53,440

so are asteroids that smooth or are they

2293

01:22:57,669 --> 01:22:55,520

like that movie where they were all

2294

01:22:59,270 --> 01:22:57,679

rugged and dry oh well yeah we are

2295

01:23:01,669 --> 01:22:59,280

limited with the resolution of the data

2296

01:23:04,149 --> 01:23:01,679

that we have so obviously in the past

2297

01:23:07,110 --> 01:23:04,159

since 2010 we have this capability to

2298

01:23:10,870 --> 01:23:07,120

image uh two image asteroids uh with uh

2299

01:23:13,110 --> 01:23:10,880

you know 12 feet resolution so anything

2300

01:23:15,669 --> 01:23:13,120

you know these uh these models um

2301

01:23:18,390 --> 01:23:15,679

usually match the data resolution

2302

01:23:20,550 --> 01:23:18,400

and the all these are based on a

2303

01:23:22,870 --> 01:23:20,560

more coarser data not necessarily you

2304

01:23:25,750 --> 01:23:22,880

know uh fine details

2305

01:23:27,590 --> 01:23:25,760

so um so yeah it is uh

2306

01:23:30,149 --> 01:23:27,600

the asteroids are not definitely that

2307

01:23:32,709 --> 01:23:30,159

smooth we know that uh many of them have

2308

01:23:35,510 --> 01:23:32,719

these surface boulders a lot of them

2309

01:23:37,030 --> 01:23:35,520

have the concavities and and i didn't

2310

01:23:39,030 --> 01:23:37,040

bring you examples of the asteroids

2311

01:23:41,030 --> 01:23:39,040

where we actually clearly see you know

2312

01:23:43,189 --> 01:23:41,040

something like concavities and ridges

2313

01:23:45,270 --> 01:23:43,199

and hills and so there is much more

2314

01:23:47,189 --> 01:23:45,280

diversity than what i what i i just

2315

01:23:48,870 --> 01:23:47,199

picked up this was the first thing lying

2316

01:23:50,629 --> 01:23:48,880

on my desk this morning so

2317

01:23:52,310 --> 01:23:50,639

this is what you end up seeing but we

2318

01:23:54,550 --> 01:23:52,320

have many more i mean this one is pretty

2319

01:23:56,310 --> 01:23:54,560

rugged if you look this is europe and it

2320

01:23:59,110 --> 01:23:56,320

looks it's it's everything but smooth

2321

01:24:03,590 --> 01:23:59,120

this is about 120 meter object

2322

01:24:04,790 --> 01:24:03,600

and definitely a lot of structure there

2323

01:24:07,590 --> 01:24:04,800

do we have another question in the room

2324

01:24:11,510 --> 01:24:09,750

yes this is uh for marina as well as a

2325

01:24:15,990 --> 01:24:11,520

paleontologist i'm

2326

01:24:17,510 --> 01:24:16,000

really interested in asteroids um

2327

01:24:19,270 --> 01:24:17,520

mainly because you know dinosaurs went

2328

01:24:22,790 --> 01:24:19,280

bye-bye thanks to one

2329

01:24:24,790 --> 01:24:22,800

the thing i want to to know uh as well

2330

01:24:26,229 --> 01:24:24,800

as everyone watching and throughout

2331

01:24:27,910 --> 01:24:26,239

twitter and all that

2332

01:24:29,750 --> 01:24:27,920

so many people are concerned with

2333

01:24:31,910 --> 01:24:29,760

extinction-level events of asteroid

2334

01:24:34,310 --> 01:24:31,920

impacts could you please just tell us

2335

01:24:35,910 --> 01:24:34,320

the infinitesimal possibility of

2336

01:24:39,590 --> 01:24:35,920

everything lining up

2337

01:24:41,350 --> 01:24:39,600

because it's it's not that certain or

2338

01:24:44,550 --> 01:24:41,360

even

2339

01:24:46,149 --> 01:24:44,560

remotely possible it is but it's just

2340

01:24:48,550 --> 01:24:46,159

tiny little

2341

01:24:50,629 --> 01:24:48,560

window of opportunity more or less

2342

01:24:52,870 --> 01:24:50,639

well i can tell you that uh well nessa

2343

01:24:54,790 --> 01:24:52,880

is obviously nasa through its surveys is

2344

01:24:56,830 --> 01:24:54,800

keeping a very close watch

2345

01:25:00,149 --> 01:24:56,840

on on asteroids and

2346

01:25:02,870 --> 01:25:00,159

the lot of the survey of a really large

2347

01:25:03,910 --> 01:25:02,880

ones has been completed so at this point

2348

01:25:06,310 --> 01:25:03,920

we know

2349

01:25:07,990 --> 01:25:06,320

we have mapped everything that is larger

2350

01:25:10,390 --> 01:25:08,000

than one kilometer

2351
01:25:13,430 --> 01:25:10,400
um that it we we mapped it at the order

2352
01:25:15,590 --> 01:25:13,440
of the survey is complete at like 99

2353
01:25:18,229 --> 01:25:15,600
level there's only a handful of objects

2354
01:25:20,390 --> 01:25:18,239
out there that we haven't seen yet that

2355
01:25:22,550 --> 01:25:20,400
we don't know about so that's a very

2356
01:25:23,910 --> 01:25:22,560
good news for us because actually the

2357
01:25:27,750 --> 01:25:23,920
one that

2358
01:25:29,430 --> 01:25:27,760
that impacted um in mexico and that

2359
01:25:31,110 --> 01:25:29,440
caused the dinosaur extinction i believe

2360
01:25:33,669 --> 01:25:31,120
it was a really big monster it was

2361
01:25:36,070 --> 01:25:33,679
something like 10 kilometers so we know

2362
01:25:37,990 --> 01:25:36,080
we know about those objects but still

2363
01:25:40,550 --> 01:25:38,000

there are a lot of smaller objects that

2364

01:25:42,950 --> 01:25:40,560

can also cause significant damage so

2365

01:25:44,950 --> 01:25:42,960

nasa has a goal to really map out all

2366

01:25:48,229 --> 01:25:44,960

the objects that are larger than about

2367

01:25:50,229 --> 01:25:48,239

130 meters in diameter because they can

2368

01:25:52,550 --> 01:25:50,239

they can still cause a significant uh

2369

01:25:55,830 --> 01:25:52,560

damage and definitely efforts are on the

2370

01:25:57,510 --> 01:25:55,840

way to to really make sure that we know

2371

01:25:59,350 --> 01:25:57,520

where everything is is in near

2372

01:26:01,430 --> 01:25:59,360

population

2373

01:26:03,030 --> 01:26:01,440

um you know i'll add to that also that

2374

01:26:05,189 --> 01:26:03,040

all of the information about every

2375

01:26:06,950 --> 01:26:05,199

asteroid that has been discovered and is

2376

01:26:08,790 --> 01:26:06,960

now being tracked all of its online it's

2377

01:26:11,110 --> 01:26:08,800

available to anyone and we actually here

2378

01:26:13,830 --> 01:26:11,120

at jpl have a twitter account called

2379

01:26:15,430 --> 01:26:13,840

asteroid watch and we don't tell you

2380

01:26:16,709 --> 01:26:15,440

about every single asteroid but we can

2381

01:26:19,430 --> 01:26:16,719

direct you to the full list it's

2382

01:26:21,110 --> 01:26:19,440

enormous you'd be surprised um but we do

2383

01:26:23,590 --> 01:26:21,120

tell you if there's an asteroid that is

2384

01:26:25,830 --> 01:26:23,600

going to come within about uh three or

2385

01:26:27,110 --> 01:26:25,840

four lunar distances that kind of puts a

2386

01:26:28,870 --> 01:26:27,120

good picture in people's mind about how

2387

01:26:30,870 --> 01:26:28,880

far out that is that it would be about a

2388

01:26:32,229 --> 01:26:30,880

million miles right so we when when

2389

01:26:34,149 --> 01:26:32,239

they're coming within that distance

2390

01:26:36,550 --> 01:26:34,159

we'll often tweet about them just so

2391

01:26:38,629 --> 01:26:36,560

that uh people get a feel for how often

2392

01:26:40,470 --> 01:26:38,639

that actually does happen it happens

2393

01:26:43,110 --> 01:26:40,480

quite a bit i think the

2394

01:26:44,790 --> 01:26:43,120

one passes between earth and the moon um

2395

01:26:47,590 --> 01:26:44,800

every couple of weeks and and those are

2396

01:26:49,270 --> 01:26:47,600

mostly very very small objects that

2397

01:26:50,470 --> 01:26:49,280

would just burn up in the atmosphere

2398

01:26:52,629 --> 01:26:50,480

even if they did

2399

01:26:54,070 --> 01:26:52,639

get close to earth

2400

01:26:55,750 --> 01:26:54,080

uh we have a question over here in the

2401

01:26:57,350 --> 01:26:55,760

back let me get you the microphone oh

2402

01:26:59,189 --> 01:26:57,360

you've got one great

2403

01:27:01,030 --> 01:26:59,199

um with all the advances that we've had

2404

01:27:03,270 --> 01:27:01,040

in the past over 50 years

2405

01:27:04,470 --> 01:27:03,280

since we launched when was warrior one

2406

01:27:07,990 --> 01:27:04,480

launched

2407

01:27:10,229 --> 01:27:08,000

97 87 77 all the advances that we've had

2408

01:27:11,510 --> 01:27:10,239

in technology since are there any plans

2409

01:27:14,149 --> 01:27:11,520

to send other

2410

01:27:15,590 --> 01:27:14,159

spacecrafts out into the universe to get

2411

01:27:18,229 --> 01:27:15,600

other data that we might not be able to

2412

01:27:19,910 --> 01:27:18,239

get in be getting right now from voyager

2413

01:27:21,910 --> 01:27:19,920

i have plans to

2414

01:27:23,669 --> 01:27:21,920

well voyager is the only

2415

01:27:24,950 --> 01:27:23,679

the spacecraft that's leaving the solar

2416

01:27:27,590 --> 01:27:24,960

system and you can think of it as our

2417

01:27:29,669 --> 01:27:27,600

silent ambassador going out into space

2418

01:27:31,430 --> 01:27:29,679

it carries a gold record it has

2419

01:27:33,750 --> 01:27:31,440

information without the sights and

2420

01:27:35,270 --> 01:27:33,760

sounds of earth and even how to find us

2421

01:27:37,030 --> 01:27:35,280

if you can read the pictures on the

2422

01:27:39,030 --> 01:27:37,040

cover of the record

2423

01:27:40,950 --> 01:27:39,040

there are other missions in the you know

2424

01:27:43,110 --> 01:27:40,960

just the planning and thought processes

2425

01:27:45,350 --> 01:27:43,120

to perhaps go out further to other

2426

01:27:47,669 --> 01:27:45,360

planets new horizons for instance is

2427

01:27:49,669 --> 01:27:47,679

going to fly by pluto and then on out to

2428

01:27:53,590 --> 01:27:49,679

a kuiper belt object so we're slowly

2429

01:27:55,270 --> 01:27:53,600

expanding the range in which we explore

2430

01:27:58,310 --> 01:27:55,280

we are getting very close to the end of

2431

01:27:59,990 --> 01:27:58,320

our time now on with nasa television um

2432

01:28:01,669 --> 01:28:00,000

you all are invited to stay and and

2433

01:28:04,229 --> 01:28:01,679

answer some more questions after our

2434

01:28:06,629 --> 01:28:04,239

broadcast ends for those of you watching

2435

01:28:07,910 --> 01:28:06,639

uh on nasa tv or on the live stream i

2436

01:28:10,709 --> 01:28:07,920

invite you to

2437

01:28:12,709 --> 01:28:10,719

follow now the hashtag dsn50 you'll be

2438

01:28:14,310 --> 01:28:12,719

sure to get plenty more pictures and

2439

01:28:15,910 --> 01:28:14,320

information coming from the people who

2440

01:28:18,709 --> 01:28:15,920

are in this room today

2441

01:28:21,430 --> 01:28:18,719

and now we're going to do a

2442

01:28:23,750 --> 01:28:21,440

nasa social tradition which is we take a

2443

01:28:25,590 --> 01:28:23,760

group photograph at every single nasa

2444

01:28:27,590 --> 01:28:25,600

social now we are in a very special room

2445

01:28:30,470 --> 01:28:27,600

today and we decided here that this

2446

01:28:33,030 --> 01:28:30,480

requires a very special moment and photo

2447

01:28:36,229 --> 01:28:33,040

so i'm going to let these two give the

2448

01:28:49,270 --> 01:28:36,239

cue and the rest of you know what to do