
ORION
SPACECRAFT
ORION
ORION MULTI PURPOSE CREW VEHICLE

1
00:00:05,030 --> 00:00:03,510
good afternoon and welcome to nasa

2
00:00:07,190 --> 00:00:05,040
headquarters in washington i'm nasa

3
00:00:08,549 --> 00:00:07,200
public affairs officer trent parado and

4
00:00:10,390 --> 00:00:08,559
thank you for joining us today for

5
00:00:12,549 --> 00:00:10,400
nasa's exploration forum on the human

6
00:00:14,470 --> 00:00:12,559
path to mars it's a really exciting day

7
00:00:16,230 --> 00:00:14,480
for us here at nasa because today we get

8
00:00:17,830 --> 00:00:16,240
to spend a couple of hours this

9
00:00:20,070 --> 00:00:17,840
afternoon on one of people's favorite

10
00:00:22,310 --> 00:00:20,080
topics when it comes to space and that's

11
00:00:24,710 --> 00:00:22,320
sending astronauts to mars what's the

12
00:00:26,630 --> 00:00:24,720
path to get humans to mars what do we

13
00:00:28,550 --> 00:00:26,640

need to do it we have a really unique

14
00:00:30,470 --> 00:00:28,560
opportunity today to hear the answers to

15
00:00:32,389 --> 00:00:30,480
those questions from nasa leadership

16
00:00:34,630 --> 00:00:32,399
from across the agency so you hear

17
00:00:36,310 --> 00:00:34,640
directly about nasa science currently on

18
00:00:38,470 --> 00:00:36,320
and around mars some of the new planned

19
00:00:40,310 --> 00:00:38,480
science new technologies currently in

20
00:00:42,549 --> 00:00:40,320
development and our ultimate plans for

21
00:00:43,990 --> 00:00:42,559
the human exploration of mars for those

22
00:00:45,510 --> 00:00:44,000
of you watching from home i'd encourage

23
00:00:48,670 --> 00:00:45,520
you to find out more information about

24
00:00:50,389 --> 00:00:48,680
nasa's human exploration program at

25
00:00:52,069 --> 00:00:50,399
www.nasa.gov

26
00:00:53,750 --> 00:00:52,079
exploration if you're joining the

27
00:00:55,830 --> 00:00:53,760
conversation online today you can do so

28
00:00:57,189 --> 00:00:55,840
with the hashtag mars

29
00:01:00,869 --> 00:00:57,199
if you have questions during the event

30
00:01:02,310 --> 00:01:00,879
we'll stop for q a at about halfway and

31
00:01:03,590 --> 00:01:02,320
try to get as many of those as possible

32
00:01:06,630 --> 00:01:03,600
you can let us know your question on

33
00:01:08,390 --> 00:01:06,640
twitter using the hashtag asknasa

34
00:01:09,830 --> 00:01:08,400
we have an incredibly impressive lineup

35
00:01:12,230 --> 00:01:09,840
of speakers today here to tell you much

36
00:01:14,149 --> 00:01:12,240
more about the human path to mars but

37
00:01:16,070 --> 00:01:14,159
first i'd like to show a short highlight

38
00:01:18,149 --> 00:01:16,080

video that showcases some of the things

39
00:01:25,270 --> 00:01:18,159
i'll be talking about in more detail if

40
00:01:25,280 --> 00:01:41,030
a big watch

41
00:01:44,950 --> 00:01:42,469
mars

42
00:01:47,990 --> 00:01:44,960
a rich destination for scientific

43
00:01:50,630 --> 00:01:48,000
discovery as we expand our presence into

44
00:01:53,429 --> 00:01:50,640
the solar system with robotic and human

45
00:01:54,630 --> 00:01:53,439
exploration the formation and evolution

46
00:01:56,789 --> 00:01:54,640
of mars

47
00:01:59,830 --> 00:01:56,799
will help us learn more about our own

48
00:02:02,310 --> 00:01:59,840
planet's history and future in its past

49
00:02:04,870 --> 00:02:02,320
the red planet had conditions suitable

50
00:02:07,350 --> 00:02:04,880
for life and future exploration may

51
00:02:10,710 --> 00:02:07,360
uncover evidence of life answering one

52
00:02:14,070 --> 00:02:10,720
of the fundamental mysteries of humanity

53
00:02:16,070 --> 00:02:14,080
does life exist beyond earth

54
00:02:17,830 --> 00:02:16,080
at nasa we're reaching for new heights

55
00:02:20,309 --> 00:02:17,840
so that we remain the world's leader in

56
00:02:21,510 --> 00:02:20,319
space we're pioneers and we always have

57
00:02:23,670 --> 00:02:21,520
been and we're building on that

58
00:02:25,510 --> 00:02:23,680
pioneering spirit in science and

59
00:02:27,670 --> 00:02:25,520
technology so that we make the world a

60
00:02:29,910 --> 00:02:27,680
better place and we create jobs right

61
00:02:33,030 --> 00:02:29,920
here on earth nasa is developing the

62
00:02:36,309 --> 00:02:33,040
capabilities needed to send humans to an

63
00:02:37,990 --> 00:02:36,319

asteroid by 2025 and to mars in the

64
00:02:39,750 --> 00:02:38,000
2030s

65
00:02:41,350 --> 00:02:39,760
we're building something that can go

66
00:02:43,509 --> 00:02:41,360
lunar we can build something to go to an

67
00:02:45,990 --> 00:02:43,519
asteroid we can go to mars with this

68
00:02:48,229 --> 00:02:46,000
this is the next step that we've been

69
00:02:50,630 --> 00:02:48,239
looking for since the apollo area

70
00:02:52,949 --> 00:02:50,640
robotic explorers have studied mars for

71
00:02:55,190 --> 00:02:52,959
more than 40 years

72
00:02:58,470 --> 00:02:55,200
nasa's path for human exploration of

73
00:03:00,550 --> 00:02:58,480
mars begins in low earth orbit aboard

74
00:03:02,949 --> 00:03:00,560
the international space station onboard

75
00:03:04,470 --> 00:03:02,959
the orbiting laboratory astronauts are

76
00:03:07,190 --> 00:03:04,480
helping us prove many of the

77
00:03:09,350 --> 00:03:07,200
technologies and communications systems

78
00:03:11,670 --> 00:03:09,360
needed for human missions into deep

79
00:03:13,030 --> 00:03:11,680
space well the crews right now on the

80
00:03:14,869 --> 00:03:13,040
international space station are using

81
00:03:16,390 --> 00:03:14,879
this wonderful outpost to help us get

82
00:03:19,190 --> 00:03:16,400
father and father into space to

83
00:03:21,030 --> 00:03:19,200
asteroids to to mars eventually

84
00:03:22,390 --> 00:03:21,040
i think the science on station is making

85
00:03:23,990 --> 00:03:22,400
incredible breakthroughs that are going

86
00:03:26,229 --> 00:03:24,000
to help us make life better for people

87
00:03:27,990 --> 00:03:26,239
right here on earth we and our other

88
00:03:31,589 --> 00:03:28,000

international partner crewmates are

89
00:03:33,350 --> 00:03:31,599
working off the planet for the planet

90
00:03:35,670 --> 00:03:33,360
nasa along with our international

91
00:03:37,430 --> 00:03:35,680
partners conduct scientific research

92
00:03:39,589 --> 00:03:37,440
every day here on the station as we use

93
00:03:42,149 --> 00:03:39,599
this orbiting laboratory as a stepping

94
00:03:44,949 --> 00:03:42,159
stone for future deep space exploration

95
00:03:47,270 --> 00:03:44,959
in tandem with space station research

96
00:03:49,910 --> 00:03:47,280
nasa will send a robotic mission to

97
00:03:51,830 --> 00:03:49,920
capture and redirect an asteroid to

98
00:03:53,830 --> 00:03:51,840
orbit the moon

99
00:03:57,190 --> 00:03:53,840
astronauts aboard nasa's orion

100
00:04:00,229 --> 00:03:57,200
spacecraft will explore the asteroid and

101
00:04:03,030 --> 00:04:00,239
return to earth with samples

102
00:04:05,110 --> 00:04:03,040
this experience will help nasa test new

103
00:04:07,990 --> 00:04:05,120
systems and capabilities

104
00:04:10,229 --> 00:04:08,000
such as solar electric propulsion

105
00:04:14,949 --> 00:04:10,239
which will send cargo as part of human

106
00:04:20,789 --> 00:04:17,749
nasa's new space launch system will

107
00:04:23,590 --> 00:04:20,799
enable these proving ground missions

108
00:04:26,230 --> 00:04:23,600
to test new capabilities

109
00:04:27,350 --> 00:04:26,240
human missions to mars will rely on

110
00:04:30,390 --> 00:04:27,360
orion

111
00:04:32,870 --> 00:04:30,400
and an evolved version of the sls

112
00:04:35,030 --> 00:04:32,880
which will be the most powerful rocket

113
00:04:36,870 --> 00:04:35,040

ever flow

114
00:04:39,030 --> 00:04:36,880
with orion and our heavy lift space

115
00:04:40,710 --> 00:04:39,040
launch system we're going to send humans

116
00:04:42,469 --> 00:04:40,720
into space farther than they've ever

117
00:04:45,030 --> 00:04:42,479
gone before

118
00:04:46,629 --> 00:04:45,040
this year's orion test flight will be

119
00:04:49,350 --> 00:04:46,639
the most aggressive for a human

120
00:04:51,670 --> 00:04:49,360
spacecraft in more than 40 years apollo

121
00:04:53,670 --> 00:04:51,680
happened before i was born so this for

122
00:04:55,350 --> 00:04:53,680
our generation will be

123
00:04:57,830 --> 00:04:55,360
the exploration missions that we get to

124
00:05:01,110 --> 00:04:57,840
see in our lifetime a fleet of robotic

125
00:05:02,790 --> 00:05:01,120
spacecraft and rovers are already on and

126
00:05:04,790 --> 00:05:02,800
around mars

127
00:05:06,550 --> 00:05:04,800
dramatically increasing our knowledge

128
00:05:08,870 --> 00:05:06,560
about the red planet

129
00:05:10,950 --> 00:05:08,880
and paving the way for future human

130
00:05:13,749 --> 00:05:10,960
explorers

131
00:05:17,189 --> 00:05:13,759
future missions seeking signs of past

132
00:05:22,230 --> 00:05:17,199
life will demonstrate new technologies

133
00:05:25,749 --> 00:05:23,830
i think some of the most amazing things

134
00:05:27,590 --> 00:05:25,759
that we're learning are actually how to

135
00:05:30,310 --> 00:05:27,600
be really good detectives on another

136
00:05:33,270 --> 00:05:30,320
planet which is a really difficult job

137
00:05:34,310 --> 00:05:33,280
engineers and scientists around the

138
00:05:36,070 --> 00:05:34,320

country

139
00:05:38,469 --> 00:05:36,080
are working hard

140
00:05:41,749 --> 00:05:38,479
to develop the technologies astronauts

141
00:05:42,950 --> 00:05:41,759
will use to one day live and work on

142
00:05:45,830 --> 00:05:42,960
mars

143
00:05:49,189 --> 00:05:45,840
and then safely return home from the

144
00:05:51,590 --> 00:05:49,199
next giant leap for humanity

145
00:05:54,150 --> 00:05:51,600
through advanced aerospace technologies

146
00:05:56,230 --> 00:05:54,160
used in everything from modern aircraft

147
00:05:58,790 --> 00:05:56,240
to suborbital rockets and the commercial

148
00:06:01,430 --> 00:05:58,800
vehicles servicing low earth orbit today

149
00:06:04,710 --> 00:06:01,440
we're building the machines to take us

150
00:06:06,870 --> 00:06:04,720
farther into the high frontier

151
00:06:08,950 --> 00:06:06,880
nasa is here to raise the bar for human

152
00:06:11,110 --> 00:06:08,960
achievement we're a community dedicated

153
00:06:12,230 --> 00:06:11,120
to research and discovery in service to

154
00:06:14,390 --> 00:06:12,240
society

155
00:06:16,790 --> 00:06:14,400
we have a responsibility to the future

156
00:06:19,590 --> 00:06:16,800
generations to the future generations of

157
00:06:28,950 --> 00:06:19,600
engineers scientists technologists

158
00:06:32,469 --> 00:06:31,270
so let me just uh thank nasa tv and our

159
00:06:33,749 --> 00:06:32,479
colleagues from around the agency that

160
00:06:35,909 --> 00:06:33,759
excellent video showcasing some of the

161
00:06:37,749 --> 00:06:35,919
work that's happening around the country

162
00:06:39,270 --> 00:06:37,759
so now it's my privilege to introduce

163
00:06:41,029 --> 00:06:39,280

our first speaker

164
00:06:44,390 --> 00:06:41,039
nasa administrator charles bolden became

165
00:06:46,950 --> 00:06:44,400
the 12th nasa administrator in july 2009

166
00:06:48,550 --> 00:06:46,960
as administrator he leads the nasa team

167
00:06:50,390 --> 00:06:48,560
and manages its resources to advance the

168
00:06:52,070 --> 00:06:50,400
agency's missions and goals he's a

169
00:06:54,390 --> 00:06:52,080
retired major general the united states

170
00:06:56,230 --> 00:06:54,400
marine corps his 34 years in the marine

171
00:06:58,309 --> 00:06:56,240
corps included 14 years as a member of

172
00:06:59,749 --> 00:06:58,319
nasa's astronaut office

173
00:07:01,830 --> 00:06:59,759
he's traveled to orbit more than four

174
00:07:04,629 --> 00:07:01,840
times excuse me four times aboard the

175
00:07:05,990 --> 00:07:04,639
space shuttle between 1986 and 1994

176
00:07:09,110 --> 00:07:06,000
having commanded two of the missions he

177
00:07:10,309 --> 00:07:09,120
was pilot of sts-31 the flight of space

178
00:07:12,710 --> 00:07:10,319
shuttle discovery that deployed the

179
00:07:14,469 --> 00:07:12,720
hubble space telescope in 1990. of

180
00:07:16,629 --> 00:07:14,479
course as hubble extended our senses

181
00:07:17,830 --> 00:07:16,639
farther into the universe to see farther

182
00:07:19,430 --> 00:07:17,840
than ever before we of course look

183
00:07:20,790 --> 00:07:19,440
forward to hearing from from the

184
00:07:22,790 --> 00:07:20,800
administrator his thoughts on our plan

185
00:07:24,710 --> 00:07:22,800
to send humans farther than ever before

186
00:07:26,230 --> 00:07:24,720
into the solar system as we embark on

187
00:07:33,110 --> 00:07:26,240
the path to mars please help me welcome

188
00:07:37,110 --> 00:07:35,430

thanks very much trent um as i look

189
00:07:39,029 --> 00:07:37,120
around the audience here i i want to

190
00:07:39,990 --> 00:07:39,039
welcome everyone to this exploration

191
00:07:41,589 --> 00:07:40,000
forum

192
00:07:43,670 --> 00:07:41,599
um

193
00:07:44,710 --> 00:07:43,680
even though i i see a lot of people i

194
00:07:46,790 --> 00:07:44,720
know

195
00:07:49,189 --> 00:07:46,800
and recognize from before i'm still

196
00:07:50,710 --> 00:07:49,199
going to make my comments anyway

197
00:07:52,950 --> 00:07:50,720
because charles scales is back there and

198
00:07:54,869 --> 00:07:52,960
he didn't hear this before so so charles

199
00:07:57,430 --> 00:07:54,879
this is for you

200
00:07:59,830 --> 00:07:57,440
and there may be a few others this is

201
00:08:00,869 --> 00:07:59,840
your opportunity even if you're a nasa

202
00:08:02,950 --> 00:08:00,879
employee

203
00:08:03,909 --> 00:08:02,960
i i mean it it's your opportunity to see

204
00:08:05,909 --> 00:08:03,919
here

205
00:08:07,990 --> 00:08:05,919
discuss and learn how all of nasa's

206
00:08:10,230 --> 00:08:08,000
exploration resources are supporting our

207
00:08:13,270 --> 00:08:10,240
big goals of a human mission to an

208
00:08:15,430 --> 00:08:13,280
asteroid and human missions to mars

209
00:08:16,230 --> 00:08:15,440
some of you may have read some few of

210
00:08:19,350 --> 00:08:16,240
you

211
00:08:22,469 --> 00:08:19,360
may have read an op-ed by dana milbank

212
00:08:25,189 --> 00:08:22,479
the day after i kicked off the

213
00:08:27,670 --> 00:08:25,199

humans to mars over at gw and i found it

214
00:08:29,430 --> 00:08:27,680
to be very interesting as did my 14 year

215
00:08:32,310 --> 00:08:29,440
old granddaughter michaeli

216
00:08:33,829 --> 00:08:32,320
who was quoted quite often by me in that

217
00:08:35,829 --> 00:08:33,839
forum

218
00:08:39,829 --> 00:08:35,839
when i sent her the piece so she could

219
00:08:41,990 --> 00:08:39,839
see how dana milbank you know a world

220
00:08:43,029 --> 00:08:42,000
journalist had written her name in in an

221
00:08:45,910 --> 00:08:43,039
op-ed

222
00:08:47,590 --> 00:08:45,920
she said uh that's really cool

223
00:08:48,710 --> 00:08:47,600
except he didn't agree with anything you

224
00:08:53,509 --> 00:08:48,720
said

225
00:08:56,389 --> 00:08:53,519
so i'll go back and try it again so i'm

226
00:08:58,150 --> 00:08:56,399
i'm back here to try it again today

227
00:09:00,790 --> 00:08:58,160
you know with mars making its closest

228
00:09:02,870 --> 00:09:00,800
approach to earth since 2008 a few weeks

229
00:09:04,870 --> 00:09:02,880
ago and currently appearing as the

230
00:09:07,269 --> 00:09:04,880
brightest body in the eastern sky during

231
00:09:09,590 --> 00:09:07,279
the month of april this is an ideal time

232
00:09:12,150 --> 00:09:09,600
for this forum as the red planet draws

233
00:09:13,910 --> 00:09:12,160
nearer to earth nasa with your help is

234
00:09:15,590 --> 00:09:13,920
drawing nearer to our goal of sending

235
00:09:17,269 --> 00:09:15,600
humans to mars

236
00:09:19,190 --> 00:09:17,279
today you're going to get an update on

237
00:09:21,509 --> 00:09:19,200
nasa's path to mars from some of the

238
00:09:23,430 --> 00:09:21,519

leading experts at the agency

239
00:09:25,829 --> 00:09:23,440
including ellen stofan nasa's chief

240
00:09:27,430 --> 00:09:25,839
scientist bill gerstenmaier associate

241
00:09:29,590 --> 00:09:27,440
administrator for our human exploration

242
00:09:31,190 --> 00:09:29,600
and operations mission directorate and

243
00:09:32,630 --> 00:09:31,200
john grunsfeld head of the science

244
00:09:34,070 --> 00:09:32,640
mission directorate

245
00:09:36,389 --> 00:09:34,080
after you have a chance to hear from

246
00:09:38,070 --> 00:09:36,399
them and others ask questions

247
00:09:39,670 --> 00:09:38,080
robert lightfoot our associate

248
00:09:40,790 --> 00:09:39,680
administrator is going to give you a

249
00:09:43,509 --> 00:09:40,800
wrap-up

250
00:09:45,509 --> 00:09:43,519
but this day is really about you

251
00:09:48,070 --> 00:09:45,519
nothing we want to achieve can succeed

252
00:09:51,030 --> 00:09:48,080
without all of you the american people

253
00:09:53,030 --> 00:09:51,040
and i say that uh recognizing the fact

254
00:09:54,790 --> 00:09:53,040
that the vast majority of the american

255
00:09:57,110 --> 00:09:54,800
people are not seeing this and will not

256
00:09:58,949 --> 00:09:57,120
see this but many of you here who

257
00:10:00,470 --> 00:09:58,959
represent the media

258
00:10:02,870 --> 00:10:00,480
you are the eyes and ears for the

259
00:10:04,949 --> 00:10:02,880
american people so uh so we count on you

260
00:10:05,990 --> 00:10:04,959
asking really poking probing questions

261
00:10:08,150 --> 00:10:06,000
today

262
00:10:09,269 --> 00:10:08,160
um

263
00:10:14,470 --> 00:10:09,279

i

264
00:10:16,470 --> 00:10:14,480
hear your thoughts on the best path

265
00:10:19,030 --> 00:10:16,480
forward but let me set the stage by

266
00:10:20,630 --> 00:10:19,040
reminding us of why we're all here

267
00:10:22,790 --> 00:10:20,640
while humans have been fascinated with

268
00:10:25,030 --> 00:10:22,800
mars since the beginning of time there

269
00:10:26,550 --> 00:10:25,040
are a number of very tangible reasons

270
00:10:29,430 --> 00:10:26,560
why we need to learn more about our

271
00:10:31,190 --> 00:10:29,440
closest planetary neighbor for one thing

272
00:10:32,790 --> 00:10:31,200
mars's formation and evolution are

273
00:10:36,069 --> 00:10:32,800
comparable to earth

274
00:10:39,110 --> 00:10:36,079
and we know that at one time mars

275
00:10:40,790 --> 00:10:39,120
had conditions suitable to life

276
00:10:42,790 --> 00:10:40,800
what we learn about the red planet may

277
00:10:45,190 --> 00:10:42,800
tell us more about our own home planet's

278
00:10:47,030 --> 00:10:45,200
history and future and help us answer a

279
00:10:49,590 --> 00:10:47,040
fundamental human question

280
00:10:51,509 --> 00:10:49,600
does life exist beyond earth

281
00:10:54,790 --> 00:10:51,519
while nasa has been on a path to mars

282
00:10:56,230 --> 00:10:54,800
for decades and our earlier mars rovers

283
00:10:58,310 --> 00:10:56,240
and orbiters

284
00:11:00,470 --> 00:10:58,320
president obama made a critical national

285
00:11:03,829 --> 00:11:00,480
policy statement in in support of our

286
00:11:05,430 --> 00:11:03,839
strategy on april 15 2010

287
00:11:07,350 --> 00:11:05,440
during a visit to the kennedy space

288
00:11:08,310 --> 00:11:07,360

center when he challenged nasa and the

289
00:11:11,269 --> 00:11:08,320
nation

290
00:11:14,389 --> 00:11:11,279
to send humans to an asteroid by 2025

291
00:11:17,190 --> 00:11:14,399
and to mars in the 2030s the u s

292
00:11:19,590 --> 00:11:17,200
national space policy said in 2011

293
00:11:21,590 --> 00:11:19,600
further supports these goals

294
00:11:23,509 --> 00:11:21,600
over the past several years nasa has

295
00:11:25,910 --> 00:11:23,519
been developing the capabilities to meet

296
00:11:27,750 --> 00:11:25,920
these goals through a bipartisan space

297
00:11:30,470 --> 00:11:27,760
exploration plan agreed to by the

298
00:11:32,310 --> 00:11:30,480
administration and congress in the 2010

299
00:11:34,389 --> 00:11:32,320
authorization act and embraced by the

300
00:11:37,430 --> 00:11:34,399
international space community in the

301
00:11:39,430 --> 00:11:37,440
2013 global exploration roadmap

302
00:11:41,750 --> 00:11:39,440
while robotic explorers have studied

303
00:11:43,990 --> 00:11:41,760
mars for more than 40 years

304
00:11:45,990 --> 00:11:44,000
nasa's path for the human exploration of

305
00:11:48,069 --> 00:11:46,000
mars begins in low earth orbit aboard

306
00:11:49,910 --> 00:11:48,079
the international space station our

307
00:11:51,269 --> 00:11:49,920
springboard to the exploration of deep

308
00:11:52,710 --> 00:11:51,279
space

309
00:11:55,110 --> 00:11:52,720
as we speak

310
00:11:57,030 --> 00:11:55,120
astronauts aboard the iss are helping us

311
00:11:59,269 --> 00:11:57,040
learn how to safely execute extended

312
00:12:01,350 --> 00:11:59,279
missions deeper into space

313
00:12:03,750 --> 00:12:01,360

we are guaranteed this unique orbiting

314
00:12:05,190 --> 00:12:03,760
outpost for at least another decade by

315
00:12:09,190 --> 00:12:05,200
the administration's commitment to

316
00:12:11,190 --> 00:12:09,200
extend the iss until at least 2024.

317
00:12:12,790 --> 00:12:11,200
this means an expanded market for

318
00:12:14,470 --> 00:12:12,800
private space companies more

319
00:12:16,870 --> 00:12:14,480
groundbreaking research and science

320
00:12:19,509 --> 00:12:16,880
discovery in microgravity and

321
00:12:22,230 --> 00:12:19,519
opportunities to live work and learn in

322
00:12:24,710 --> 00:12:22,240
space over longer periods of time

323
00:12:27,030 --> 00:12:24,720
as most of you know we're working to

324
00:12:29,829 --> 00:12:27,040
return both cargo and human launches to

325
00:12:32,230 --> 00:12:29,839
the iss to american soil

326
00:12:34,069 --> 00:12:32,240
the president's 2015 budget supports the

327
00:12:36,550 --> 00:12:34,079
administration's commitment that nasa be

328
00:12:39,590 --> 00:12:36,560
a catalyst for the growth of a vibrant

329
00:12:42,230 --> 00:12:39,600
american commercial space industry

330
00:12:44,710 --> 00:12:42,240
already two american companies spacex

331
00:12:47,430 --> 00:12:44,720
and orbital sciences are making regular

332
00:12:49,430 --> 00:12:47,440
cargo deliveries to the space station

333
00:12:51,670 --> 00:12:49,440
while the russians federal space agency

334
00:12:53,190 --> 00:12:51,680
rakat roscosmos remains a strong and

335
00:12:55,670 --> 00:12:53,200
reliable partner

336
00:12:58,069 --> 00:12:55,680
later this year nasa intends to select

337
00:13:00,150 --> 00:12:58,079
from american companies competed to send

338
00:13:01,190 --> 00:13:00,160

astronauts to the station from american

339
00:13:04,470 --> 00:13:01,200
soil

340
00:13:06,389 --> 00:13:04,480
if congress fully funds our 2015 request

341
00:13:08,470 --> 00:13:06,399
we believe we can do this by the end of

342
00:13:10,710 --> 00:13:08,480
2017.

343
00:13:12,470 --> 00:13:10,720
our next step is deep space

344
00:13:14,629 --> 00:13:12,480
where nasa will send the first mission

345
00:13:16,150 --> 00:13:14,639
to capture and redirect an asteroid to

346
00:13:18,470 --> 00:13:16,160
orbit the moon

347
00:13:21,110 --> 00:13:18,480
astronauts aboard orion spacecraft will

348
00:13:23,670 --> 00:13:21,120
explore the asteroid in the 2020s

349
00:13:25,590 --> 00:13:23,680
returning to earth with samples

350
00:13:28,069 --> 00:13:25,600
this experience in human space flight

351
00:13:30,230 --> 00:13:28,079
beyond low earth orbit will help nasa

352
00:13:32,389 --> 00:13:30,240
test new systems and capabilities such

353
00:13:35,750 --> 00:13:32,399
as solar electric propulsion that will

354
00:13:38,550 --> 00:13:35,760
need to support human missions to mars

355
00:13:41,189 --> 00:13:38,560
beginning in 2017 nasa's powerful space

356
00:13:43,189 --> 00:13:41,199
launch system or sls rocket will enable

357
00:13:45,110 --> 00:13:43,199
these proving ground missions to test

358
00:13:47,269 --> 00:13:45,120
new capabilities

359
00:13:50,550 --> 00:13:47,279
human missions to mars will rely on

360
00:13:52,069 --> 00:13:50,560
orion and an evolved version of the sls

361
00:13:53,829 --> 00:13:52,079
that will be the most powerful launch

362
00:13:56,310 --> 00:13:53,839
vehicle ever flown

363
00:13:59,590 --> 00:13:56,320

a fleet of robotic spacecraft and rovers

364
00:14:01,189 --> 00:13:59,600
already are on and around mars

365
00:14:03,269 --> 00:14:01,199
they are dramatically increasing our

366
00:14:05,030 --> 00:14:03,279
knowledge about the red planet and

367
00:14:06,470 --> 00:14:05,040
paving the way for future human

368
00:14:08,710 --> 00:14:06,480
explorers

369
00:14:11,110 --> 00:14:08,720
the mars science laboratory curiosity

370
00:14:13,509 --> 00:14:11,120
rover measured radiation on the way to

371
00:14:15,110 --> 00:14:13,519
mars and is sending back radiation data

372
00:14:16,790 --> 00:14:15,120
from the surface

373
00:14:18,629 --> 00:14:16,800
this data will help us plan how to

374
00:14:20,710 --> 00:14:18,639
protect the astronauts who will be

375
00:14:23,750 --> 00:14:20,720
exploring mars

376
00:14:26,629 --> 00:14:23,760
future missions like mars 2020 rover

377
00:14:29,269 --> 00:14:26,639
seeking the signs of past life

378
00:14:31,269 --> 00:14:29,279
also will demonstrate new technologies

379
00:14:32,710 --> 00:14:31,279
that could help astronauts survive on

380
00:14:34,389 --> 00:14:32,720
mars

381
00:14:36,790 --> 00:14:34,399
engineers and scientists around the

382
00:14:39,750 --> 00:14:36,800
country are working hard to develop the

383
00:14:42,389 --> 00:14:39,760
technologies astronauts will use to one

384
00:14:45,269 --> 00:14:42,399
day live and work on mars and safely

385
00:14:47,350 --> 00:14:45,279
return home it's important to remember

386
00:14:49,590 --> 00:14:47,360
that nasa sent humans to the moon by

387
00:14:50,710 --> 00:14:49,600
setting a goal that seemed beyond our

388
00:14:53,350 --> 00:14:50,720

reach

389
00:14:55,350 --> 00:14:53,360
with mars as our focus we are steadily

390
00:14:57,189 --> 00:14:55,360
building the capability to enable human

391
00:14:59,590 --> 00:14:57,199
missions to mars

392
00:15:02,150 --> 00:14:59,600
the challenge is huge i will admit

393
00:15:04,069 --> 00:15:02,160
but we're making real progress today as

394
00:15:05,829 --> 00:15:04,079
a radiation monitor on the curiosity

395
00:15:06,949 --> 00:15:05,839
rover records martian radiation

396
00:15:09,670 --> 00:15:06,959
environments

397
00:15:10,870 --> 00:15:09,680
daily that our crews will experience

398
00:15:12,790 --> 00:15:10,880
meanwhile

399
00:15:15,030 --> 00:15:12,800
advanced entry descent and landing

400
00:15:17,590 --> 00:15:15,040
technologies needed for landing on mars

401
00:15:19,509 --> 00:15:17,600
are ready for entry speed testing high

402
00:15:20,629 --> 00:15:19,519
above the waters of the pacific ocean in

403
00:15:22,710 --> 00:15:20,639
june

404
00:15:25,269 --> 00:15:22,720
orion is finishing preparation for a

405
00:15:27,030 --> 00:15:25,279
heat shield test in december

406
00:15:29,110 --> 00:15:27,040
and in new orleans we're beginning to

407
00:15:31,509 --> 00:15:29,120
manufacture flight hardware for the

408
00:15:32,550 --> 00:15:31,519
heavy lift rocket necessary for mars

409
00:15:33,829 --> 00:15:32,560
missions

410
00:15:36,310 --> 00:15:33,839
we're counting on the support of

411
00:15:38,150 --> 00:15:36,320
congress the scientific community and

412
00:15:40,949 --> 00:15:38,160
all of you to help us realize our

413
00:15:43,509 --> 00:15:40,959

ambitious goals the future of space

414
00:15:46,550 --> 00:15:43,519
exploration is as bright as mars shining

415
00:15:49,910 --> 00:15:46,560
at us in the eastern sky this month

416
00:15:51,910 --> 00:15:49,920
but it will be up to all of us believing

417
00:15:53,509 --> 00:15:51,920
and working together to achieve our

418
00:15:55,590 --> 00:15:53,519
ambitious goals

419
00:15:57,990 --> 00:15:55,600
we're embarked on an exciting incredible

420
00:15:59,670 --> 00:15:58,000
journey and we hope you'll choose to be

421
00:16:01,350 --> 00:15:59,680
a part of that team

422
00:16:03,030 --> 00:16:01,360
uh with that i'd like to thank you trent

423
00:16:05,430 --> 00:16:03,040
i'm going to give it back to you and one

424
00:16:07,509 --> 00:16:05,440
quick reminder if you don't have a copy

425
00:16:08,870 --> 00:16:07,519
of the scorecard

426
00:16:10,870 --> 00:16:08,880
get one

427
00:16:13,030 --> 00:16:10,880
put it in your man purse as i told our

428
00:16:15,430 --> 00:16:13,040
nasa employees if you happen to have one

429
00:16:17,110 --> 00:16:15,440
if you're a woman carrying a purse big

430
00:16:19,509 --> 00:16:17,120
or little you can fold it you can put it

431
00:16:21,030 --> 00:16:19,519
in your inside pocket memorize it ask

432
00:16:22,629 --> 00:16:21,040
lots of questions about it so you're

433
00:16:24,949 --> 00:16:22,639
conversing on it and turn it into your

434
00:16:27,430 --> 00:16:24,959
30-second elevator speech whether you

435
00:16:39,030 --> 00:16:27,440
like us or not so thanks for coming out

436
00:16:43,350 --> 00:16:41,269
thanks charlie we do have uh copies of

437
00:16:44,870 --> 00:16:43,360
the chart charlie just showed uh here

438
00:16:47,110 --> 00:16:44,880

printed in the audience and for those of

439
00:16:49,350 --> 00:16:47,120
you at home you can find a printable

440
00:16:50,629 --> 00:16:49,360
copy of that at nasa.gov

441
00:16:52,069 --> 00:16:50,639
exploration

442
00:16:54,389 --> 00:16:52,079
many of you will know our next speaker

443
00:16:55,590 --> 00:16:54,399
john grunsfeld as the nasa associate

444
00:16:57,670 --> 00:16:55,600
administrator for the science mission

445
00:16:59,350 --> 00:16:57,680
directorate position he took in january

446
00:17:00,710 --> 00:16:59,360
of 2012.

447
00:17:02,710 --> 00:17:00,720
previously he served as the deputy

448
00:17:04,230 --> 00:17:02,720
director of the space telescope science

449
00:17:06,150 --> 00:17:04,240
institute in baltimore managing the

450
00:17:07,750 --> 00:17:06,160
science program for the hubble space

451
00:17:10,069 --> 00:17:07,760
telescope and forthcoming james webb

452
00:17:12,309 --> 00:17:10,079
space telescope others of you may know

453
00:17:13,829 --> 00:17:12,319
that john was a nasa astronaut

454
00:17:16,309 --> 00:17:13,839
he joined nasa's astronaut office in

455
00:17:18,309 --> 00:17:16,319
1992 he's a veteran of five space

456
00:17:19,829 --> 00:17:18,319
shuttle flights and visited hubble three

457
00:17:21,189 --> 00:17:19,839
times

458
00:17:23,029 --> 00:17:21,199
during these missions he also performed

459
00:17:25,029 --> 00:17:23,039
eight spacewalks to service and upgrade

460
00:17:26,470 --> 00:17:25,039
the observatory but if you're on twitter

461
00:17:28,150 --> 00:17:26,480
i hope all of you will get to know him

462
00:17:31,110 --> 00:17:28,160
and if you're not following him already

463
00:17:32,549 --> 00:17:31,120

at sciastro that's a ci for science a

464
00:17:34,150 --> 00:17:32,559
scientist and an astronaut is here to

465
00:17:35,750 --> 00:17:34,160
tell us about bridging those two worlds

466
00:17:42,950 --> 00:17:35,760
as we explore mars please help me

467
00:17:47,350 --> 00:17:45,270
thank you very much trent

468
00:17:49,830 --> 00:17:47,360
administrator baldwin was selected as an

469
00:17:52,150 --> 00:17:49,840
astronaut which as i remember i was not

470
00:17:55,350 --> 00:17:52,160
class of 1984

471
00:17:56,870 --> 00:17:55,360
pardon my sorry 1980 1980 i guess mike

472
00:17:58,470 --> 00:17:56,880
full was 84

473
00:18:00,870 --> 00:17:58,480
1980

474
00:18:03,190 --> 00:18:00,880
he was told that he would be a member of

475
00:18:05,830 --> 00:18:03,200
the class of astronauts that might set

476
00:18:08,789 --> 00:18:05,840
foot on mars

477
00:18:11,430 --> 00:18:08,799
following in his footsteps in 1992 i was

478
00:18:13,750 --> 00:18:11,440
selected in the 14th group of astronauts

479
00:18:15,909 --> 00:18:13,760
and like so many classes before me we

480
00:18:18,070 --> 00:18:15,919
had mars on our patch because we were

481
00:18:19,990 --> 00:18:18,080
told we would be the class that would be

482
00:18:22,470 --> 00:18:20,000
the explorers to set foot on mars at

483
00:18:24,070 --> 00:18:22,480
least some of our our members

484
00:18:25,909 --> 00:18:24,080
and one of our members of the class of

485
00:18:27,909 --> 00:18:25,919
1992 is on the international space

486
00:18:31,350 --> 00:18:27,919
station right now koichi wakata a

487
00:18:33,350 --> 00:18:31,360
classmate of mine from jaxa

488
00:18:35,510 --> 00:18:33,360

and and while i'm not going to set foot

489
00:18:39,590 --> 00:18:35,520
on mars personally i'm here to tell you

490
00:18:42,070 --> 00:18:39,600
that we all are on mars right now

491
00:18:43,909 --> 00:18:42,080
we have a really incredible science

492
00:18:45,909 --> 00:18:43,919
program uh charlie mentioned the

493
00:18:48,070 --> 00:18:45,919
curiosity rover i'm going to walk you

494
00:18:50,710 --> 00:18:48,080
through a little bit of how we all are

495
00:18:53,430 --> 00:18:50,720
on mars right now and how classmates

496
00:18:55,029 --> 00:18:53,440
like uh koichi of vine like quiche are

497
00:18:58,070 --> 00:18:55,039
on their way to mars even if not

498
00:18:59,190 --> 00:18:58,080
personally they're paving the way

499
00:19:00,870 --> 00:18:59,200
i also

500
00:19:02,390 --> 00:19:00,880
show this mars globe as you saw in the

501
00:19:04,310 --> 00:19:02,400
video because it's an excuse to show

502
00:19:10,470 --> 00:19:04,320
hubble images

503
00:19:18,549 --> 00:19:11,430
maybe

504
00:19:22,230 --> 00:19:20,310
so we've actually been on mars or

505
00:19:24,230 --> 00:19:22,240
observing mars for 50 years this is

506
00:19:26,950 --> 00:19:24,240
1964.

507
00:19:28,549 --> 00:19:26,960
mariner 4 and we started to get a view

508
00:19:30,150 --> 00:19:28,559
of mars that was very different than

509
00:19:32,630 --> 00:19:30,160
those from science fiction or our

510
00:19:35,190 --> 00:19:32,640
imagination it was a mars that at that

511
00:19:37,430 --> 00:19:35,200
time was more reminiscent of the moon

512
00:19:40,549 --> 00:19:37,440
than of earth

513
00:19:42,470 --> 00:19:40,559

we continue to explore mars next

514
00:19:50,230 --> 00:19:42,480
uh

515
00:19:50,240 --> 00:19:54,070
just talk to talk

516
00:19:59,430 --> 00:19:56,549
with a series of of orbiting missions

517
00:20:01,510 --> 00:19:59,440
that gave us pictures of mars that while

518
00:20:03,990 --> 00:20:01,520
they showed a barren mars

519
00:20:04,870 --> 00:20:04,000
clearly indicated features that appeared

520
00:20:08,549 --> 00:20:04,880
to be

521
00:20:12,710 --> 00:20:08,559
evidence of past floods of water flow

522
00:20:17,350 --> 00:20:14,870
and then viking when we landed on mars

523
00:20:19,510 --> 00:20:17,360
with two great observatories to mars

524
00:20:22,149 --> 00:20:19,520
that indeed revealed mars as what

525
00:20:24,390 --> 00:20:22,159
appeared to be a lifeless desert

526
00:20:26,070 --> 00:20:24,400
enormous amount of information a lot of

527
00:20:27,990 --> 00:20:26,080
controversy too about what was

528
00:20:30,630 --> 00:20:28,000
discovered the possible existence of

529
00:20:34,630 --> 00:20:30,640
life or of some kind of metabolism on

530
00:20:36,470 --> 00:20:34,640
mars but we pressed forward keep next

531
00:20:39,990 --> 00:20:36,480
with the exploration of mars with

532
00:20:42,789 --> 00:20:40,000
sojourner 1997 our first very capable

533
00:20:44,710 --> 00:20:42,799
rover spirit and opportunity opportunity

534
00:20:47,270 --> 00:20:44,720
is still roving today

535
00:20:49,590 --> 00:20:47,280
phoenix which landed near the polar cap

536
00:20:51,430 --> 00:20:49,600
of mars and we were trying to find out

537
00:20:53,909 --> 00:20:51,440
whether there was water and we landed on

538
00:20:55,750 --> 00:20:53,919

a glacier and curiosity which is of

539
00:20:58,070 --> 00:20:55,760
course all of you know is roving today

540
00:21:04,789 --> 00:20:58,080
next

541
00:21:06,950 --> 00:21:04,799
so here we have curiosity and

542
00:21:08,870 --> 00:21:06,960
opportunity we have mars odyssey

543
00:21:11,350 --> 00:21:08,880
orbiting mars mars reconnaissance

544
00:21:13,270 --> 00:21:11,360
orbiter orbiting mars our partners in

545
00:21:14,549 --> 00:21:13,280
the european space agency with mars

546
00:21:16,549 --> 00:21:14,559
express

547
00:21:19,190 --> 00:21:16,559
you know we really are exploring mars

548
00:21:21,590 --> 00:21:19,200
today next

549
00:21:25,029 --> 00:21:21,600
keep going

550
00:21:26,070 --> 00:21:25,039
so here's curiosity's selfie uh from the

551
00:21:28,950 --> 00:21:26,080
uh

552
00:21:31,190 --> 00:21:28,960
mars hand lens imager taken in a mosaic

553
00:21:32,789 --> 00:21:31,200
with the sun in the background

554
00:21:34,710 --> 00:21:32,799
and it does look a little bit desolate

555
00:21:36,950 --> 00:21:34,720
but mars hasn't always been that way

556
00:21:39,270 --> 00:21:36,960
next

557
00:21:41,110 --> 00:21:39,280
curiosity has been very busy this is a

558
00:21:43,350 --> 00:21:41,120
view of mount sharp we're slowly making

559
00:21:45,350 --> 00:21:43,360
our way towards mount sharp and along

560
00:21:48,870 --> 00:21:45,360
the way curiosity has made a number of

561
00:21:52,149 --> 00:21:50,950
we have already discovered that mars

562
00:21:54,310 --> 00:21:52,159
once

563
00:21:58,149 --> 00:21:54,320

billions of years ago was a happening

564
00:22:00,950 --> 00:21:58,159
place it had standing water

565
00:22:03,270 --> 00:22:00,960
probably fresh water john grotziner the

566
00:22:05,270 --> 00:22:03,280
project scientist said it was probably

567
00:22:07,830 --> 00:22:05,280
such that you could drink it

568
00:22:10,310 --> 00:22:07,840
and the mineral content showed that it

569
00:22:11,190 --> 00:22:10,320
was basically neutral ph and lasted long

570
00:22:13,110 --> 00:22:11,200
enough

571
00:22:15,350 --> 00:22:13,120
that it could have supported primitive

572
00:22:17,270 --> 00:22:15,360
life microbial life for instance

573
00:22:18,710 --> 00:22:17,280
if it existed on mars and so we've

574
00:22:20,789 --> 00:22:18,720
answered the question

575
00:22:22,230 --> 00:22:20,799
was mars ever habitable we haven't

576
00:22:23,669 --> 00:22:22,240
answered whether there's life there but

577
00:22:25,990 --> 00:22:23,679
we have answered that question so

578
00:22:29,190 --> 00:22:26,000
curiosity is pressing on it's roving

579
00:22:31,350 --> 00:22:29,200
it's drilling it's investigating it is a

580
00:22:33,430 --> 00:22:31,360
surrogate for a planetary scientist on

581
00:22:34,630 --> 00:22:33,440
mars next

582
00:22:36,789 --> 00:22:34,640
this is where

583
00:22:38,230 --> 00:22:36,799
curiosity is today

584
00:22:41,350 --> 00:22:38,240
if you look in the middle of the photo

585
00:22:43,510 --> 00:22:41,360
there's kind of a blue dot there

586
00:22:45,590 --> 00:22:43,520
and you can see some tire tracks if you

587
00:22:50,390 --> 00:22:45,600
look really closely that's kimberly

588
00:22:50,400 --> 00:22:53,669

next

589
00:22:56,230 --> 00:22:54,390
so

590
00:22:57,430 --> 00:22:56,240
science has been coming out like crazy i

591
00:22:59,430 --> 00:22:57,440
want you all to continue to pay

592
00:23:01,430 --> 00:22:59,440
attention we have explored mars

593
00:23:03,270 --> 00:23:01,440
habitability now we're looking for any

594
00:23:05,510 --> 00:23:03,280
kind of signs of

595
00:23:07,350 --> 00:23:05,520
carbon perhaps in the rock record that

596
00:23:11,510 --> 00:23:07,360
might be an indication of fossil

597
00:23:12,950 --> 00:23:11,520
evidence of past organic activity next

598
00:23:14,710 --> 00:23:12,960
and so what have we learned that is

599
00:23:17,190 --> 00:23:14,720
interesting for human exploration of

600
00:23:18,710 --> 00:23:17,200
mars future human exploration of mars

601
00:23:20,070 --> 00:23:18,720
next

602
00:23:22,310 --> 00:23:20,080
so of course an opportunity to show

603
00:23:23,830 --> 00:23:22,320
another hubble picture and we know that

604
00:23:26,470 --> 00:23:23,840
mars has weather we know that it has

605
00:23:28,630 --> 00:23:26,480
polar caps it has clouds it has sand

606
00:23:31,830 --> 00:23:28,640
storms so it's a it is a very active

607
00:23:34,070 --> 00:23:31,840
planet like earth next

608
00:23:36,310 --> 00:23:34,080
this is a picture from the opportunity

609
00:23:38,630 --> 00:23:36,320
rover looking up at some of those clouds

610
00:23:40,789 --> 00:23:38,640
next and we know that mars does indeed

611
00:23:43,430 --> 00:23:40,799
have a very thin atmosphere does support

612
00:23:45,029 --> 00:23:43,440
winds it supports weather but it doesn't

613
00:23:47,430 --> 00:23:45,039

support the ability to have liquid water

614
00:23:49,590 --> 00:23:47,440
on the surface next the pressure is just

615
00:23:53,350 --> 00:23:49,600
too low and so it would sublimate

616
00:23:55,669 --> 00:23:53,360
immediately off into the atmosphere next

617
00:23:57,750 --> 00:23:55,679
but we get weather reports and sometimes

618
00:24:00,070 --> 00:23:57,760
it's cold enough and humid enough that

619
00:24:02,070 --> 00:24:00,080
in fact you might expect to see frost so

620
00:24:04,149 --> 00:24:02,080
we know there's water a relative

621
00:24:06,390 --> 00:24:04,159
humidity that could be extracted if you

622
00:24:08,870 --> 00:24:06,400
wanted to have water the temperatures

623
00:24:11,269 --> 00:24:08,880
sometimes are quite temperate

624
00:24:12,789 --> 00:24:11,279
this happens this is today on mars it's

625
00:24:14,230 --> 00:24:12,799
the rem instrument the rover

626
00:24:17,269 --> 00:24:14,240
environmental monitoring system which

627
00:24:19,750 --> 00:24:17,279
was contributed by the by the spanish

628
00:24:22,149 --> 00:24:19,760
and and thus the spanish language but we

629
00:24:25,190 --> 00:24:22,159
see that it's about eight hecta pascals

630
00:24:28,310 --> 00:24:25,200
so that one percent uh

631
00:24:30,549 --> 00:24:28,320
relatively cold day on mars minus 24c uh

632
00:24:32,149 --> 00:24:30,559
daytime temperature minus 82 night mars

633
00:24:34,870 --> 00:24:32,159
rotates at about the same rotation rate

634
00:24:36,789 --> 00:24:34,880
as earth but sometimes it's 10 degrees c

635
00:24:38,149 --> 00:24:36,799
you know quite habitable for uh for

636
00:24:41,029 --> 00:24:38,159
humans i like to climb mountains in

637
00:24:42,549 --> 00:24:41,039
these kind of temperatures next

638
00:24:44,390 --> 00:24:42,559

we also know that as i said there's

639
00:24:46,230 --> 00:24:44,400
water in the atmosphere most of the

640
00:24:48,789 --> 00:24:46,240
atmosphere is carbon dioxide carbon

641
00:24:51,350 --> 00:24:48,799
dioxide we could extract oxygen from we

642
00:24:53,909 --> 00:24:51,360
could use the carbon dioxide for plants

643
00:24:55,430 --> 00:24:53,919
to transpire argon which is really

644
00:24:57,029 --> 00:24:55,440
interesting because we have argon on

645
00:24:59,269 --> 00:24:57,039
earth at about the same percentage

646
00:25:01,669 --> 00:24:59,279
nitrogen nitrogen is very important the

647
00:25:04,070 --> 00:25:01,679
fact there's nitrogen on mars means that

648
00:25:05,830 --> 00:25:04,080
you could have fertilizer nitrogen in

649
00:25:07,750 --> 00:25:05,840
our atmosphere is the major component

650
00:25:11,110 --> 00:25:07,760
means you could extract that to produce

651
00:25:13,190 --> 00:25:11,120
an earth-like atmosphere next

652
00:25:15,029 --> 00:25:13,200
and of course water on mars now people

653
00:25:16,149 --> 00:25:15,039
say we've recently discovered water on

654
00:25:18,390 --> 00:25:16,159
mars well in fact we've known

655
00:25:20,390 --> 00:25:18,400
spectroscopically about water on mars

656
00:25:22,230 --> 00:25:20,400
for many many decades since we started

657
00:25:23,669 --> 00:25:22,240
doing spectroscopy with telescopes but

658
00:25:26,070 --> 00:25:23,679
now we're actually this is from mars

659
00:25:28,470 --> 00:25:26,080
reconnaissance orbiter able to study you

660
00:25:30,230 --> 00:25:28,480
know the polar caps carbon dioxide and

661
00:25:32,789 --> 00:25:30,240
water ice glaciers

662
00:25:36,549 --> 00:25:32,799
and and we know a lot about the history

663
00:25:38,149 --> 00:25:36,559

of mars and water on mars next

664
00:25:39,669 --> 00:25:38,159
this is something really striking these

665
00:25:41,510 --> 00:25:39,679
are a series of images from mars

666
00:25:42,630 --> 00:25:41,520
reconnaissance orbiter looking down on

667
00:25:45,990 --> 00:25:42,640
gullies

668
00:25:48,310 --> 00:25:46,000
seeping out

669
00:25:51,269 --> 00:25:48,320
and resident for some long periods of

670
00:25:53,830 --> 00:25:51,279
time seasonally so in summer something's

671
00:25:55,830 --> 00:25:53,840
leaking out and if it's very briny water

672
00:25:57,590 --> 00:25:55,840
it actually could survive at the low

673
00:26:00,630 --> 00:25:57,600
temperatures and pressures for a little

674
00:26:03,750 --> 00:26:00,640
while before it sublimated and so some

675
00:26:05,350 --> 00:26:03,760
scientists think that underneath

676
00:26:07,750 --> 00:26:05,360
the mars surface is some kind of a

677
00:26:09,430 --> 00:26:07,760
glacier that's periodically melting and

678
00:26:11,590 --> 00:26:09,440
releasing that salty water and would

679
00:26:13,510 --> 00:26:11,600
then be accessible and if there's life

680
00:26:16,230 --> 00:26:13,520
on mars this could be some place that it

681
00:26:18,070 --> 00:26:16,240
could effeminately exist next

682
00:26:19,990 --> 00:26:18,080
and of course we see that on upper left

683
00:26:22,070 --> 00:26:20,000
on mars this is from mars express in

684
00:26:23,909 --> 00:26:22,080
many different places that look very

685
00:26:25,269 --> 00:26:23,919
much like the similar types of gullies

686
00:26:26,870 --> 00:26:25,279
that we see on earth and so we're able

687
00:26:29,110 --> 00:26:26,880
to go and explore those try and

688
00:26:30,710 --> 00:26:29,120

understand those on earth to compare to

689
00:26:32,070 --> 00:26:30,720
mars because mars is really a very

690
00:26:33,990 --> 00:26:32,080
similar place to earth that's the

691
00:26:37,750 --> 00:26:34,000
message i want you to take away is that

692
00:26:39,909 --> 00:26:37,760
mars is really very much like earth next

693
00:26:41,909 --> 00:26:39,919
lots of evidence for accessible water

694
00:26:44,149 --> 00:26:41,919
the upper left is from phoenix we dug a

695
00:26:46,070 --> 00:26:44,159
little bit in the mars surface and lo

696
00:26:48,470 --> 00:26:46,080
and behold we find water ice which over

697
00:26:50,549 --> 00:26:48,480
time sublimated we occasionally see

698
00:26:53,269 --> 00:26:50,559
meteor meteoritic impacts asteroid

699
00:26:54,070 --> 00:26:53,279
impacts on the surface of mars that

700
00:26:56,390 --> 00:26:54,080
create

701
00:26:58,070 --> 00:26:56,400
depressions craters which show that

702
00:27:00,310 --> 00:26:58,080
there's water ice just under the surface

703
00:27:02,230 --> 00:27:00,320
which then over time sublimates off into

704
00:27:04,310 --> 00:27:02,240
the martian atmosphere and of course on

705
00:27:06,710 --> 00:27:04,320
the lower right and and upper right many

706
00:27:09,510 --> 00:27:06,720
many places on mars that clearly look

707
00:27:11,029 --> 00:27:09,520
like morphologically that water has been

708
00:27:12,950 --> 00:27:11,039
flowing there for some long period of

709
00:27:16,870 --> 00:27:12,960
times large outflow channels from some

710
00:27:21,909 --> 00:27:19,830
we think there's a lot a big chance from

711
00:27:24,950 --> 00:27:21,919
the topology that mars once had a great

712
00:27:27,110 --> 00:27:24,960
ocean perhaps uh inland seas

713
00:27:28,549 --> 00:27:27,120

some fresh water some salt water and in

714
00:27:30,070 --> 00:27:28,559
fact there's there's

715
00:27:31,990 --> 00:27:30,080
just an enormous amount of water

716
00:27:35,430 --> 00:27:32,000
probably still today frozen underneath

717
00:27:37,510 --> 00:27:35,440
ours mars from the evidence next

718
00:27:39,590 --> 00:27:37,520
uh we think maybe 500 000 years ago

719
00:27:42,230 --> 00:27:39,600
because of the changing tilt of mars

720
00:27:43,830 --> 00:27:42,240
that it probably had a kind of mini ice

721
00:27:45,590 --> 00:27:43,840
age and the polar caps would have

722
00:27:49,029 --> 00:27:45,600
expanded almost all the way to plus or

723
00:27:51,269 --> 00:27:49,039
minus 30 degrees next

724
00:27:52,710 --> 00:27:51,279
now living on the surface of mars is not

725
00:27:55,029 --> 00:27:52,720
going to be easy

726
00:27:57,190 --> 00:27:55,039
there are a lot of dangers now from a

727
00:27:58,710 --> 00:27:57,200
microbial standpoint i think the earth

728
00:28:01,029 --> 00:27:58,720
is probably the most dangerous planet

729
00:28:02,389 --> 00:28:01,039
for humans in the solar system

730
00:28:03,990 --> 00:28:02,399
but mars does

731
00:28:05,830 --> 00:28:04,000
doesn't have a magnetic field it doesn't

732
00:28:06,870 --> 00:28:05,840
have a thick atmosphere and so we do

733
00:28:09,590 --> 00:28:06,880
have to worry about things like

734
00:28:11,590 --> 00:28:09,600
radiation uh next

735
00:28:13,430 --> 00:28:11,600
so we have the rad instrument which

736
00:28:15,350 --> 00:28:13,440
measured the radiation next all the way

737
00:28:16,710 --> 00:28:15,360
to mars so we learned about the cruise

738
00:28:18,549 --> 00:28:16,720

and is continuing to measure that

739
00:28:21,029 --> 00:28:18,559
radiation level on the surface from

740
00:28:23,029 --> 00:28:21,039
cosmic rays galactic cosmic rays solar

741
00:28:24,789 --> 00:28:23,039
cosmic rays so we're understanding what

742
00:28:26,230 --> 00:28:24,799
those risks are you know clearly a

743
00:28:27,990 --> 00:28:26,240
mission to mars is going to be risky

744
00:28:31,750 --> 00:28:28,000
overall but all of our space missions

745
00:28:33,350 --> 00:28:31,760
with humans are risky next

746
00:28:35,029 --> 00:28:33,360
if you don't like the surface there's

747
00:28:37,269 --> 00:28:35,039
places where we have access to

748
00:28:39,350 --> 00:28:37,279
subterranean

749
00:28:41,430 --> 00:28:39,360
lava tubes and where the ceiling has

750
00:28:43,750 --> 00:28:41,440
collapsed and you might be able to build

751
00:28:45,990 --> 00:28:43,760
an encampment underneath of mars with a

752
00:28:47,510 --> 00:28:46,000
big dome maybe an inflatable who knows

753
00:28:48,789 --> 00:28:47,520
but that would be protected from that

754
00:28:51,269 --> 00:28:48,799
surface radiation if you were going to

755
00:28:52,630 --> 00:28:51,279
stay for a long time next these are all

756
00:28:54,549 --> 00:28:52,640
the observations we're making so what

757
00:28:57,110 --> 00:28:54,559
are our next steps on mars

758
00:29:01,430 --> 00:28:59,669
so we have a mars exploration program a

759
00:29:03,190 --> 00:29:01,440
series of interlinked missions which

760
00:29:05,590 --> 00:29:03,200
help us learn more and more about mars

761
00:29:08,230 --> 00:29:05,600
on each mission and also are giving us

762
00:29:09,669 --> 00:29:08,240
further steps in human exploration so we

763
00:29:11,669 --> 00:29:09,679

currently have the missions i told you

764
00:29:13,669 --> 00:29:11,679
about with curiosity the maven

765
00:29:16,230 --> 00:29:13,679
spacecraft to study the mars atmosphere

766
00:29:18,389 --> 00:29:16,240
and how it's lost to space is on its way

767
00:29:20,630 --> 00:29:18,399
to mars it'll be there this fall

768
00:29:23,430 --> 00:29:20,640
we have participation with the european

769
00:29:25,669 --> 00:29:23,440
space agency trace gas orbiter we're

770
00:29:28,870 --> 00:29:25,679
preparing an insight mission to land on

771
00:29:31,110 --> 00:29:28,880
mars and study mars interior in 2018

772
00:29:33,909 --> 00:29:31,120
participation in the exomars with a mars

773
00:29:36,870 --> 00:29:33,919
organic molecular analyzer to look for

774
00:29:38,710 --> 00:29:36,880
organics and the big news is in 2020

775
00:29:40,389 --> 00:29:38,720
we're sending the next rover based on

776
00:29:42,070 --> 00:29:40,399
the chassis of the mars science

777
00:29:44,630 --> 00:29:42,080
laboratory but with new instruments and

778
00:29:46,149 --> 00:29:44,640
new capabilities next

779
00:29:48,470 --> 00:29:46,159
as i said maven's going to help us

780
00:29:50,149 --> 00:29:48,480
understand what happened to mars how did

781
00:29:51,990 --> 00:29:50,159
it lose its thick atmosphere and all

782
00:29:54,389 --> 00:29:52,000
that water that we were talking about

783
00:29:55,830 --> 00:29:54,399
when did it happen so between curiosity

784
00:29:58,389 --> 00:29:55,840
and maven we hope to unravel that

785
00:30:00,630 --> 00:29:58,399
mystery next

786
00:30:02,149 --> 00:30:00,640
and then of course the mars 2020 rover

787
00:30:04,510 --> 00:30:02,159
which will have new instruments we're in

788
00:30:07,669 --> 00:30:04,520

selection now but it will extend our

789
00:30:10,070 --> 00:30:07,679
astrobiology search for evidence of past

790
00:30:11,830 --> 00:30:10,080
life past habitable environments but

791
00:30:14,070 --> 00:30:11,840
also to enable the future in

792
00:30:15,750 --> 00:30:14,080
collaboration with the human exploration

793
00:30:17,590 --> 00:30:15,760
operations mission directorate and space

794
00:30:19,830 --> 00:30:17,600
technology mission directorate we have

795
00:30:21,830 --> 00:30:19,840
accommodation for a significant payload

796
00:30:25,029 --> 00:30:21,840
that's going to do in-situ resource

797
00:30:27,029 --> 00:30:25,039
utilization it's going to extract oxygen

798
00:30:28,470 --> 00:30:27,039
from local resources and this will be

799
00:30:30,950 --> 00:30:28,480
the first demonstration of that on the

800
00:30:35,029 --> 00:30:30,960
surface deliberately intended to support

801
00:30:39,669 --> 00:30:37,350
so mars exploration is a common goal for

802
00:30:41,510 --> 00:30:39,679
all of us here at nasa today we're

803
00:30:43,190 --> 00:30:41,520
working together at the margins but in

804
00:30:45,510 --> 00:30:43,200
the future next we're going to be

805
00:30:47,990 --> 00:30:45,520
inextricably linked as we try and do

806
00:30:49,669 --> 00:30:48,000
human exploration science and develop

807
00:30:51,510 --> 00:30:49,679
technologies that will get us to mars

808
00:30:53,510 --> 00:30:51,520
and then allow us to work and thrive on

809
00:30:55,909 --> 00:30:53,520
mars next

810
00:30:58,230 --> 00:30:55,919
so just like neil armstrong's footprint

811
00:31:00,789 --> 00:30:58,240
on the moon we are doing wheel prints on

812
00:31:03,830 --> 00:31:00,799
mars today and inspiring you know young

813
00:31:05,830 --> 00:31:03,840

and old alike next

814
00:31:08,310 --> 00:31:05,840
we had our astronauts this is one of my

815
00:31:09,669 --> 00:31:08,320
favorite photos of the apollo 16 crew

816
00:31:10,789 --> 00:31:09,679
with john young my hero in the

817
00:31:16,070 --> 00:31:10,799
background

818
00:31:20,149 --> 00:31:18,149
we're training crews today and people to

819
00:31:23,350 --> 00:31:20,159
develop the technology the science the

820
00:31:25,269 --> 00:31:23,360
exploration techniques uh in on on

821
00:31:27,909 --> 00:31:25,279
planet earth in environments that are

822
00:31:30,310 --> 00:31:27,919
similar to mars preparing the way for

823
00:31:33,269 --> 00:31:30,320
what we will do on mars and uh it's my

824
00:31:35,750 --> 00:31:33,279
great belief next that our future is on

825
00:31:37,990 --> 00:31:35,760
mars and this courtesy of photoshop is

826
00:31:39,990 --> 00:31:38,000
jack schmidt on the moon but what we

827
00:31:42,470 --> 00:31:40,000
might see hopefully soon

828
00:31:46,950 --> 00:31:42,480
in a future scientist on mars so with

829
00:31:46,960 --> 00:31:49,909
thank you john

830
00:31:53,269 --> 00:31:51,350
and you're able to stick around for a

831
00:31:54,630 --> 00:31:53,279
bit so we break for q a to take some

832
00:32:01,029 --> 00:31:54,640
questions excellent okay so we'll keep

833
00:32:04,710 --> 00:32:02,870
all right thank you for that john our

834
00:32:06,230 --> 00:32:04,720
our next speaker is william gerstenmaier

835
00:32:08,070 --> 00:32:06,240
he is the associate administrator for

836
00:32:09,990 --> 00:32:08,080
the human exploration and operations

837
00:32:12,470 --> 00:32:10,000
mission directorate a position he's held

838
00:32:14,389 --> 00:32:12,480

since 2005 this makes him the official

839
00:32:16,549 --> 00:32:14,399
responsible for all aspects of nasa's

840
00:32:17,669 --> 00:32:16,559
human exploration of space this includes

841
00:32:19,350 --> 00:32:17,679
of course the international space

842
00:32:21,190 --> 00:32:19,360
station the development of the space

843
00:32:22,389 --> 00:32:21,200
launch system rocket and orion

844
00:32:23,669 --> 00:32:22,399
spacecraft

845
00:32:25,029 --> 00:32:23,679
and he provides strategic guidance and

846
00:32:27,190 --> 00:32:25,039
direction for the commercial crew and

847
00:32:29,029 --> 00:32:27,200
cargo programs providing logistics and

848
00:32:30,710 --> 00:32:29,039
soon crew transportation to the

849
00:32:31,590 --> 00:32:30,720
international space station from u.s

850
00:32:33,909 --> 00:32:31,600
soil

851
00:32:35,750 --> 00:32:33,919
he began his career at nasa in 1977

852
00:32:37,350 --> 00:32:35,760
what's now the glenn research center was

853
00:32:39,190 --> 00:32:37,360
nasa lewis working on aeronautical

854
00:32:41,350 --> 00:32:39,200
research throughout his distinguished

855
00:32:42,789 --> 00:32:41,360
career he's held multiple positions in a

856
00:32:44,549 --> 00:32:42,799
number of programs including the space

857
00:32:46,870 --> 00:32:44,559
shuttle program later the international

858
00:32:48,389 --> 00:32:46,880
space station program uh among the

859
00:32:50,789 --> 00:32:48,399
highlights this includes directing the

860
00:32:52,070 --> 00:32:50,799
safe completion of the last 21 space

861
00:32:54,070 --> 00:32:52,080
shuttle missions that completed

862
00:32:56,070 --> 00:32:54,080
construction of the international space

863
00:32:58,710 --> 00:32:56,080

station the orbiting laboratory 260

864
00:33:08,950 --> 00:32:58,720
miles overhead please help me welcome

865
00:33:13,669 --> 00:33:12,310
okay thanks trent camera next slide

866
00:33:19,590 --> 00:33:13,679
john gave a

867
00:33:21,669 --> 00:33:19,600
what's going on in mars today with the

868
00:33:23,350 --> 00:33:21,679
rovers and i think it's interesting is

869
00:33:25,750 --> 00:33:23,360
as we kind of sit here and we all look

870
00:33:28,389 --> 00:33:25,760
and we're inquisitively asking was there

871
00:33:30,470 --> 00:33:28,399
life on mars i think the other question

872
00:33:32,870 --> 00:33:30,480
is we should be asking ourselves is when

873
00:33:34,870 --> 00:33:32,880
will life be back on mars and each one

874
00:33:37,430 --> 00:33:34,880
of us in this auditorium has a chance to

875
00:33:39,190 --> 00:33:37,440
affect that future to help us get humans

876
00:33:41,590 --> 00:33:39,200
to the surface of mars to actually do

877
00:33:44,549 --> 00:33:41,600
investigations and as john described to

878
00:33:47,269 --> 00:33:44,559
us mars is probably the most

879
00:33:49,269 --> 00:33:47,279
earth or human hospitable program or

880
00:33:51,590 --> 00:33:49,279
planet rather in the

881
00:33:53,509 --> 00:33:51,600
in the solar system so so how can we

882
00:33:55,430 --> 00:33:53,519
take advantage of what's there on mars

883
00:33:56,630 --> 00:33:55,440
and how can we move forward so i think

884
00:33:58,470 --> 00:33:56,640
the first thing we ought to talk a

885
00:34:01,110 --> 00:33:58,480
little bit about is why why do we do

886
00:34:02,710 --> 00:34:01,120
human exploration you know john showed a

887
00:34:06,710 --> 00:34:02,720
tremendous

888
00:34:08,710 --> 00:34:06,720

what's occurred on mars if you look at

889
00:34:11,349 --> 00:34:08,720
what's occurred from the 60s through

890
00:34:13,270 --> 00:34:11,359
today our knowledge has really advanced

891
00:34:15,990 --> 00:34:13,280
tremendously on mars through robotic

892
00:34:18,950 --> 00:34:16,000
exploration so i think of scientific and

893
00:34:20,950 --> 00:34:18,960
human exploration and pioneering is as

894
00:34:22,869 --> 00:34:20,960
marking advancing civilizations and

895
00:34:24,629 --> 00:34:22,879
extending human presence you know

896
00:34:27,349 --> 00:34:24,639
expands our knowledge fuels the

897
00:34:29,430 --> 00:34:27,359
imagination spurs commerce but it does

898
00:34:30,869 --> 00:34:29,440
require risk acceptance

899
00:34:32,470 --> 00:34:30,879
the other term that i'm kind of bringing

900
00:34:35,270 --> 00:34:32,480
out in here that you maybe haven't seen

901
00:34:37,430 --> 00:34:35,280
before is i talk about pioneering and

902
00:34:39,430 --> 00:34:37,440
and that's brought out purposely because

903
00:34:42,149 --> 00:34:39,440
i believe that the amount of effort it

904
00:34:43,909 --> 00:34:42,159
takes to send humans to mars

905
00:34:46,069 --> 00:34:43,919
shouldn't be an exploration activity i

906
00:34:47,829 --> 00:34:46,079
think of exploration as you go out you

907
00:34:50,069 --> 00:34:47,839
visit something you learn something new

908
00:34:52,310 --> 00:34:50,079
and you come back i think of pioneering

909
00:34:54,310 --> 00:34:52,320
as we're actually making a step to move

910
00:34:56,149 --> 00:34:54,320
out with the intent to actually stay for

911
00:34:58,230 --> 00:34:56,159
an extended period of time so i'm trying

912
00:35:00,630 --> 00:34:58,240
to change the rhetoric a little bit so

913
00:35:02,390 --> 00:35:00,640

we talk about thinking about pioneering

914
00:35:04,150 --> 00:35:02,400
mars are going with the idea that we

915
00:35:05,829 --> 00:35:04,160
will stay with an extended human

916
00:35:07,430 --> 00:35:05,839
presence for an extended period of time

917
00:35:10,230 --> 00:35:07,440
and take advantage of the earth-like

918
00:35:12,470 --> 00:35:10,240
properties of mars as we move forward i

919
00:35:13,750 --> 00:35:12,480
think again exploration and pioneering

920
00:35:16,150 --> 00:35:13,760
leverages

921
00:35:17,990 --> 00:35:16,160
really powerful motivations for us it

922
00:35:19,589 --> 00:35:18,000
ignites our imaginations it makes us

923
00:35:21,910 --> 00:35:19,599
think of things impossible think of

924
00:35:24,069 --> 00:35:21,920
things in different ways i mean it leads

925
00:35:26,150 --> 00:35:24,079
to discovery and science and technology

926
00:35:28,150 --> 00:35:26,160
advances and we'll hear again from mike

927
00:35:29,510 --> 00:35:28,160
gazerick later about the the technology

928
00:35:32,390 --> 00:35:29,520
that's required to make these things

929
00:35:34,550 --> 00:35:32,400
happen it also creates a better vision

930
00:35:35,750 --> 00:35:34,560
of a better future for next generations

931
00:35:37,430 --> 00:35:35,760
we look at what we can do with our

932
00:35:39,670 --> 00:35:37,440
technology and how we can keep humans

933
00:35:41,270 --> 00:35:39,680
alive in this environment if you think

934
00:35:42,950 --> 00:35:41,280
back many of the problems we're trying

935
00:35:44,550 --> 00:35:42,960
to solve in the martian environment we

936
00:35:46,069 --> 00:35:44,560
will be trying to solve here on earth so

937
00:35:48,310 --> 00:35:46,079
there's a lot of things that we learn

938
00:35:50,550 --> 00:35:48,320

that affect us every day today on earth

939
00:35:52,790 --> 00:35:50,560
that we can learn by going to mars

940
00:35:54,390 --> 00:35:52,800
you know and then again as it's clearly

941
00:35:56,870 --> 00:35:54,400
evidence from from both what john's

942
00:35:58,390 --> 00:35:56,880
saying and what i'm saying is that this

943
00:36:00,150 --> 00:35:58,400
exploration is really done in

944
00:36:02,230 --> 00:36:00,160
partnership you know robotics they

945
00:36:04,470 --> 00:36:02,240
explore the distance hazard hazardous

946
00:36:06,150 --> 00:36:04,480
environments they extend our scientific

947
00:36:08,310 --> 00:36:06,160
knowledge our understanding our planning

948
00:36:09,829 --> 00:36:08,320
for the human missions that will follow

949
00:36:11,910 --> 00:36:09,839
but then the human explorers they

950
00:36:14,310 --> 00:36:11,920
provide greater speed

951
00:36:16,069 --> 00:36:14,320
intuitive ease and efficiency as they do

952
00:36:17,910 --> 00:36:16,079
the exploration and i think you can see

953
00:36:19,349 --> 00:36:17,920
that again as you contrast what we did

954
00:36:21,670 --> 00:36:19,359
on the moon and what we're doing with

955
00:36:24,230 --> 00:36:21,680
the rovers on mars today if you look at

956
00:36:25,750 --> 00:36:24,240
where the the human rovers have driven

957
00:36:27,270 --> 00:36:25,760
around on the surface of the moon

958
00:36:29,190 --> 00:36:27,280
compared to the distances that the

959
00:36:30,790 --> 00:36:29,200
robotic rovers have done the moon

960
00:36:33,030 --> 00:36:30,800
exploration with the human actually

961
00:36:35,270 --> 00:36:33,040
there driving dramatically increases the

962
00:36:35,990 --> 00:36:35,280
amount of area we were able to cover

963
00:36:38,630 --> 00:36:36,000

the

964
00:36:40,230 --> 00:36:38,640
geologists in place can actually go find

965
00:36:42,630 --> 00:36:40,240
interesting rocks that are there they're

966
00:36:45,190 --> 00:36:42,640
immediately intuitive to it to a human

967
00:36:47,349 --> 00:36:45,200
so so cutting that time delay between

968
00:36:49,349 --> 00:36:47,359
when the investigator or the researcher

969
00:36:51,589 --> 00:36:49,359
sees the data is really important and

970
00:36:53,190 --> 00:36:51,599
putting the humans there but to do that

971
00:36:54,630 --> 00:36:53,200
we have to understand the environment we

972
00:36:57,109 --> 00:36:54,640
need to do things like we're doing with

973
00:36:59,109 --> 00:36:57,119
the radiation monitor on on the surface

974
00:37:00,790 --> 00:36:59,119
of mars today so we can understand what

975
00:37:02,390 --> 00:37:00,800
that environment is so the risks are

976
00:37:04,790 --> 00:37:02,400
reasonable for us to go do these

977
00:37:07,510 --> 00:37:04,800
activities and in a human

978
00:37:09,829 --> 00:37:07,520
human human space exploration really you

979
00:37:10,790 --> 00:37:09,839
know garners national prestige it unites

980
00:37:12,230 --> 00:37:10,800
nations

981
00:37:13,750 --> 00:37:12,240
around the common goal and there's

982
00:37:15,190 --> 00:37:13,760
probably no better example of that than

983
00:37:16,870 --> 00:37:15,200
the international space station and the

984
00:37:19,349 --> 00:37:16,880
partnership that's working and operating

985
00:37:21,190 --> 00:37:19,359
in space today so again we build on our

986
00:37:23,109 --> 00:37:21,200
investments in technology robotics

987
00:37:25,030 --> 00:37:23,119
missions international space station

988
00:37:26,630 --> 00:37:25,040

commercial crew and cargo space launch

989
00:37:29,270 --> 00:37:26,640
systems and orion

990
00:37:31,270 --> 00:37:29,280
and america is poised to lead the next

991
00:37:33,349 --> 00:37:31,280
wave of partnerships for international

992
00:37:35,109 --> 00:37:33,359
science and human space exploration i

993
00:37:36,310 --> 00:37:35,119
mean if you look at all those words that

994
00:37:38,310 --> 00:37:36,320
are down there in that bottom little

995
00:37:40,069 --> 00:37:38,320
phrase every one of them is in the is a

996
00:37:42,069 --> 00:37:40,079
human exploration operations mission

997
00:37:43,910 --> 00:37:42,079
directorate so we don't have a single

998
00:37:45,990 --> 00:37:43,920
program we're really linked as an

999
00:37:48,150 --> 00:37:46,000
overall series of programs all pushing

1000
00:37:49,750 --> 00:37:48,160
human presence into the solar system

1001
00:37:51,829 --> 00:37:49,760
next

1002
00:37:53,910 --> 00:37:51,839
this is a chart that john used

1003
00:37:55,829 --> 00:37:53,920
again i think that this is not a single

1004
00:37:57,670 --> 00:37:55,839
directorate activity we need to really

1005
00:37:59,349 --> 00:37:57,680
look at at the way we're working

1006
00:38:00,790 --> 00:37:59,359
together and and i would say on this

1007
00:38:02,950 --> 00:38:00,800
chart we probably ought to update the

1008
00:38:04,790 --> 00:38:02,960
chart where it says future it really the

1009
00:38:06,470 --> 00:38:04,800
future is now we are really working

1010
00:38:08,150 --> 00:38:06,480
together with the space technology

1011
00:38:10,069 --> 00:38:08,160
mission directorate the science mission

1012
00:38:11,750 --> 00:38:10,079
directorate and human exploration to

1013
00:38:13,349 --> 00:38:11,760

look at ways that we can break down

1014
00:38:15,430 --> 00:38:13,359
barriers between our directors where we

1015
00:38:17,670 --> 00:38:15,440
used to work in single activities how we

1016
00:38:20,150 --> 00:38:17,680
can combine those activities and it

1017
00:38:21,910 --> 00:38:20,160
really started many you know it's been

1018
00:38:23,589 --> 00:38:21,920
going on for a long period of time but i

1019
00:38:25,430 --> 00:38:23,599
think we're doing it even more now as

1020
00:38:27,190 --> 00:38:25,440
you see the radiation monitor and and

1021
00:38:29,190 --> 00:38:27,200
you saw on the heat shield that was used

1022
00:38:30,950 --> 00:38:29,200
for curiosity rover we flew some

1023
00:38:32,790 --> 00:38:30,960
aerodynamic uh

1024
00:38:34,390 --> 00:38:32,800
probes to actually measure the martian

1025
00:38:35,990 --> 00:38:34,400
atmosphere to look at how we might land

1026
00:38:38,630 --> 00:38:36,000
large objects in large cargo on the

1027
00:38:41,190 --> 00:38:38,640
surface of mars next

1028
00:38:43,349 --> 00:38:41,200
and it's not only a u.s activity this is

1029
00:38:46,950 --> 00:38:43,359
a chart from the global exploration

1030
00:38:48,870 --> 00:38:46,960
roadmap it's built by the u.s and 11

1031
00:38:50,710 --> 00:38:48,880
other partners it shows that there's a

1032
00:38:53,430 --> 00:38:50,720
general consensus on what we're doing

1033
00:38:56,470 --> 00:38:53,440
moving forward it's not a plan it's not

1034
00:38:57,829 --> 00:38:56,480
a detailed investigation but it provides

1035
00:38:59,030 --> 00:38:57,839
a general framework of what we're

1036
00:39:00,950 --> 00:38:59,040
interested in doing it shows the

1037
00:39:02,630 --> 00:39:00,960
international space station which is

1038
00:39:04,470 --> 00:39:02,640

critically important to us today you'll

1039
00:39:05,750 --> 00:39:04,480
hear some more about that later this

1040
00:39:07,270 --> 00:39:05,760
afternoon

1041
00:39:09,109 --> 00:39:07,280
space station lets us understand the

1042
00:39:10,470 --> 00:39:09,119
microgravity environment how it affects

1043
00:39:12,310 --> 00:39:10,480
the human

1044
00:39:13,670 --> 00:39:12,320
it also lets us understand how hardware

1045
00:39:14,950 --> 00:39:13,680
performs in the

1046
00:39:16,870 --> 00:39:14,960
in the

1047
00:39:19,109 --> 00:39:16,880
microgravity environment and in a space

1048
00:39:20,710 --> 00:39:19,119
environment it'll let us gain knowledge

1049
00:39:23,030 --> 00:39:20,720
about life support systems to keep

1050
00:39:25,109 --> 00:39:23,040
humans alive tremendously important to

1051
00:39:27,270 --> 00:39:25,119
what we're doing going forward

1052
00:39:29,829 --> 00:39:27,280
in the middle you can see a series of

1053
00:39:31,829 --> 00:39:29,839
robotic missions and and projects and

1054
00:39:33,589 --> 00:39:31,839
those allow us to get prepared you know

1055
00:39:37,190 --> 00:39:33,599
we're looking again internationally it's

1056
00:39:38,710 --> 00:39:37,200
not just one nation's robot or activity

1057
00:39:40,790 --> 00:39:38,720
that's going to mars how can we put

1058
00:39:42,870 --> 00:39:40,800
other experiments on on other payloads

1059
00:39:44,390 --> 00:39:42,880
other planetary things to just continue

1060
00:39:45,910 --> 00:39:44,400
to bring back knowledge

1061
00:39:48,390 --> 00:39:45,920
and then lastly we talk about the

1062
00:39:50,069 --> 00:39:48,400
missions beyond low earth orbit

1063
00:39:51,589 --> 00:39:50,079

we talk about the asteroid redirect

1064
00:39:54,550 --> 00:39:51,599
mission you'll hear about that again

1065
00:39:56,630 --> 00:39:54,560
today that allows us to go into this

1066
00:39:58,310 --> 00:39:56,640
proving ground of space or lets us hone

1067
00:40:00,790 --> 00:39:58,320
the skills that we need to really get

1068
00:40:02,870 --> 00:40:00,800
prepared to go to mars it will be not

1069
00:40:05,030 --> 00:40:02,880
easy going to mars in any way shape or

1070
00:40:07,190 --> 00:40:05,040
form and we need to really prepare to do

1071
00:40:09,589 --> 00:40:07,200
that we do that preparation first on the

1072
00:40:11,349 --> 00:40:09,599
space station then we push the envelope

1073
00:40:13,589 --> 00:40:11,359
a little bit further look at the

1074
00:40:15,430 --> 00:40:13,599
vicinity around the moon where we can

1075
00:40:17,030 --> 00:40:15,440
have this asteroid redirected in this

1076
00:40:18,630 --> 00:40:17,040
location to continue to build those

1077
00:40:20,309 --> 00:40:18,640
skills that

1078
00:40:22,630 --> 00:40:20,319
are necessary for us to eventually go to

1079
00:40:24,390 --> 00:40:22,640
mars next

1080
00:40:26,390 --> 00:40:24,400
and this is the same the same chart i

1081
00:40:29,829 --> 00:40:26,400
think that charlie used and is basically

1082
00:40:32,390 --> 00:40:29,839
on the on the scorecard um again you can

1083
00:40:34,470 --> 00:40:32,400
you can look at it again uh the low

1084
00:40:36,630 --> 00:40:34,480
earth orbit activity that's the earth

1085
00:40:38,710 --> 00:40:36,640
reliant place where we can get back if

1086
00:40:40,950 --> 00:40:38,720
we need to from space station we can

1087
00:40:42,309 --> 00:40:40,960
bring supplies up very easily

1088
00:40:44,069 --> 00:40:42,319

then we go to this proving ground to

1089
00:40:46,630 --> 00:40:44,079
space where now it's more difficult to

1090
00:40:48,309 --> 00:40:46,640
get to we need to home our skills and in

1091
00:40:50,790 --> 00:40:48,319
the proving ground to space much like we

1092
00:40:53,510 --> 00:40:50,800
did with the mercury and gemini as

1093
00:40:55,430 --> 00:40:53,520
leading up to apogo we we build skills

1094
00:40:57,910 --> 00:40:55,440
we build techniques we build operational

1095
00:40:59,430 --> 00:40:57,920
techniques in this region so we we're

1096
00:41:01,990 --> 00:40:59,440
really preparing ourselves with that

1097
00:41:03,750 --> 00:41:02,000
ultimate goal towards mars and and you

1098
00:41:06,790 --> 00:41:03,760
know the mars chart is is interesting

1099
00:41:08,069 --> 00:41:06,800
you see the four sls rockets essentially

1100
00:41:10,470 --> 00:41:08,079
being launched from the earth heading

1101
00:41:12,710 --> 00:41:10,480
towards mars you know some folks said it

1102
00:41:14,870 --> 00:41:12,720
looks like we're attacking mars

1103
00:41:17,030 --> 00:41:14,880
that's that's not really the intent the

1104
00:41:19,270 --> 00:41:17,040
intent is to show how complex it is to

1105
00:41:21,190 --> 00:41:19,280
to actually put some kind of capability

1106
00:41:23,190 --> 00:41:21,200
on mars you know john showed some

1107
00:41:25,750 --> 00:41:23,200
extremely interesting pictures could we

1108
00:41:27,750 --> 00:41:25,760
take advantage of the lava tubes etc on

1109
00:41:30,230 --> 00:41:27,760
mars if we put some capability down

1110
00:41:31,750 --> 00:41:30,240
ahead of time before crews go how do we

1111
00:41:33,670 --> 00:41:31,760
do that and we need this heavy lift

1112
00:41:35,670 --> 00:41:33,680
launch vehicle and on the order of four

1113
00:41:37,270 --> 00:41:35,680

or five heavy lift launch vehicles to

1114
00:41:39,510 --> 00:41:37,280
actually get that infrastructure in

1115
00:41:41,030 --> 00:41:39,520
place for humans to go there to to

1116
00:41:42,950 --> 00:41:41,040
reside for a period of time and then

1117
00:41:44,630 --> 00:41:42,960
then come back so again

1118
00:41:46,390 --> 00:41:44,640
i think you can look at this as an

1119
00:41:48,390 --> 00:41:46,400
expanding presence we can continue to

1120
00:41:50,390 --> 00:41:48,400
make significant progress i think you'll

1121
00:41:52,630 --> 00:41:50,400
hear later today how all these pieces

1122
00:41:54,309 --> 00:41:52,640
really link together so they appear

1123
00:41:56,470 --> 00:41:54,319
disconnected they appear that they're

1124
00:41:58,550 --> 00:41:56,480
not really linked but but they truly are

1125
00:42:00,150 --> 00:41:58,560
linked commercial crew commercial cargo

1126
00:42:02,230 --> 00:42:00,160
is extremely important in low earth

1127
00:42:04,390 --> 00:42:02,240
orbit it relieves us of the burden to

1128
00:42:06,950 --> 00:42:04,400
take supplies to station allows us to

1129
00:42:08,870 --> 00:42:06,960
get cargo to station without us having

1130
00:42:10,230 --> 00:42:08,880
to build new systems and develop systems

1131
00:42:12,550 --> 00:42:10,240
those are available from commercial

1132
00:42:13,990 --> 00:42:12,560
industry space station lets us work

1133
00:42:15,670 --> 00:42:14,000
internationally with our partners it

1134
00:42:17,750 --> 00:42:15,680
lets us build these skills for the human

1135
00:42:19,750 --> 00:42:17,760
side provides drake benefits to us here

1136
00:42:22,710 --> 00:42:19,760
on the earth lets us experiment with

1137
00:42:24,710 --> 00:42:22,720
technology the asteroid redirect mission

1138
00:42:26,790 --> 00:42:24,720

places us in cis lunar space where we

1139
00:42:28,950 --> 00:42:26,800
are now four or five days away it

1140
00:42:30,790 --> 00:42:28,960
increases the risk environment

1141
00:42:32,950 --> 00:42:30,800
requires us to do now automated

1142
00:42:35,109 --> 00:42:32,960
rendezvous without communications back

1143
00:42:36,390 --> 00:42:35,119
to the earth potentially pushes us on

1144
00:42:38,150 --> 00:42:36,400
the other side of the moon where we

1145
00:42:40,150 --> 00:42:38,160
start having periods of no communication

1146
00:42:42,790 --> 00:42:40,160
with the ground starts breaking that tie

1147
00:42:45,190 --> 00:42:42,800
with the earth lets us get skilled and

1148
00:42:47,990 --> 00:42:45,200
ready to go do that next step which is

1149
00:42:49,430 --> 00:42:48,000
which is mars ready or earth independent

1150
00:42:51,190 --> 00:42:49,440
when we're really ready to break that

1151
00:42:53,510 --> 00:42:51,200
tie with the home planet and move out to

1152
00:42:55,670 --> 00:42:53,520
mars so it should be interesting as you

1153
00:42:57,829 --> 00:42:55,680
listen to all the groups today and and

1154
00:42:59,750 --> 00:42:57,839
think of how you can be part of this

1155
00:43:09,589 --> 00:42:59,760
activity and how you can contribute to

1156
00:43:12,630 --> 00:43:10,870
able to stick around a couple of minutes

1157
00:43:14,950 --> 00:43:12,640
to take questions here great we'll break

1158
00:43:16,710 --> 00:43:14,960
for q a right after this panel

1159
00:43:18,550 --> 00:43:16,720
uh before we do that let me ask our

1160
00:43:21,270 --> 00:43:18,560
panelists to us to begin to come up and

1161
00:43:23,190 --> 00:43:21,280
take their seats if you would

1162
00:43:25,109 --> 00:43:23,200
great uh just a quick reminder we'll

1163
00:43:26,069 --> 00:43:25,119

we'll break for q a directly after this

1164
00:43:27,430 --> 00:43:26,079
panel you're going to see number of

1165
00:43:29,829 --> 00:43:27,440
presentations today you've seen quite a

1166
00:43:32,790 --> 00:43:29,839
few excellent ones already those will be

1167
00:43:35,030 --> 00:43:32,800
archived later at nasa.gov

1168
00:43:36,870 --> 00:43:35,040
exploration

1169
00:43:39,109 --> 00:43:36,880
if you have questions for us for any of

1170
00:43:41,109 --> 00:43:39,119
the speakers so far you can ask us those

1171
00:43:42,710 --> 00:43:41,119
questions on twitter using the hashtag

1172
00:43:44,870 --> 00:43:42,720
ask nasa of course you can find out more

1173
00:43:46,950 --> 00:43:44,880
information about nasa's exploration

1174
00:43:48,870 --> 00:43:46,960
plans at nasa.gov

1175
00:43:52,150 --> 00:43:48,880
exploration and again the hashtag for

1176
00:43:54,230 --> 00:43:52,160
today is mars if you're joining online

1177
00:43:56,550 --> 00:43:54,240
it's my pleasure to introduce our next

1178
00:43:58,069 --> 00:43:56,560
distinguished panel uh representing

1179
00:43:59,750 --> 00:43:58,079
different offices and divisions and the

1180
00:44:01,670 --> 00:43:59,760
human exploration operations mission

1181
00:44:02,950 --> 00:44:01,680
directorate here in washington uh

1182
00:44:05,349 --> 00:44:02,960
they're here to talk to us a little bit

1183
00:44:07,430 --> 00:44:05,359
about the portfolio of human exploration

1184
00:44:08,470 --> 00:44:07,440
operations or what we call heo and how

1185
00:44:11,190 --> 00:44:08,480
it relates to the ultimate goal of

1186
00:44:12,950 --> 00:44:11,200
sending humans to mars to my left is sam

1187
00:44:14,390 --> 00:44:12,960
shimini he is the director for the

1188
00:44:15,750 --> 00:44:14,400

international space station here at nasa

1189
00:44:17,510 --> 00:44:15,760
headquarters

1190
00:44:19,030 --> 00:44:17,520
he has 27 years of experience in human

1191
00:44:20,550 --> 00:44:19,040
space flight earth and space science

1192
00:44:22,790 --> 00:44:20,560
missions his background spans

1193
00:44:24,950 --> 00:44:22,800
development of complex space systems

1194
00:44:27,750 --> 00:44:24,960
testing in extreme conditions in

1195
00:44:29,270 --> 00:44:27,760
real-time crew operations he's been

1196
00:44:31,349 --> 00:44:29,280
employed at four different nasa centers

1197
00:44:33,270 --> 00:44:31,359
johnson space center in houston ames of

1198
00:44:35,109 --> 00:44:33,280
course in california goddard space

1199
00:44:36,630 --> 00:44:35,119
flight center right down the road

1200
00:44:38,309 --> 00:44:36,640
here in greenbelt and here at nasa

1201
00:44:40,150 --> 00:44:38,319
headquarters he's also been a part of

1202
00:44:41,430 --> 00:44:40,160
many programs here at nasa including the

1203
00:44:42,950 --> 00:44:41,440
space shuttle international space

1204
00:44:44,710 --> 00:44:42,960
station programs

1205
00:44:46,069 --> 00:44:44,720
next to sam is phil mcallister phil is

1206
00:44:48,150 --> 00:44:46,079
the director of the commercial space

1207
00:44:50,150 --> 00:44:48,160
flight division here at nasa he has more

1208
00:44:51,990 --> 00:44:50,160
than 20 years of experience in civil

1209
00:44:53,589 --> 00:44:52,000
military and commercial space programs

1210
00:44:54,950 --> 00:44:53,599
he currently oversees management of

1211
00:44:56,710 --> 00:44:54,960
nasa's commercial crew and cargo

1212
00:44:58,550 --> 00:44:56,720
programs throughout his career he's

1213
00:45:01,109 --> 00:44:58,560

participated in the development of new

1214
00:45:02,470 --> 00:45:01,119
launch vehicles rockets the redesign of

1215
00:45:04,309 --> 00:45:02,480
the international space station and the

1216
00:45:05,510 --> 00:45:04,319
advancement of several commercial space

1217
00:45:08,230 --> 00:45:05,520
ventures

1218
00:45:09,910 --> 00:45:08,240
next to phil is dan dunbacher dan is the

1219
00:45:12,150 --> 00:45:09,920
deputy associate administrator for

1220
00:45:14,150 --> 00:45:12,160
exploration systems development dan has

1221
00:45:16,630 --> 00:45:14,160
more than 30 years at nasa i'm sorry to

1222
00:45:18,309 --> 00:45:16,640
say he recently announced he is retiring

1223
00:45:19,990 --> 00:45:18,319
going to embarrass him here for a second

1224
00:45:21,589 --> 00:45:20,000
to return to his alma mater at purdue

1225
00:45:22,710 --> 00:45:21,599
it's very much our loss uh but i'm

1226
00:45:24,470 --> 00:45:22,720
really happy he was able to join us

1227
00:45:25,829 --> 00:45:24,480
today and talk about the work he's been

1228
00:45:27,750 --> 00:45:25,839
managing on the space launch system

1229
00:45:29,829 --> 00:45:27,760
rocket and orion spacecraft that'll

1230
00:45:32,150 --> 00:45:29,839
carry humans farther into space than

1231
00:45:34,150 --> 00:45:32,160
ever before including to mars next to

1232
00:45:37,030 --> 00:45:34,160
dan is michelle gates senior technical

1233
00:45:38,790 --> 00:45:37,040
advisor for heo she has more than 20

1234
00:45:40,710 --> 00:45:38,800
years of experience at nasa in this role

1235
00:45:42,069 --> 00:45:40,720
she provides overall advice and support

1236
00:45:44,790 --> 00:45:42,079
to mr gerstenmaier our associate

1237
00:45:46,870 --> 00:45:44,800
administrator across a broad array of

1238
00:45:48,230 --> 00:45:46,880

strategic and tactical issues affecting

1239
00:45:50,069 --> 00:45:48,240
the mission directorate she provided

1240
00:45:52,230 --> 00:45:50,079
critical support to the implementation

1241
00:45:53,910 --> 00:45:52,240
of a flexible sustainable human

1242
00:45:55,829 --> 00:45:53,920
spaceflight program portfolio you'll

1243
00:45:57,270 --> 00:45:55,839
hear more about that including both

1244
00:45:59,109 --> 00:45:57,280
government commercially owned operated

1245
00:46:00,710 --> 00:45:59,119
elements during the transition

1246
00:46:01,990 --> 00:46:00,720
from the space shuttle program she also

1247
00:46:03,990 --> 00:46:02,000
represents the direct written

1248
00:46:05,589 --> 00:46:04,000
cross-cutting agency initiatives which

1249
00:46:07,270 --> 00:46:05,599
includes most recently the asteroid

1250
00:46:09,030 --> 00:46:07,280
redirect mission

1251
00:46:10,630 --> 00:46:09,040
finally we have jason kruzan who's the

1252
00:46:11,990 --> 00:46:10,640
director of the advanced exploration

1253
00:46:14,470 --> 00:46:12,000
systems division

1254
00:46:16,470 --> 00:46:14,480
in this capacity jason jason oversees

1255
00:46:18,390 --> 00:46:16,480
aes portfolio which pioneers new

1256
00:46:20,470 --> 00:46:18,400
approaches for rapidly developing

1257
00:46:22,470 --> 00:46:20,480
prototype systems demonstrating key

1258
00:46:24,470 --> 00:46:22,480
capabilities and validating operational

1259
00:46:25,829 --> 00:46:24,480
concepts for future human missions

1260
00:46:27,510 --> 00:46:25,839
beyond low earth orbit those are

1261
00:46:29,190 --> 00:46:27,520
complicated words basically if it looks

1262
00:46:31,109 --> 00:46:29,200
like sci-fi it's really cool and long

1263
00:46:34,550 --> 00:46:31,119

lead it's probably jason working on it

1264
00:46:36,550 --> 00:46:34,560
so with that i will hand it over to sam

1265
00:46:42,870 --> 00:46:36,560
thank you trent

1266
00:46:46,230 --> 00:46:45,430
all right i'm going to uh follow up

1267
00:46:48,550 --> 00:46:46,240
where

1268
00:46:50,230 --> 00:46:48,560
gerst and john and charlie left off

1269
00:46:52,069 --> 00:46:50,240
talking about space station and how

1270
00:46:55,109 --> 00:46:52,079
we're utilizing the space station to get

1271
00:46:56,390 --> 00:46:55,119
us beyond low earth orbit next slide

1272
00:46:57,750 --> 00:46:56,400
as charlie mentioned

1273
00:47:00,069 --> 00:46:57,760
station

1274
00:47:02,550 --> 00:47:00,079
we've agreed to extend it for at least

1275
00:47:04,230 --> 00:47:02,560
another 10 years and

1276
00:47:06,069 --> 00:47:04,240
what we're doing on station is directly

1277
00:47:08,630 --> 00:47:06,079
linked to deep space

1278
00:47:10,790 --> 00:47:08,640
human space flight beyond north orbit

1279
00:47:13,349 --> 00:47:10,800
and to the development of the commercial

1280
00:47:16,069 --> 00:47:13,359
low earth orbit market uh for all the

1281
00:47:18,390 --> 00:47:16,079
capabilities that we use uh in human

1282
00:47:20,950 --> 00:47:18,400
space flight next slide

1283
00:47:22,630 --> 00:47:20,960
uh you've seen this before from from uh

1284
00:47:24,390 --> 00:47:22,640
mr gestermeier

1285
00:47:25,829 --> 00:47:24,400
i want to focus on a little bit

1286
00:47:27,510 --> 00:47:25,839
on what space station is if you look

1287
00:47:30,309 --> 00:47:27,520
down at the bottom of that of that slide

1288
00:47:32,230 --> 00:47:30,319

and look at the time periods uh that we

1289
00:47:35,030 --> 00:47:32,240
are actually spinning in space on space

1290
00:47:37,349 --> 00:47:35,040
station we are currently we have six

1291
00:47:39,109 --> 00:47:37,359
month duration crew expeditions next

1292
00:47:41,349 --> 00:47:39,119
year about this time we'll start our one

1293
00:47:44,630 --> 00:47:41,359
for our first one year expedition cruise

1294
00:47:46,549 --> 00:47:44,640
and the systems that's needed to keep

1295
00:47:48,069 --> 00:47:46,559
crews alive

1296
00:47:50,390 --> 00:47:48,079
where it shows earthly line i'll show

1297
00:47:53,430 --> 00:47:50,400
you this we are really earth-reliant and

1298
00:47:55,750 --> 00:47:53,440
when you get out to the mars time frame

1299
00:47:58,069 --> 00:47:55,760
in the 2030s our missions are two to

1300
00:47:59,990 --> 00:47:58,079
three years in length to keep crews

1301
00:48:01,670 --> 00:48:00,000
alive so it's a large gap between where

1302
00:48:03,190 --> 00:48:01,680
we are today with space station and

1303
00:48:06,630 --> 00:48:03,200
human space flight and where we needed

1304
00:48:08,710 --> 00:48:06,640
to go for from ours next slide

1305
00:48:10,309 --> 00:48:08,720
so this is sort of a graphic

1306
00:48:12,230 --> 00:48:10,319
if you look at the bottom caption there

1307
00:48:13,270 --> 00:48:12,240
we're basically car camping in space

1308
00:48:15,109 --> 00:48:13,280
right now

1309
00:48:18,390 --> 00:48:15,119
everything that we need to keep crews

1310
00:48:20,870 --> 00:48:18,400
alive in space is very close by round

1311
00:48:23,190 --> 00:48:20,880
trip times to space station is within

1312
00:48:25,109 --> 00:48:23,200
two days our communications is near real

1313
00:48:27,510 --> 00:48:25,119

time it's you might as well just be

1314
00:48:30,630 --> 00:48:27,520
on a phone our we have con we have crew

1315
00:48:33,750 --> 00:48:30,640
exchanges four times a year uh we have

1316
00:48:36,309 --> 00:48:33,760
uh up to 15 flights to space station

1317
00:48:38,710 --> 00:48:36,319
with crews and supplies

1318
00:48:41,190 --> 00:48:38,720
and we also get all our medical in uh

1319
00:48:42,870 --> 00:48:41,200
samples and atmospheric samples and our

1320
00:48:45,109 --> 00:48:42,880
research samples that come back to the

1321
00:48:47,030 --> 00:48:45,119
earth when we go to mars these things

1322
00:48:48,390 --> 00:48:47,040
really don't exist

1323
00:48:50,230 --> 00:48:48,400
we also have a convenient way to get rid

1324
00:48:51,910 --> 00:48:50,240
of trash we can take trash off the space

1325
00:48:54,470 --> 00:48:51,920
station put it in our commercial

1326
00:48:57,430 --> 00:48:54,480
vehicles and then burn them up in in

1327
00:48:59,829 --> 00:48:57,440
orbit if you go to the next slide

1328
00:49:01,990 --> 00:48:59,839
going to mars we have none of that in

1329
00:49:04,470 --> 00:49:02,000
fact our communications are quite

1330
00:49:07,190 --> 00:49:04,480
delayed it can be up to 42 minutes

1331
00:49:08,950 --> 00:49:07,200
round-trip uh communications time so to

1332
00:49:10,150 --> 00:49:08,960
go from where we are in station to go to

1333
00:49:12,630 --> 00:49:10,160
where we

1334
00:49:14,549 --> 00:49:12,640
for mars missions there's a quite a

1335
00:49:16,390 --> 00:49:14,559
large gap in what we need to learn and

1336
00:49:18,230 --> 00:49:16,400
that's what space station is all about

1337
00:49:20,069 --> 00:49:18,240
next slide

1338
00:49:22,950 --> 00:49:20,079

so what stations doing to fill in the

1339
00:49:25,030 --> 00:49:22,960
gap so we intend to demonstrate the

1340
00:49:26,710 --> 00:49:25,040
actual environmental control system that

1341
00:49:28,790 --> 00:49:26,720
will take us to mars and demonstrate it

1342
00:49:31,670 --> 00:49:28,800
on station based on what we're doing

1343
00:49:34,069 --> 00:49:31,680
today right now with our eclipse system

1344
00:49:35,990 --> 00:49:34,079
in the uh in our carbon dioxide removal

1345
00:49:37,750 --> 00:49:36,000
system we're learning what technologies

1346
00:49:39,670 --> 00:49:37,760
work which don't work same thing with

1347
00:49:42,390 --> 00:49:39,680
our carbon excuse me our oxygen

1348
00:49:44,870 --> 00:49:42,400
generation and waste management systems

1349
00:49:47,270 --> 00:49:44,880
we're learning how the humans interact

1350
00:49:49,670 --> 00:49:47,280
with these systems when you bring humans

1351
00:49:52,069 --> 00:49:49,680
you also bring all the microbiology

1352
00:49:54,309 --> 00:49:52,079
microbiology along with the humans and

1353
00:49:55,829 --> 00:49:54,319
all the interactions with stuff growing

1354
00:49:57,589 --> 00:49:55,839
inside the space station into the

1355
00:49:58,710 --> 00:49:57,599
systems to learning how to deal with

1356
00:50:00,870 --> 00:49:58,720
that

1357
00:50:05,109 --> 00:50:00,880
we're learning how all the human health

1358
00:50:06,549 --> 00:50:05,119
and performance activities uh in space

1359
00:50:07,829 --> 00:50:06,559
to keep the crews alive for long

1360
00:50:11,109 --> 00:50:07,839
durations

1361
00:50:13,990 --> 00:50:11,119
from from bone loss and muscle loss to

1362
00:50:16,710 --> 00:50:14,000
endocrine or pressure uh in in the eyes

1363
00:50:19,109 --> 00:50:16,720

issues uh and be able to to keep

1364
00:50:20,230 --> 00:50:19,119
exercise equipment going long enough

1365
00:50:23,270 --> 00:50:20,240
with

1366
00:50:24,950 --> 00:50:23,280
to keep the crews uh healthy and and

1367
00:50:26,630 --> 00:50:24,960
such we're also learning how to break

1368
00:50:29,109 --> 00:50:26,640
the bonds of earth through logistics and

1369
00:50:31,670 --> 00:50:29,119
crew health and monitoring and

1370
00:50:35,270 --> 00:50:31,680
ground to crew communications we're

1371
00:50:37,510 --> 00:50:35,280
doing simulations on how to uh do com

1372
00:50:39,510 --> 00:50:37,520
delays learning how to

1373
00:50:41,270 --> 00:50:39,520
handle logistics in a more efficient

1374
00:50:42,950 --> 00:50:41,280
manner we're also demonstrating all the

1375
00:50:45,030 --> 00:50:42,960
other technologies needed to go beyond

1376
00:50:47,510 --> 00:50:45,040
low earth orbit like next generation

1377
00:50:51,349 --> 00:50:47,520
solar arrays rendezvous sensors and

1378
00:50:52,470 --> 00:50:51,359
docking systems and the like next slide

1379
00:50:54,950 --> 00:50:52,480
you'll see these charts a little bit

1380
00:50:56,230 --> 00:50:54,960
later but i wanted a highlight on

1381
00:50:58,069 --> 00:50:56,240
station what we're doing in the earth

1382
00:51:00,950 --> 00:50:58,079
reliant in the blue section if you look

1383
00:51:02,950 --> 00:51:00,960
at all for this slide and the next slide

1384
00:51:04,950 --> 00:51:02,960
don't go there yet but working in space

1385
00:51:07,430 --> 00:51:04,960
all the things for for instance

1386
00:51:10,309 --> 00:51:07,440
communication with earth our eva

1387
00:51:12,390 --> 00:51:10,319
capabilities mobility and robotics

1388
00:51:13,829 --> 00:51:12,400

in situ utilization we're doing

1389
00:51:15,270 --> 00:51:13,839
a lot of things on space station and

1390
00:51:17,270 --> 00:51:15,280
research and technology development to

1391
00:51:18,549 --> 00:51:17,280
support those activities same thing with

1392
00:51:20,470 --> 00:51:18,559
the next slide

1393
00:51:22,710 --> 00:51:20,480
staying healthy

1394
00:51:24,390 --> 00:51:22,720
our hrp program and other programs we

1395
00:51:26,150 --> 00:51:24,400
have on station is really geared towards

1396
00:51:28,150 --> 00:51:26,160
keeping our crews healthy

1397
00:51:30,309 --> 00:51:28,160
and productive in orbit

1398
00:51:33,030 --> 00:51:30,319
next slide

1399
00:51:34,069 --> 00:51:33,040
so what we're doing on space station is

1400
00:51:36,309 --> 00:51:34,079
not only

1401
00:51:37,990 --> 00:51:36,319
related to deep space exploration but

1402
00:51:39,190 --> 00:51:38,000
it's also related to the development of

1403
00:51:41,750 --> 00:51:39,200
low earth orbit

1404
00:51:44,069 --> 00:51:41,760
commercialization of a market driven

1405
00:51:45,910 --> 00:51:44,079
activity all the things we need to keep

1406
00:51:47,589 --> 00:51:45,920
crews in space for long durations is

1407
00:51:48,549 --> 00:51:47,599
also the same things we need to keep

1408
00:51:50,150 --> 00:51:48,559
crews

1409
00:51:53,589 --> 00:51:50,160
safe in low earth orbit things like

1410
00:51:55,430 --> 00:51:53,599
habitation structures eclipse systems uh

1411
00:51:57,190 --> 00:51:55,440
crew health and monitoring

1412
00:51:58,309 --> 00:51:57,200
things like medical equipment exercise

1413
00:52:00,470 --> 00:51:58,319

equipment

1414
00:52:02,630 --> 00:52:00,480
eva support systems

1415
00:52:05,750 --> 00:52:02,640
spacecraft systems like avionics and

1416
00:52:07,430 --> 00:52:05,760
electrical power and things like car go

1417
00:52:09,589 --> 00:52:07,440
supply and and

1418
00:52:11,589 --> 00:52:09,599
and crew supply all those things were

1419
00:52:14,470 --> 00:52:11,599
actually working out on space station

1420
00:52:17,190 --> 00:52:14,480
that will enable both uh exploration of

1421
00:52:19,990 --> 00:52:17,200
mars and the development of the low

1422
00:52:21,589 --> 00:52:20,000
orbit uh commercial market

1423
00:52:23,030 --> 00:52:21,599
and next slide and i believe that's all

1424
00:52:24,790 --> 00:52:23,040
i've got

1425
00:52:26,470 --> 00:52:24,800
do i have thanks sam do i have time for

1426
00:52:27,990 --> 00:52:26,480
questions well i will break as soon as

1427
00:52:30,549 --> 00:52:28,000
the panel's over we'll take 10 to 15

1428
00:52:33,750 --> 00:52:30,559
minutes as time allows to take questions

1429
00:52:35,510 --> 00:52:33,760
go ahead phil so thanks trent i'm here

1430
00:52:39,190 --> 00:52:35,520
to talk about our commercial space

1431
00:52:40,710 --> 00:52:39,200
flight initiatives at nasa and uh

1432
00:52:43,030 --> 00:52:40,720
really demonstrate that this is an

1433
00:52:44,870 --> 00:52:43,040
integrated strategy for nasa our

1434
00:52:47,750 --> 00:52:44,880
commercial space flight initiatives are

1435
00:52:50,549 --> 00:52:47,760
really enabling nasa and the nation to

1436
00:52:53,270 --> 00:52:50,559
do much more what we're finding is that

1437
00:52:55,270 --> 00:52:53,280
nasa doesn't need to do everything we

1438
00:52:58,150 --> 00:52:55,280

can rely on the private sector now to

1439
00:53:00,470 --> 00:52:58,160
just purchase services for nasa and the

1440
00:53:03,349 --> 00:53:00,480
reason why that's good is if nasa had to

1441
00:53:05,990 --> 00:53:03,359
do everything we would always be limited

1442
00:53:07,750 --> 00:53:06,000
by nasa's budget for our aspirations in

1443
00:53:10,309 --> 00:53:07,760
space and once we bring the private

1444
00:53:13,270 --> 00:53:10,319
sector along the pie just grows bigger

1445
00:53:14,630 --> 00:53:13,280
and the nation can do do more we can all

1446
00:53:16,150 --> 00:53:14,640
do more

1447
00:53:17,829 --> 00:53:16,160
when we have the combination and the

1448
00:53:19,510 --> 00:53:17,839
partnerships between the government and

1449
00:53:22,069 --> 00:53:19,520
the private sector

1450
00:53:24,950 --> 00:53:22,079
to push the boundaries of exploration

1451
00:53:26,790 --> 00:53:24,960
out into the solar system so next slide

1452
00:53:28,470 --> 00:53:26,800
please

1453
00:53:31,510 --> 00:53:28,480
what i like about this this shows our

1454
00:53:34,710 --> 00:53:31,520
cargo uh cargo demonstration project

1455
00:53:36,470 --> 00:53:34,720
that was completed uh in 2013 and what i

1456
00:53:38,950 --> 00:53:36,480
like about this this is all actual

1457
00:53:39,990 --> 00:53:38,960
pictures there's no artist conceptions

1458
00:53:41,430 --> 00:53:40,000
on this

1459
00:53:42,470 --> 00:53:41,440
we made it all the way through

1460
00:53:44,630 --> 00:53:42,480
development

1461
00:53:47,510 --> 00:53:44,640
with two new launch vehicles two

1462
00:53:49,510 --> 00:53:47,520
autonomous spacecraft two end-to-end

1463
00:53:51,430 --> 00:53:49,520

systems capable of supplying the

1464
00:53:54,630 --> 00:53:51,440
international space station and cargo to

1465
00:53:57,270 --> 00:53:54,640
low earth orbit and um two privately

1466
00:53:59,589 --> 00:53:57,280
developed launch sites as well all in

1467
00:54:01,430 --> 00:53:59,599
the span of about seven years

1468
00:54:03,430 --> 00:54:01,440
we went four for four in terms of

1469
00:54:05,030 --> 00:54:03,440
launches and two for two in terms of

1470
00:54:07,670 --> 00:54:05,040
birthings and now we've already seen

1471
00:54:10,630 --> 00:54:07,680
regular cargo delivery um to the

1472
00:54:12,710 --> 00:54:10,640
international space station um two i

1473
00:54:14,870 --> 00:54:12,720
think two missions for spacex one for

1474
00:54:17,910 --> 00:54:14,880
orbital sciences actually a dragon is on

1475
00:54:20,390 --> 00:54:17,920
orbit uh as we speak and the next launch

1476
00:54:22,470 --> 00:54:20,400
of us of an orbital sciences cygnus is

1477
00:54:24,710 --> 00:54:22,480
in the june time frame so we're seeing

1478
00:54:26,390 --> 00:54:24,720
that transition already nasa facilitated

1479
00:54:28,790 --> 00:54:26,400
the development but private sector very

1480
00:54:30,549 --> 00:54:28,800
much took the reins uh for the

1481
00:54:31,670 --> 00:54:30,559
development they own and operate these

1482
00:54:34,230 --> 00:54:31,680
systems

1483
00:54:36,789 --> 00:54:34,240
nasa was an investor and a technical

1484
00:54:38,710 --> 00:54:36,799
advisor throughout this process and now

1485
00:54:40,309 --> 00:54:38,720
we're a customer just purchasing

1486
00:54:42,789 --> 00:54:40,319
services we don't own and operate these

1487
00:54:45,589 --> 00:54:42,799
systems and it really frees up nasa to

1488
00:54:47,430 --> 00:54:45,599

do the more difficult uh jobs of deep

1489
00:54:48,630 --> 00:54:47,440
space exploration which dan will talk

1490
00:54:51,990 --> 00:54:48,640
about

1491
00:54:54,230 --> 00:54:52,000
next slide please

1492
00:54:56,309 --> 00:54:54,240
so to follow on the footsteps of

1493
00:54:58,549 --> 00:54:56,319
commercial cargo we are now in the midst

1494
00:55:00,789 --> 00:54:58,559
of commercial crew you can see there's a

1495
00:55:02,390 --> 00:55:00,799
mix of real pictures and some artist

1496
00:55:03,750 --> 00:55:02,400
conceptions which shows we're about

1497
00:55:05,190 --> 00:55:03,760
halfway through development i've got

1498
00:55:07,270 --> 00:55:05,200
another slide which will show you where

1499
00:55:09,030 --> 00:55:07,280
we are in the overall roadmap

1500
00:55:11,510 --> 00:55:09,040
we have four partners

1501
00:55:13,430 --> 00:55:11,520
today that we are interacting with to

1502
00:55:15,589 --> 00:55:13,440
help provide eventual crew

1503
00:55:17,030 --> 00:55:15,599
transportation services to low earth

1504
00:55:18,150 --> 00:55:17,040
orbit and the international space

1505
00:55:19,829 --> 00:55:18,160
station

1506
00:55:22,549 --> 00:55:19,839
three of those partners boeing sierra

1507
00:55:24,309 --> 00:55:22,559
nevada and spacex are funded meaning we

1508
00:55:26,549 --> 00:55:24,319
are providing not only technical

1509
00:55:28,230 --> 00:55:26,559
expertise but also investment uh blue

1510
00:55:30,710 --> 00:55:28,240
origin is on a no exchange of funds

1511
00:55:32,150 --> 00:55:30,720
basis uh but what i really like about

1512
00:55:34,549 --> 00:55:32,160
this slide is it really shows the

1513
00:55:36,470 --> 00:55:34,559

diversity of approaches we have

1514
00:55:39,270 --> 00:55:36,480
different levels of reusability

1515
00:55:40,870 --> 00:55:39,280
different rockets different designs

1516
00:55:42,710 --> 00:55:40,880
shows multiple different ways that we

1517
00:55:44,630 --> 00:55:42,720
can do this and it really strengthens

1518
00:55:48,630 --> 00:55:44,640
this whole

1519
00:55:49,990 --> 00:55:48,640
approach and process to bringing crew to

1520
00:55:52,069 --> 00:55:50,000
low earth orbit we don't want to be

1521
00:55:54,470 --> 00:55:52,079
reliant on a single system

1522
00:55:56,390 --> 00:55:54,480
that can be a very tenuous situation and

1523
00:55:57,750 --> 00:55:56,400
we now are seeing multiple divine

1524
00:55:59,829 --> 00:55:57,760
designs

1525
00:56:01,510 --> 00:55:59,839
these companies are very capable of

1526
00:56:03,510 --> 00:56:01,520
doing this mission

1527
00:56:05,510 --> 00:56:03,520
with nasa's help and hopefully we will

1528
00:56:07,030 --> 00:56:05,520
be seeing the fruits of their labor

1529
00:56:09,109 --> 00:56:07,040
fairly soon

1530
00:56:11,349 --> 00:56:09,119
next slide

1531
00:56:14,150 --> 00:56:11,359
so this is our road map chart you can

1532
00:56:15,910 --> 00:56:14,160
see that we started in about 2010 we're

1533
00:56:18,150 --> 00:56:15,920
slightly more than halfway through the

1534
00:56:20,549 --> 00:56:18,160
development so we're transitioning from

1535
00:56:22,710 --> 00:56:20,559
a lot of design reviews

1536
00:56:24,870 --> 00:56:22,720
to more hardware testing so you saw on

1537
00:56:26,710 --> 00:56:24,880
the previous slide a lot of parachute

1538
00:56:28,390 --> 00:56:26,720

tests some drop tests

1539
00:56:29,829 --> 00:56:28,400
we're seeing some actual hardware so

1540
00:56:31,670 --> 00:56:29,839
it's getting very exciting and getting

1541
00:56:33,030 --> 00:56:31,680
very interesting we have a lot of work

1542
00:56:34,950 --> 00:56:33,040
ahead of us

1543
00:56:36,950 --> 00:56:34,960
we are about to make awards for the next

1544
00:56:38,309 --> 00:56:36,960
round which you can see we call tcap

1545
00:56:39,829 --> 00:56:38,319
commercial crew transportation

1546
00:56:41,910 --> 00:56:39,839
capability

1547
00:56:43,670 --> 00:56:41,920
later on this summer

1548
00:56:45,430 --> 00:56:43,680
which will take us all the way through

1549
00:56:47,430 --> 00:56:45,440
development and complete hopefully i'll

1550
00:56:49,030 --> 00:56:47,440
be showing a similar picture to cargo

1551
00:56:50,870 --> 00:56:49,040
which will show our crew transportation

1552
00:56:52,470 --> 00:56:50,880
systems in just a few years time

1553
00:56:54,470 --> 00:56:52,480
hopefully

1554
00:56:56,549 --> 00:56:54,480
next slide

1555
00:56:58,789 --> 00:56:56,559
and then one other thing uh that we

1556
00:57:00,309 --> 00:56:58,799
wanted to leverage we've noticed that

1557
00:57:03,829 --> 00:57:00,319
there was a significant number of

1558
00:57:06,150 --> 00:57:03,839
companies that were popping up with

1559
00:57:09,030 --> 00:57:06,160
entrepreneurial ideas that wanted to

1560
00:57:11,190 --> 00:57:09,040
provide commercial services

1561
00:57:13,910 --> 00:57:11,200
to not only nasa but to commercial

1562
00:57:16,150 --> 00:57:13,920
customers as well non-nasa customers

1563
00:57:17,510 --> 00:57:16,160

this is good for nasa again it's good

1564
00:57:19,589 --> 00:57:17,520
for private industry it's good for the

1565
00:57:21,589 --> 00:57:19,599
nation so we have a lot of expertise at

1566
00:57:23,190 --> 00:57:21,599
nasa that we wanted to share and make

1567
00:57:24,309 --> 00:57:23,200
available to these companies to

1568
00:57:25,990 --> 00:57:24,319
hopefully

1569
00:57:27,990 --> 00:57:26,000
increase the likelihood that they will

1570
00:57:30,390 --> 00:57:28,000
be successful so that we can purchase

1571
00:57:33,030 --> 00:57:30,400
services um from them just like we're

1572
00:57:34,789 --> 00:57:33,040
doing with cots now later on so we are

1573
00:57:37,510 --> 00:57:34,799
in the midst of an evaluation right now

1574
00:57:39,190 --> 00:57:37,520
this is a no exchange of funds uh space

1575
00:57:42,549 --> 00:57:39,200
act agreements is what we'll feature so

1576
00:57:44,069 --> 00:57:42,559
each each company each partner the

1577
00:57:45,670 --> 00:57:44,079
government and the private sector will

1578
00:57:49,030 --> 00:57:45,680
bear their own

1579
00:57:50,549 --> 00:57:49,040
costs and we collaborate which is why we

1580
00:57:53,510 --> 00:57:50,559
got the title collaborations through

1581
00:57:55,910 --> 00:57:53,520
this partnership and we hope to find and

1582
00:57:58,150 --> 00:57:55,920
be able to facilitate

1583
00:58:00,230 --> 00:57:58,160
in additional services not just current

1584
00:58:02,150 --> 00:58:00,240
cargo but other services that nasa can

1585
00:58:04,710 --> 00:58:02,160
leverage in the future we hope to be

1586
00:58:06,789 --> 00:58:04,720
making selections in uh the july time

1587
00:58:09,030 --> 00:58:06,799
frame for multiple unfunded space act

1588
00:58:11,430 --> 00:58:09,040

agreements

1589
00:58:13,510 --> 00:58:11,440
and so uh with that what i'd like to say

1590
00:58:16,150 --> 00:58:13,520
is that we're seeing a very logical

1591
00:58:17,750 --> 00:58:16,160
progression in my opinion of pushing the

1592
00:58:21,430 --> 00:58:17,760
boundaries

1593
00:58:22,870 --> 00:58:21,440
out into space where the government is

1594
00:58:25,270 --> 00:58:22,880
doing those things where you really

1595
00:58:26,870 --> 00:58:25,280
don't see a clear profit motive uh there

1596
00:58:28,870 --> 00:58:26,880
might only be one customer that we're

1597
00:58:30,470 --> 00:58:28,880
really pushing the state of the art in

1598
00:58:31,990 --> 00:58:30,480
terms of our deep space initiatives and

1599
00:58:34,470 --> 00:58:32,000
then we see the private sector coming in

1600
00:58:36,549 --> 00:58:34,480
behind where where you can actually see

1601
00:58:38,390 --> 00:58:36,559
a profit motive these missions are a

1602
00:58:40,150 --> 00:58:38,400
little bit more achievable

1603
00:58:41,750 --> 00:58:40,160
and it is time now it's certainly for

1604
00:58:43,589 --> 00:58:41,760
low earth orbit for us to move that

1605
00:58:45,510 --> 00:58:43,599
responsibility over the private sector

1606
00:58:48,390 --> 00:58:45,520
they've demonstrated capability and then

1607
00:58:50,470 --> 00:58:48,400
that frees nasa up to do the uh the

1608
00:58:51,829 --> 00:58:50,480
state-of-the-art things the pushing the

1609
00:58:53,430 --> 00:58:51,839
state-of-the-art things that are still

1610
00:58:54,950 --> 00:58:53,440
very very difficult and through this

1611
00:58:57,109 --> 00:58:54,960
integrated strategy i think you're going

1612
00:58:59,589 --> 00:58:57,119
to see us go a lot further and a lot

1613
00:59:01,589 --> 00:58:59,599

faster thank you

1614
00:59:03,990 --> 00:59:01,599
thanks phil on to dan

1615
00:59:06,309 --> 00:59:04,000
okay thank you phil and welcome again

1616
00:59:07,750 --> 00:59:06,319
everyone uh both here in person as well

1617
00:59:09,510 --> 00:59:07,760
as online if we could go to the next

1618
00:59:11,670 --> 00:59:09,520
chart please

1619
00:59:13,750 --> 00:59:11,680
what we'd like to do is talk about the

1620
00:59:16,470 --> 00:59:13,760
progress that's been made on the space

1621
00:59:20,390 --> 00:59:16,480
launch system and orion since the 2011

1622
00:59:23,030 --> 00:59:20,400
time frame these programs are real

1623
00:59:25,109 --> 00:59:23,040
we are making good steady progress on

1624
00:59:26,549 --> 00:59:25,119
these uh programs

1625
00:59:29,589 --> 00:59:26,559
and even though there are some artist

1626
00:59:31,349 --> 00:59:29,599
concepts in this in this montage here

1627
00:59:33,750 --> 00:59:31,359
you see some of the testing that we've

1628
00:59:36,390 --> 00:59:33,760
done with the parachutes technicians

1629
00:59:37,910 --> 00:59:36,400
working on building the hardware changes

1630
00:59:39,589 --> 00:59:37,920
at the

1631
00:59:42,470 --> 00:59:39,599
kennedy space center for the ground

1632
00:59:44,950 --> 00:59:42,480
systems all in preparation

1633
00:59:46,549 --> 00:59:44,960
to go achieve the goals that john and

1634
00:59:48,789 --> 00:59:46,559
gerst have talked about

1635
00:59:50,870 --> 00:59:48,799
in terms of getting humans to mars and

1636
00:59:52,069 --> 00:59:50,880
continuing our exploration into deep

1637
00:59:55,030 --> 00:59:52,079
space

1638
00:59:56,309 --> 00:59:55,040

if we could go to the next chart please

1639
00:59:58,150 --> 00:59:56,319
this is a picture of the orion

1640
01:00:00,309 --> 00:59:58,160
spacecraft currently at the kennedy

1641
01:00:02,950 --> 01:00:00,319
space center being prepared for the

1642
01:00:04,630 --> 01:00:02,960
flight test in december of this year

1643
01:00:06,789 --> 01:00:04,640
this flight test we'll talk a little bit

1644
01:00:08,309 --> 01:00:06,799
later but the main purpose is to test

1645
01:00:09,910 --> 01:00:08,319
out the heat shield

1646
01:00:10,950 --> 01:00:09,920
and some of the structure

1647
01:00:13,030 --> 01:00:10,960
elements

1648
01:00:14,470 --> 01:00:13,040
of the orion spacecraft so that we can

1649
01:00:17,190 --> 01:00:14,480
use that information

1650
01:00:19,430 --> 01:00:17,200
to better design the spacecraft as we

1651
01:00:21,510 --> 01:00:19,440
prepare to take humans further into

1652
01:00:23,270 --> 01:00:21,520
space than they've ever been before

1653
01:00:25,030 --> 01:00:23,280
on the left hand side you see some of

1654
01:00:27,750 --> 01:00:25,040
the work with our heat shield

1655
01:00:29,750 --> 01:00:27,760
protections our service module

1656
01:00:31,910 --> 01:00:29,760
and on the right is the crew module

1657
01:00:33,670 --> 01:00:31,920
getting prepared for its flight test as

1658
01:00:36,309 --> 01:00:33,680
it goes through some of its final test

1659
01:00:38,870 --> 01:00:36,319
and checkout at the kennedy space center

1660
01:00:40,549 --> 01:00:38,880
next chart please

1661
01:00:42,870 --> 01:00:40,559
for the space launch system major

1662
01:00:45,270 --> 01:00:42,880
progress on that front also

1663
01:00:47,190 --> 01:00:45,280

in the upper left hand corner you see

1664
01:00:48,950 --> 01:00:47,200
the domes that we are building at the

1665
01:00:50,789 --> 01:00:48,960
michoud assembly facility near new

1666
01:00:53,270 --> 01:00:50,799
orleans uh where we used to make the

1667
01:00:55,190 --> 01:00:53,280
external tanks and we have totally

1668
01:00:56,950 --> 01:00:55,200
redone the facility

1669
01:00:59,430 --> 01:00:56,960
put in the new tooling that we need for

1670
01:01:00,710 --> 01:00:59,440
the friction stir welding that we use on

1671
01:01:03,829 --> 01:01:00,720
this system

1672
01:01:07,109 --> 01:01:03,839
and we're we have tested out all of our

1673
01:01:09,030 --> 01:01:07,119
welds so far and all have come in clean

1674
01:01:10,870 --> 01:01:09,040
and on the right hand side you see the

1675
01:01:13,349 --> 01:01:10,880
last tool that we are putting in where

1676
01:01:15,349 --> 01:01:13,359
we will begin to stack the tanks and

1677
01:01:16,230 --> 01:01:15,359
then do the circumferential welds we

1678
01:01:19,190 --> 01:01:16,240
need

1679
01:01:21,109 --> 01:01:19,200
to to build the entire tanks

1680
01:01:22,789 --> 01:01:21,119
you get a feeling for the size of the

1681
01:01:24,549 --> 01:01:22,799
structure this is big structure this

1682
01:01:27,270 --> 01:01:24,559
will be the largest friction stir weld

1683
01:01:29,349 --> 01:01:27,280
machine in the world when we complete it

1684
01:01:31,589 --> 01:01:29,359
all of this is on track

1685
01:01:32,789 --> 01:01:31,599
we will begin we will be doing our first

1686
01:01:36,230 --> 01:01:32,799
welds

1687
01:01:38,309 --> 01:01:36,240
in this new tool later this summer

1688
01:01:41,430 --> 01:01:38,319

the space launch system is continuing

1689
01:01:43,510 --> 01:01:41,440
towards uh its critical design review

1690
01:01:46,069 --> 01:01:43,520
the design and the in the production

1691
01:01:48,069 --> 01:01:46,079
pathfinder work is proceeding very well

1692
01:01:50,309 --> 01:01:48,079
next chart please

1693
01:01:52,549 --> 01:01:50,319
and at the kennedy space center uh the

1694
01:01:54,470 --> 01:01:52,559
mobile launch platform we have

1695
01:01:57,349 --> 01:01:54,480
repurposed it from the constellation

1696
01:02:00,150 --> 01:01:57,359
days turned it over into what we need

1697
01:02:02,230 --> 01:02:00,160
for the space launch system uh beefing

1698
01:02:04,309 --> 01:02:02,240
it up getting our

1699
01:02:07,430 --> 01:02:04,319
ground command and control software

1700
01:02:09,270 --> 01:02:07,440
systems all in place as well as uh the

1701
01:02:11,910 --> 01:02:09,280
vertical assembly building that we will

1702
01:02:14,630 --> 01:02:11,920
use to stack the the launch vehicle and

1703
01:02:17,109 --> 01:02:14,640
to stack orion on the launch vehicle so

1704
01:02:19,670 --> 01:02:17,119
you see that's an artist concept over in

1705
01:02:22,150 --> 01:02:19,680
the vab that we're doing

1706
01:02:23,910 --> 01:02:22,160
but we have all the work under contract

1707
01:02:26,789 --> 01:02:23,920
uh the space launch system's under

1708
01:02:28,950 --> 01:02:26,799
contract orion's under contract so very

1709
01:02:30,630 --> 01:02:28,960
good progress so to give you a little

1710
01:02:32,549 --> 01:02:30,640
bit better feel the progress if we could

1711
01:02:34,630 --> 01:02:32,559
go to the next chart which is actually

1712
01:02:37,750 --> 01:02:34,640
the video if we could roll the video

1713
01:02:39,190 --> 01:02:37,760

tape please i always wanted to say that

1714
01:04:59,430 --> 01:02:39,200
never got on the news but i always

1715
01:05:03,829 --> 01:05:01,430
so you see with that the nasa industry

1716
01:05:04,950 --> 01:05:03,839
team across the country is making great

1717
01:05:07,430 --> 01:05:04,960
progress

1718
01:05:09,270 --> 01:05:07,440
and you'll see it first step

1719
01:05:11,349 --> 01:05:09,280
with our exploration flight test one

1720
01:05:12,789 --> 01:05:11,359
this december we will do two high earth

1721
01:05:14,309 --> 01:05:12,799
orbits

1722
01:05:16,789 --> 01:05:14,319
orion will re-enter the earth's

1723
01:05:18,870 --> 01:05:16,799
atmosphere at approximately 85 percent

1724
01:05:21,029 --> 01:05:18,880
of what we expect the re-entry velocity

1725
01:05:23,510 --> 01:05:21,039
to be from the moon so we will get a

1726
01:05:25,990 --> 01:05:23,520
very good test and and put that data

1727
01:05:27,829 --> 01:05:26,000
directly into our design process for the

1728
01:05:31,190 --> 01:05:27,839
next mission if i go to the next chart

1729
01:05:33,589 --> 01:05:31,200
please which is exploration mission one

1730
01:05:36,230 --> 01:05:33,599
currently scheduled for fiscal year 18

1731
01:05:38,150 --> 01:05:36,240
where sls and orion will fly together we

1732
01:05:39,510 --> 01:05:38,160
will take orion out

1733
01:05:41,270 --> 01:05:39,520
to the moon

1734
01:05:43,430 --> 01:05:41,280
to the in a put it in a distant

1735
01:05:45,349 --> 01:05:43,440
retrograde orbit and this is essentially

1736
01:05:47,910 --> 01:05:45,359
a practice mission in an uncrewed

1737
01:05:49,430 --> 01:05:47,920
fashion as we prepare for our asteroid

1738
01:05:51,990 --> 01:05:49,440

redirect mission

1739
01:05:54,230 --> 01:05:52,000
the next chart please will show em

1740
01:05:56,870 --> 01:05:54,240
exploration mission two which will be

1741
01:05:58,950 --> 01:05:56,880
our first crude flight of orion

1742
01:06:01,270 --> 01:05:58,960
and that flight will take us out to hot

1743
01:06:04,309 --> 01:06:01,280
will take us out to high lunar orbit

1744
01:06:07,589 --> 01:06:04,319
so that we can exercise the crew systems

1745
01:06:09,430 --> 01:06:07,599
uh check out our orion spacecraft along

1746
01:06:11,910 --> 01:06:09,440
with the space launch system all in

1747
01:06:13,190 --> 01:06:11,920
preparation for taking crew out to the

1748
01:06:14,549 --> 01:06:13,200
asteroid

1749
01:06:17,190 --> 01:06:14,559
and what we will do

1750
01:06:19,270 --> 01:06:17,200
what you see here is the hardware and

1751
01:06:20,470 --> 01:06:19,280
the in addition to

1752
01:06:21,190 --> 01:06:20,480
to

1753
01:06:23,270 --> 01:06:21,200
our

1754
01:06:25,190 --> 01:06:23,280
commercial cargo capabilities and what

1755
01:06:28,390 --> 01:06:25,200
phil's team have been working on to get

1756
01:06:30,470 --> 01:06:28,400
the transportation system in place uh to

1757
01:06:32,789 --> 01:06:30,480
space station we are extending that

1758
01:06:35,910 --> 01:06:32,799
transportation system out into deep

1759
01:06:38,470 --> 01:06:35,920
space and our first test for that excuse

1760
01:06:40,630 --> 01:06:38,480
me our first test for that will be what

1761
01:06:42,630 --> 01:06:40,640
michelle talks about in our asteroid

1762
01:06:44,870 --> 01:06:42,640
redirect mission and it's our first step

1763
01:06:48,870 --> 01:06:44,880

on the way to mars thank you

1764
01:06:51,670 --> 01:06:50,150
honey michelle

1765
01:06:54,390 --> 01:06:51,680
he always gets the applause for the

1766
01:06:55,829 --> 01:06:54,400
video it's always hard to go after hi

1767
01:06:59,109 --> 01:06:55,839
michelle it's great to be here today

1768
01:07:04,309 --> 01:07:03,109
um the next for next one thanks

1769
01:07:05,990 --> 01:07:04,319
so today i'm going to talk a little bit

1770
01:07:08,470 --> 01:07:06,000
about the asteroid redirect mission

1771
01:07:10,309 --> 01:07:08,480
which is a compelling early mission in

1772
01:07:13,349 --> 01:07:10,319
the proving ground

1773
01:07:14,950 --> 01:07:13,359
that mr gersen meyer and sam

1774
01:07:18,069 --> 01:07:14,960
talked about earlier

1775
01:07:20,150 --> 01:07:18,079
the asteroid region mission will utilize

1776
01:07:22,390 --> 01:07:20,160
advanced capabilities and technologies

1777
01:07:25,109 --> 01:07:22,400
that are needed for the future

1778
01:07:26,870 --> 01:07:25,119
human exploration of mars as well as

1779
01:07:29,670 --> 01:07:26,880
complement the international space

1780
01:07:32,950 --> 01:07:29,680
station learning an experience that sam

1781
01:07:34,789 --> 01:07:32,960
described earlier next slide

1782
01:07:36,390 --> 01:07:34,799
the asteroid redirect mission consists

1783
01:07:38,390 --> 01:07:36,400
of three segments

1784
01:07:40,230 --> 01:07:38,400
the first is a

1785
01:07:42,150 --> 01:07:40,240
actually a benefit of the science

1786
01:07:44,069 --> 01:07:42,160
mission directorates near-earth object

1787
01:07:46,230 --> 01:07:44,079
observation program

1788
01:07:48,309 --> 01:07:46,240

uh in which we'll identify

1789
01:07:50,309 --> 01:07:48,319
target asteroids that actually actually

1790
01:07:51,990 --> 01:07:50,319
has already begun

1791
01:07:54,829 --> 01:07:52,000
followed by the demonstration of an

1792
01:07:56,470 --> 01:07:54,839
advanced solar electric propulsion

1793
01:07:59,510 --> 01:07:56,480
system

1794
01:08:01,910 --> 01:07:59,520
uh to redirect an asteroid to a stable

1795
01:08:04,230 --> 01:08:01,920
orbit in the lunar vicinity

1796
01:08:07,670 --> 01:08:04,240
and finally the crude mission to take

1797
01:08:10,950 --> 01:08:07,680
our astronauts aboard the orion and sls

1798
01:08:13,589 --> 01:08:10,960
vehicles to visit explore and take

1799
01:08:17,269 --> 01:08:13,599
samples from that asteroid in the stable

1800
01:08:19,990 --> 01:08:17,279
orbit around the moon next slide

1801
01:08:22,550 --> 01:08:20,000
asteroid redirect mission or arm

1802
01:08:25,110 --> 01:08:22,560
integrates several building blocks as we

1803
01:08:27,430 --> 01:08:25,120
initiate deep space human exploration

1804
01:08:28,709 --> 01:08:27,440
including again the orion multi-purpose

1805
01:08:30,870 --> 01:08:28,719
crude vehicle

1806
01:08:34,550 --> 01:08:30,880
the space launch system heavy lift

1807
01:08:37,110 --> 01:08:34,560
launch vehicle advanced high power

1808
01:08:39,669 --> 01:08:37,120
long life solar electric propulsion

1809
01:08:40,470 --> 01:08:39,679
technology components and systems

1810
01:08:42,709 --> 01:08:40,480
the

1811
01:08:43,829 --> 01:08:42,719
capture and maneuver of non-cooperative

1812
01:08:46,390 --> 01:08:43,839
targets

1813
01:08:48,789 --> 01:08:46,400

the moving of large objects through

1814
01:08:51,269 --> 01:08:48,799
interplanetary space trajectories using

1815
01:08:54,149 --> 01:08:51,279
solar electric propulsion

1816
01:08:57,189 --> 01:08:54,159
and the integrated uh robotic and human

1817
01:08:59,030 --> 01:08:57,199
vehicle stack operations in deep space

1818
01:09:00,950 --> 01:08:59,040
uh you'll find this mission

1819
01:09:02,950 --> 01:09:00,960
significantly contributes to the

1820
01:09:06,070 --> 01:09:02,960
extension of human exploration beyond

1821
01:09:08,309 --> 01:09:06,080
low earth orbit and into deep space in

1822
01:09:10,470 --> 01:09:08,319
fact we'll go a thousand times farther

1823
01:09:12,470 --> 01:09:10,480
than leo for the first time in 40 years

1824
01:09:14,470 --> 01:09:12,480
and for a longer duration

1825
01:09:17,910 --> 01:09:14,480
in deep space than humans have been

1826
01:09:21,510 --> 01:09:19,349
just a few of the

1827
01:09:23,749 --> 01:09:21,520
assets that are being enhanced by the

1828
01:09:25,110 --> 01:09:23,759
science mission directorate for

1829
01:09:27,030 --> 01:09:25,120
detection of

1830
01:09:29,189 --> 01:09:27,040
potentially hazardous objects which the

1831
01:09:30,550 --> 01:09:29,199
asteroid redirect mission is benefiting

1832
01:09:31,990 --> 01:09:30,560
from including

1833
01:09:35,269 --> 01:09:32,000
enhancements and upgrades to the

1834
01:09:37,510 --> 01:09:35,279
catalina sky survey full-time operations

1835
01:09:39,829 --> 01:09:37,520
on pan stars one completion of actually

1836
01:09:42,229 --> 01:09:39,839
a pan-starrs two asset

1837
01:09:45,030 --> 01:09:42,239
the space-based observation of asteroids

1838
01:09:46,829 --> 01:09:45,040

using the wise telescope

1839
01:09:51,749 --> 01:09:46,839
and some enhancements to

1840
01:09:55,830 --> 01:09:54,550
there are two capture options which are

1841
01:09:57,990 --> 01:09:55,840
currently

1842
01:10:00,550 --> 01:09:58,000
being investigated for

1843
01:10:02,870 --> 01:10:00,560
the asteroid redirect mission robotic

1844
01:10:04,950 --> 01:10:02,880
mission which actually the concept

1845
01:10:07,030 --> 01:10:04,960
is been pretty fleshed out if you had

1846
01:10:09,030 --> 01:10:07,040
seen the upper opportunities forum in

1847
01:10:11,350 --> 01:10:09,040
march it's available online

1848
01:10:13,510 --> 01:10:11,360
the first option is the inflatable

1849
01:10:15,510 --> 01:10:13,520
capture of a small free-floating

1850
01:10:17,830 --> 01:10:15,520
asteroid

1851
01:10:21,189 --> 01:10:17,840
we are estimating it would be less than

1852
01:10:23,990 --> 01:10:21,199
a thousand metric tons in mass which is

1853
01:10:27,430 --> 01:10:24,000
actually still pretty large

1854
01:10:29,830 --> 01:10:27,440
the current reference target is 2009 bd

1855
01:10:31,590 --> 01:10:29,840
which would be crew accessible in the

1856
01:10:34,950 --> 01:10:31,600
lunar distant retrograde orbit by

1857
01:10:37,669 --> 01:10:34,960
february 2024 potentially as early as

1858
01:10:39,189 --> 01:10:37,679
2023 depending on trajectories

1859
01:10:42,950 --> 01:10:39,199
and actually a recent spitzer

1860
01:10:45,030 --> 01:10:42,960
observation of 2011 md

1861
01:10:46,790 --> 01:10:45,040
is likely to raise that to a valid

1862
01:10:50,229 --> 01:10:46,800
target as well and that would be crew

1863
01:10:52,950 --> 01:10:50,239

accessible as early as august 2025

1864
01:10:55,110 --> 01:10:52,960
option b is the robotic

1865
01:10:58,149 --> 01:10:55,120
acquisition of a

1866
01:10:59,750 --> 01:10:58,159
two to four meter boulder from a larger

1867
01:11:01,270 --> 01:10:59,760
asteroid

1868
01:11:03,990 --> 01:11:01,280
and actually while there we would do a

1869
01:11:05,270 --> 01:11:04,000
deflection demonstration of that larger

1870
01:11:07,350 --> 01:11:05,280
asteroid to

1871
01:11:09,590 --> 01:11:07,360
demonstrate planetary defense techniques

1872
01:11:12,229 --> 01:11:09,600
but regardless with either option there

1873
01:11:13,669 --> 01:11:12,239
would be a large asteroid mass made

1874
01:11:16,070 --> 01:11:13,679
available

1875
01:11:17,990 --> 01:11:16,080
in a stable orbit around the moon for

1876
01:11:20,470 --> 01:11:18,000
exploration and sampling by astronauts

1877
01:11:22,709 --> 01:11:20,480
next slide

1878
01:11:25,110 --> 01:11:22,719
and indeed this crude mission is quite

1879
01:11:26,950 --> 01:11:25,120
compelling for the mid-2020s to

1880
01:11:29,270 --> 01:11:26,960
complement our work on the international

1881
01:11:30,229 --> 01:11:29,280
space station the astronaut crews would

1882
01:11:31,990 --> 01:11:30,239
launch

1883
01:11:34,790 --> 01:11:32,000
aboard the orion multi-purpose crude

1884
01:11:35,750 --> 01:11:34,800
vehicle and the sls heavy lift launch

1885
01:11:38,709 --> 01:11:35,760
vehicle

1886
01:11:41,270 --> 01:11:38,719
traverse the eight or so days out to the

1887
01:11:44,149 --> 01:11:41,280
lunar dust retrograde orbit using a

1888
01:11:46,790 --> 01:11:44,159

lunar gravity assist

1889
01:11:49,270 --> 01:11:46,800
there the orion vehicle would rendezvous

1890
01:11:52,149 --> 01:11:49,280
and dock with the high-powered sep

1891
01:11:55,430 --> 01:11:52,159
spacecraft with the asteroid attached

1892
01:11:57,430 --> 01:11:55,440
you see the integrated robotic and human

1893
01:11:59,189 --> 01:11:57,440
vehicle stack there

1894
01:12:01,510 --> 01:11:59,199
at the top

1895
01:12:03,830 --> 01:12:01,520
right on my side corner

1896
01:12:06,070 --> 01:12:03,840
and there we would actually demonstrate

1897
01:12:09,189 --> 01:12:06,080
integrated attitude control including

1898
01:12:11,110 --> 01:12:09,199
solar orientation eva

1899
01:12:13,270 --> 01:12:11,120
support capability and deep space

1900
01:12:15,750 --> 01:12:13,280
trajectories

1901
01:12:18,070 --> 01:12:15,760
which is still fairly close to the earth

1902
01:12:20,950 --> 01:12:18,080
and again the proving ground

1903
01:12:23,350 --> 01:12:20,960
that trajectory is an estimated 11 days

1904
01:12:25,350 --> 01:12:23,360
return from the moon

1905
01:12:28,470 --> 01:12:25,360
or from the lunar orbit sorry counting

1906
01:12:30,070 --> 01:12:28,480
um a total of 26 day mission we're

1907
01:12:34,390 --> 01:12:30,080
turning the samples with the crew to

1908
01:12:38,550 --> 01:12:36,149
so we've done quite a bit of work as

1909
01:12:40,229 --> 01:12:38,560
well in investigating the

1910
01:12:42,390 --> 01:12:40,239
potential and better understanding the

1911
01:12:44,870 --> 01:12:42,400
applicability of this high-powered solar

1912
01:12:47,669 --> 01:12:44,880
electric propulsion system to enable

1913
01:12:49,750 --> 01:12:47,679

future human missions to mars and it

1914
01:12:52,070 --> 01:12:49,760
turns out that there are several

1915
01:12:53,110 --> 01:12:52,080
architectures and opportunities

1916
01:12:55,830 --> 01:12:53,120
which are

1917
01:12:59,030 --> 01:12:55,840
going to be described summarized by

1918
01:13:01,990 --> 01:12:59,040
jason next however the the solar arrays

1919
01:13:04,709 --> 01:13:02,000
the component technologies potentially

1920
01:13:07,030 --> 01:13:04,719
the spacecraft bus would be exactly the

1921
01:13:08,390 --> 01:13:07,040
same bus that could be used to take

1922
01:13:09,669 --> 01:13:08,400
cargo

1923
01:13:12,149 --> 01:13:09,679
to mars

1924
01:13:14,390 --> 01:13:12,159
the exploration eva capability

1925
01:13:17,430 --> 01:13:14,400
capabilities described earlier including

1926
01:13:18,950 --> 01:13:17,440
solar orientation sampling

1927
01:13:21,030 --> 01:13:18,960
the portable

1928
01:13:24,070 --> 01:13:21,040
life support system which is actually a

1929
01:13:25,990 --> 01:13:24,080
primary life support system

1930
01:13:28,470 --> 01:13:26,000
as well as the

1931
01:13:29,669 --> 01:13:28,480
rendezvous and docking sensors which

1932
01:13:32,229 --> 01:13:29,679
we're looking

1933
01:13:34,390 --> 01:13:32,239
to enhance and exploit commonality there

1934
01:13:36,470 --> 01:13:34,400
as well

1935
01:13:41,750 --> 01:13:36,480
thank you very much

1936
01:13:44,630 --> 01:13:43,430
and on to jason

1937
01:13:45,910 --> 01:13:44,640
great um

1938
01:13:47,110 --> 01:13:45,920

i'm going to be betting clean up a

1939
01:13:48,709 --> 01:13:47,120
little bit on this panel here so what

1940
01:13:50,790 --> 01:13:48,719
i'm going to try to do is step back a

1941
01:13:52,630 --> 01:13:50,800
little bit higher level back to our some

1942
01:13:53,830 --> 01:13:52,640
of our architecture planning and and

1943
01:13:55,110 --> 01:13:53,840
work we've been doing there if i can get

1944
01:13:56,149 --> 01:13:55,120
the next slide

1945
01:13:57,990 --> 01:13:56,159
please

1946
01:14:00,310 --> 01:13:58,000
one of the first things

1947
01:14:02,149 --> 01:14:00,320
we've talked about is as you look at how

1948
01:14:03,910 --> 01:14:02,159
to bring together all these various

1949
01:14:05,830 --> 01:14:03,920
elements within human space flight space

1950
01:14:07,990 --> 01:14:05,840
technology and science

1951
01:14:11,350 --> 01:14:08,000
you need to be driven by a couple key

1952
01:14:13,590 --> 01:14:11,360
principles in order to drive all of our

1953
01:14:15,910 --> 01:14:13,600
what would seem to be separate programs

1954
01:14:17,430 --> 01:14:15,920
into an integrated effort

1955
01:14:19,030 --> 01:14:17,440
these are the six guiding principles

1956
01:14:20,790 --> 01:14:19,040
that we've been using to drive that

1957
01:14:21,590 --> 01:14:20,800
you'll see slight variations of these

1958
01:14:23,110 --> 01:14:21,600
that

1959
01:14:24,470 --> 01:14:23,120
we actually are constantly involving it

1960
01:14:25,590 --> 01:14:24,480
as we've been actually getting feedback

1961
01:14:27,750 --> 01:14:25,600
from you and the community and our

1962
01:14:29,830 --> 01:14:27,760
stakeholders the first of which on the

1963
01:14:32,229 --> 01:14:29,840

list here is

1964
01:14:33,830 --> 01:14:32,239
living within our budget realities um

1965
01:14:35,270 --> 01:14:33,840
and in the near term executing with our

1966
01:14:37,510 --> 01:14:35,280
current budgets and in the long term

1967
01:14:40,229 --> 01:14:37,520
looking at uh growth that's commensurate

1968
01:14:41,350 --> 01:14:40,239
to economic growth um so not looking at

1969
01:14:44,950 --> 01:14:41,360
very

1970
01:14:47,510 --> 01:14:44,960
to the agency

1971
01:14:49,990 --> 01:14:47,520
that are all spiked and not very level

1972
01:14:51,750 --> 01:14:50,000
level set as as we go to execute all

1973
01:14:53,910 --> 01:14:51,760
these programs we're also looking at the

1974
01:14:54,950 --> 01:14:53,920
application of high technology readiness

1975
01:14:56,070 --> 01:14:54,960
levels

1976
01:14:58,709 --> 01:14:56,080
so you're looking at that with what

1977
01:15:00,550 --> 01:14:58,719
michelle described with our arm mission

1978
01:15:02,070 --> 01:15:00,560
is using a series of technologies

1979
01:15:04,950 --> 01:15:02,080
stitched together in a very compelling

1980
01:15:06,229 --> 01:15:04,960
way to advance those capabilities

1981
01:15:08,310 --> 01:15:06,239
and that's due in part because of the

1982
01:15:09,990 --> 01:15:08,320
high readiness levels that they are at

1983
01:15:11,430 --> 01:15:10,000
the same time we're though though to

1984
01:15:13,990 --> 01:15:11,440
keep a balanced portfolio of next

1985
01:15:15,590 --> 01:15:14,000
generation technologies to help advance

1986
01:15:17,590 --> 01:15:15,600
our stepping stone approach on the way

1987
01:15:20,070 --> 01:15:17,600
to mars

1988
01:15:21,030 --> 01:15:20,080

the next piece here is near-term mission

1989
01:15:23,030 --> 01:15:21,040
so

1990
01:15:24,870 --> 01:15:23,040
one of the things to think about is this

1991
01:15:27,350 --> 01:15:24,880
isn't just a monolithic program that one

1992
01:15:29,590 --> 01:15:27,360
day we we launch a singular campaign to

1993
01:15:31,669 --> 01:15:29,600
mars but rather it's a series of

1994
01:15:33,430 --> 01:15:31,679
missions over time that have a constant

1995
01:15:34,950 --> 01:15:33,440
cadence for allowing us to advance our

1996
01:15:37,990 --> 01:15:34,960
capabilities

1997
01:15:40,390 --> 01:15:38,000
in a very systematic way that go from

1998
01:15:43,510 --> 01:15:40,400
precursors to pre-emplacement to

1999
01:15:46,310 --> 01:15:43,520
enabling then our crew first crew

2000
01:15:48,070 --> 01:15:46,320
a visit to mars and mars vicinity

2001
01:15:50,550 --> 01:15:48,080
with that along with that you heard from

2002
01:15:52,790 --> 01:15:50,560
phil and and also from

2003
01:15:54,790 --> 01:15:52,800
sam related to commercial business

2004
01:15:57,030 --> 01:15:54,800
we are expanding the use of commercial

2005
01:15:59,669 --> 01:15:57,040
models and commercial acquisition of

2006
01:16:01,189 --> 01:15:59,679
capabilities as uh as we keep on pushing

2007
01:16:02,790 --> 01:16:01,199
the envelope and capabilities where is

2008
01:16:03,990 --> 01:16:02,800
the next market that kind of follows

2009
01:16:06,149 --> 01:16:04,000
behind

2010
01:16:08,229 --> 01:16:06,159
with us in order to enable us to acquire

2011
01:16:09,830 --> 01:16:08,239
capabilities at a lower cost

2012
01:16:11,669 --> 01:16:09,840
for us

2013
01:16:13,270 --> 01:16:11,679

michelle touched on a little bit one of

2014
01:16:15,669 --> 01:16:13,280
our key principles is multi-use

2015
01:16:17,750 --> 01:16:15,679
evolvable space infrastructure so when

2016
01:16:19,750 --> 01:16:17,760
you look at the components of arm the

2017
01:16:21,430 --> 01:16:19,760
asteroid redirect mission you're looking

2018
01:16:23,669 --> 01:16:21,440
at solar electric propulsion that at a

2019
01:16:25,430 --> 01:16:23,679
modular level is our evolvable strategy

2020
01:16:27,189 --> 01:16:25,440
for solar electric propulsion for cargo

2021
01:16:30,390 --> 01:16:27,199
to mars you're looking at reuse

2022
01:16:33,110 --> 01:16:30,400
infrastructure of orion and sls as core

2023
01:16:34,310 --> 01:16:33,120
principles of our work that we have and

2024
01:16:36,070 --> 01:16:34,320
the last one is building on our

2025
01:16:37,669 --> 01:16:36,080
international and commercial

2026
01:16:39,270 --> 01:16:37,679
participation so we have a strong

2027
01:16:40,550 --> 01:16:39,280
relationship with our

2028
01:16:42,070 --> 01:16:40,560
space station international space

2029
01:16:44,470 --> 01:16:42,080
station community but in addition to

2030
01:16:46,950 --> 01:16:44,480
that our exploration global exploration

2031
01:16:48,630 --> 01:16:46,960
roadmap countries as well and we want to

2032
01:16:50,790 --> 01:16:48,640
build upon those partnerships to not go

2033
01:16:52,470 --> 01:16:50,800
it alone but to go together and answer a

2034
01:16:53,750 --> 01:16:52,480
lot of the key attributes that we need

2035
01:16:55,270 --> 01:16:53,760
to send crew

2036
01:16:56,870 --> 01:16:55,280
before we send crew answer those

2037
01:17:00,550 --> 01:16:56,880
attributes as a global community not

2038
01:17:01,750 --> 01:17:00,560

just as nasa so the next slide

2039
01:17:03,110 --> 01:17:01,760
so i'm going to take a little bit of

2040
01:17:05,189 --> 01:17:03,120
time to explain this chart because we

2041
01:17:06,790 --> 01:17:05,199
haven't uh briefed this one in public

2042
01:17:08,870 --> 01:17:06,800
all that much at this point so in the

2043
01:17:11,189 --> 01:17:08,880
past you've seen nasa's plans for mars

2044
01:17:13,270 --> 01:17:11,199
to be very monolithic in nature meaning

2045
01:17:15,510 --> 01:17:13,280
that we have a series of build outs and

2046
01:17:17,750 --> 01:17:15,520
we we have a singular mission that sends

2047
01:17:19,590 --> 01:17:17,760
humans to the surface of mars

2048
01:17:21,830 --> 01:17:19,600
what you're seeing here is a shift in

2049
01:17:23,430 --> 01:17:21,840
our general philosophy to an evolvable

2050
01:17:25,669 --> 01:17:23,440
mars campaign

2051
01:17:27,669 --> 01:17:25,679
so what we're looking at is what are the

2052
01:17:29,430 --> 01:17:27,679
various capabilities that you don't just

2053
01:17:32,550 --> 01:17:29,440
build a whole series of hardware and

2054
01:17:34,950 --> 01:17:32,560
launch at once but rather over a series

2055
01:17:36,709 --> 01:17:34,960
a period of time start pre and placement

2056
01:17:38,709 --> 01:17:36,719
of capabilities and testing those

2057
01:17:40,950 --> 01:17:38,719
capabilities not just for the purpose of

2058
01:17:42,630 --> 01:17:40,960
demoing it but to actually if it works

2059
01:17:44,550 --> 01:17:42,640
it now will be in place for future

2060
01:17:46,790 --> 01:17:44,560
missions so we're looking at the various

2061
01:17:49,510 --> 01:17:46,800
trade spaces that you see solar electric

2062
01:17:51,189 --> 01:17:49,520
propulsion as our in-space propulsion

2063
01:17:54,149 --> 01:17:51,199

segment that we have we're studying the

2064
01:17:56,630 --> 01:17:54,159
use of in-situ resource utilization

2065
01:17:59,270 --> 01:17:56,640
all of our mars architectures require

2066
01:18:00,870 --> 01:17:59,280
some level of isru

2067
01:18:02,550 --> 01:18:00,880
to be able to live off the land and go

2068
01:18:04,470 --> 01:18:02,560
to what mr gristimer said about

2069
01:18:06,870 --> 01:18:04,480
pioneering and starting to figure out

2070
01:18:08,070 --> 01:18:06,880
how we harvest resources and consumables

2071
01:18:09,830 --> 01:18:08,080
whether it's for

2072
01:18:11,750 --> 01:18:09,840
human consumption or for our rocket

2073
01:18:13,830 --> 01:18:11,760
engines consumption how do we harvest

2074
01:18:15,669 --> 01:18:13,840
those along the way

2075
01:18:17,830 --> 01:18:15,679
thinking about as as we have been

2076
01:18:19,590 --> 01:18:17,840
already with our science lab we heard

2077
01:18:21,270 --> 01:18:19,600
about the rad instrument our previous

2078
01:18:24,550 --> 01:18:21,280
entry descent landing technologies with

2079
01:18:26,470 --> 01:18:24,560
that um mars 2020 is extending that but

2080
01:18:28,070 --> 01:18:26,480
how do all these robotic precursors with

2081
01:18:29,910 --> 01:18:28,080
us and the science mission director work

2082
01:18:31,830 --> 01:18:29,920
together to answer key strategic

2083
01:18:34,310 --> 01:18:31,840
knowledge gaps we have about the

2084
01:18:36,070 --> 01:18:34,320
stepping stones as humans extended a

2085
01:18:37,830 --> 01:18:36,080
deep space

2086
01:18:39,430 --> 01:18:37,840
so we're looking at this how humans and

2087
01:18:41,030 --> 01:18:39,440
robotics actually work together and

2088
01:18:43,510 --> 01:18:41,040

complement each other that then

2089
01:18:46,310 --> 01:18:43,520
precursors actually evolve into what is

2090
01:18:48,310 --> 01:18:46,320
more like pre-emplacement of hardware

2091
01:18:50,470 --> 01:18:48,320
for uh say institute resource

2092
01:18:53,510 --> 01:18:50,480
utilization plan or pre-emplacement of

2093
01:18:56,070 --> 01:18:53,520
habitats that are

2094
01:18:57,669 --> 01:18:56,080
extensible for our future human returns

2095
01:19:00,149 --> 01:18:57,679
so we're doing various trade studies

2096
01:19:01,830 --> 01:19:00,159
related to that in cis lunar space and

2097
01:19:03,030 --> 01:19:01,840
extending that into mars orbit we're

2098
01:19:03,990 --> 01:19:03,040
looking at

2099
01:19:05,510 --> 01:19:04,000
various

2100
01:19:07,750 --> 01:19:05,520
other stepping stones that may include

2101
01:19:10,550 --> 01:19:07,760
mars moons or a direct path to mars

2102
01:19:13,110 --> 01:19:10,560
surface and how those can help weigh in

2103
01:19:14,790 --> 01:19:13,120
on our overall campaign to mars

2104
01:19:17,110 --> 01:19:14,800
so this is a really critical way to

2105
01:19:19,350 --> 01:19:17,120
start thinking about human exploration

2106
01:19:21,590 --> 01:19:19,360
not as a singular monolithic effort but

2107
01:19:22,390 --> 01:19:21,600
rather an integrated effort across all

2108
01:19:24,229 --> 01:19:22,400
of nasa

2109
01:19:25,830 --> 01:19:24,239
and all of human space flight

2110
01:19:27,430 --> 01:19:25,840
so next chart

2111
01:19:31,270 --> 01:19:27,440
um we're doing this because

2112
01:19:32,310 --> 01:19:31,280
fundamentally mars is extremely hard um

2113
01:19:34,390 --> 01:19:32,320

at the end of the day we need the

2114
01:19:36,149 --> 01:19:34,400
critical transportation elements both to

2115
01:19:38,310 --> 01:19:36,159
get to and from space and into deep

2116
01:19:40,070 --> 01:19:38,320
space we need

2117
01:19:42,149 --> 01:19:40,080
the in-space transportation both

2118
01:19:43,590 --> 01:19:42,159
propulsion and the habitat

2119
01:19:45,189 --> 01:19:43,600
that we have there we obviously the

2120
01:19:46,310 --> 01:19:45,199
happy and healthy piece

2121
01:19:48,630 --> 01:19:46,320
we need to be able to figure out the

2122
01:19:50,709 --> 01:19:48,640
high reliability systems that sam

2123
01:19:52,709 --> 01:19:50,719
alluded to how do we build off a station

2124
01:19:55,110 --> 01:19:52,719
experience but increase the reliability

2125
01:19:57,669 --> 01:19:55,120
and decrease the consumables uh for us

2126
01:19:58,870 --> 01:19:57,679
sending the the crews all the way to

2127
01:20:00,149 --> 01:19:58,880
mars

2128
01:20:01,030 --> 01:20:00,159
and at the end of the day when we get

2129
01:20:05,030 --> 01:20:01,040
there

2130
01:20:06,709 --> 01:20:05,040
missions how do we ensure that we're

2131
01:20:08,629 --> 01:20:06,719
well equipped and productive over that

2132
01:20:10,790 --> 01:20:08,639
time so how do we look at the science

2133
01:20:12,870 --> 01:20:10,800
aspects that can be addressed both in

2134
01:20:14,149 --> 01:20:12,880
precursor missions but and as we send

2135
01:20:16,550 --> 01:20:14,159
the crew there

2136
01:20:17,510 --> 01:20:16,560
so next slide

2137
01:20:18,790 --> 01:20:17,520
so

2138
01:20:20,870 --> 01:20:18,800

a couple folks started talking about

2139
01:20:22,629 --> 01:20:20,880
this sam did at the beginning so we've

2140
01:20:24,790 --> 01:20:22,639
been breaking down our various elements

2141
01:20:26,070 --> 01:20:24,800
into three categories first of which is

2142
01:20:27,990 --> 01:20:26,080
transportation so if you look at

2143
01:20:29,990 --> 01:20:28,000
transportation fundamentally it's the

2144
01:20:32,149 --> 01:20:30,000
crew transport it's cargo it's

2145
01:20:34,229 --> 01:20:32,159
propulsion and it's a planetary

2146
01:20:36,229 --> 01:20:34,239
rendezvous an ops and landings type

2147
01:20:37,910 --> 01:20:36,239
capabilities and what you're seeing here

2148
01:20:40,070 --> 01:20:37,920
is an integration between our early

2149
01:20:41,669 --> 01:20:40,080
flights of sls and orion and the

2150
01:20:43,189 --> 01:20:41,679
asteroid mission starting to buy down

2151
01:20:45,430 --> 01:20:43,199
the risk and the proving on related to

2152
01:20:47,110 --> 01:20:45,440
crew transportation and cargo

2153
01:20:49,510 --> 01:20:47,120
in addition to that the solar electric

2154
01:20:52,149 --> 01:20:49,520
propulsion then starts bringing down our

2155
01:20:53,990 --> 01:20:52,159
risk and and bringing up our capability

2156
01:20:55,350 --> 01:20:54,000
as a knowledge for in-space propulsion

2157
01:20:56,709 --> 01:20:55,360
for pre-emplacement of some of that

2158
01:20:57,669 --> 01:20:56,719
cargo

2159
01:21:01,270 --> 01:20:57,679
the

2160
01:21:03,350 --> 01:21:01,280
manipulating large objects such as

2161
01:21:05,030 --> 01:21:03,360
asteroids start actually working out the

2162
01:21:07,510 --> 01:21:05,040
fundamental dynamics to be able to do

2163
01:21:09,910 --> 01:21:07,520

trajectories of large stacks to and from

2164
01:21:12,070 --> 01:21:09,920
mars do we throw away everything that on

2165
01:21:13,430 --> 01:21:12,080
every trip to mars but rather or do we

2166
01:21:15,189 --> 01:21:13,440
rather actually put it in different

2167
01:21:17,350 --> 01:21:15,199
parking orbits so that we use it on the

2168
01:21:19,189 --> 01:21:17,360
next visit to mars so we're looking at

2169
01:21:21,590 --> 01:21:19,199
how do you maintain orbits in long

2170
01:21:23,990 --> 01:21:21,600
periods of time and manipulate the those

2171
01:21:26,310 --> 01:21:24,000
objects that we have in addition we look

2172
01:21:27,669 --> 01:21:26,320
at opportunistic

2173
01:21:29,910 --> 01:21:27,679
partnerships with our international

2174
01:21:32,470 --> 01:21:29,920
commercial opportunities related to can

2175
01:21:34,950 --> 01:21:32,480
we advance in-situ resource utilization

2176
01:21:37,430 --> 01:21:34,960
knowledge um even in the cis lunar space

2177
01:21:40,550 --> 01:21:37,440
as our international partners focus um

2178
01:21:42,870 --> 01:21:40,560
on those areas um next chart one of the

2179
01:21:44,629 --> 01:21:42,880
key um points that a lot of others have

2180
01:21:47,189 --> 01:21:44,639
brought up is we're continuing a strong

2181
01:21:50,149 --> 01:21:47,199
partnership between us science and space

2182
01:21:52,629 --> 01:21:50,159
technology uh mars 2020 is a

2183
01:21:54,950 --> 01:21:52,639
continuation of a path of cooperation

2184
01:21:57,030 --> 01:21:54,960
within the within the agency

2185
01:21:58,950 --> 01:21:57,040
building on our knowledge and gaining

2186
01:22:00,629 --> 01:21:58,960
knowledge and entry descent and landing

2187
01:22:04,149 --> 01:22:00,639
with another flight of our medley

2188
01:22:05,430 --> 01:22:04,159

instrument uh on mars 2020 and as john

2189
01:22:07,189 --> 01:22:05,440
noted

2190
01:22:09,430 --> 01:22:07,199
addressing strategic knowledge gaps one

2191
01:22:11,830 --> 01:22:09,440
of which is in-situ resource utilization

2192
01:22:13,990 --> 01:22:11,840
which is our key uh key to us on our

2193
01:22:15,910 --> 01:22:14,000
return from mars one of our fundamentals

2194
01:22:17,990 --> 01:22:15,920
and most mars architectures is the

2195
01:22:19,590 --> 01:22:18,000
production of oxidizer for our

2196
01:22:21,430 --> 01:22:19,600
propulsion systems for the ascent

2197
01:22:23,270 --> 01:22:21,440
vehicles and our return trip on the

2198
01:22:25,510 --> 01:22:23,280
surface of mars so mars 2020 is

2199
01:22:27,189 --> 01:22:25,520
beginning that buy down of the the

2200
01:22:29,990 --> 01:22:27,199
knowledge of that uh that we need before

2201
01:22:31,750 --> 01:22:30,000
sending humans next slide

2202
01:22:32,950 --> 01:22:31,760
in addition to that um

2203
01:22:34,229 --> 01:22:32,960
we're trying to also work with the

2204
01:22:36,310 --> 01:22:34,239
commercial sector on landing

2205
01:22:38,229 --> 01:22:36,320
capabilities so we have an initiative

2206
01:22:40,470 --> 01:22:38,239
called the lunar catalyst which very

2207
01:22:42,390 --> 01:22:40,480
much like phil described we're doing no

2208
01:22:44,470 --> 01:22:42,400
exchange fund partnerships with

2209
01:22:46,470 --> 01:22:44,480
commercial industry this allows us to

2210
01:22:47,910 --> 01:22:46,480
continue to advance our landing

2211
01:22:49,430 --> 01:22:47,920
capabilities that we've been advancing

2212
01:22:51,430 --> 01:22:49,440
internally on programs such as mighty

2213
01:22:53,350 --> 01:22:51,440

eagle and morpheus but also then bring

2214
01:22:55,669 --> 01:22:53,360
in the commercial sector as well to

2215
01:22:57,669 --> 01:22:55,679
continue to advance this for our use for

2216
01:23:00,310 --> 01:22:57,679
planning on mars but also for commercial

2217
01:23:01,990 --> 01:23:00,320
use as they endeavor to uh create

2218
01:23:04,390 --> 01:23:02,000
landing type services and landing

2219
01:23:06,149 --> 01:23:04,400
capabilities for the lunar area in fact

2220
01:23:09,350 --> 01:23:06,159
we're getting ready to announce uh the

2221
01:23:11,350 --> 01:23:09,360
selection of this very very soon um uh

2222
01:23:12,470 --> 01:23:11,360
most likely this week so we're looking

2223
01:23:15,990 --> 01:23:12,480
forward to the announcements of these

2224
01:23:19,350 --> 01:23:16,000
partnerships that we have here next one

2225
01:23:21,430 --> 01:23:19,360
um one of the things to pull on is as we

2226
01:23:23,910 --> 01:23:21,440
advance commercial capabilities like in

2227
01:23:25,910 --> 01:23:23,920
catalyst it allows us to start testing

2228
01:23:28,550 --> 01:23:25,920
isru technologies maybe on a more

2229
01:23:30,629 --> 01:23:28,560
periodic basis um so one of the areas of

2230
01:23:32,790 --> 01:23:30,639
working in space you'll see isru is

2231
01:23:34,390 --> 01:23:32,800
captured in the proving ground down here

2232
01:23:37,030 --> 01:23:34,400
but you also see the communication

2233
01:23:39,350 --> 01:23:37,040
challenges the space walk challenges um

2234
01:23:41,750 --> 01:23:39,360
during uh assembly of space station we

2235
01:23:44,790 --> 01:23:41,760
we we overcame the a very big challenge

2236
01:23:46,470 --> 01:23:44,800
of rapid eva more frequent eva and as we

2237
01:23:48,629 --> 01:23:46,480
go to the mars surface now we need to

2238
01:23:50,950 --> 01:23:48,639

actually pick up that same capability

2239
01:23:52,870 --> 01:23:50,960
but in deep space and actually get even

2240
01:23:55,110 --> 01:23:52,880
more rapid eva that we do on station

2241
01:23:57,270 --> 01:23:55,120
today as we get to a planetary surface

2242
01:24:00,629 --> 01:23:57,280
type eva community

2243
01:24:01,750 --> 01:24:00,639
a capability on the next one

2244
01:24:04,390 --> 01:24:01,760
we're going to talk about staying

2245
01:24:06,310 --> 01:24:04,400
healthy and as we

2246
01:24:08,470 --> 01:24:06,320
do these high reliability type missions

2247
01:24:10,709 --> 01:24:08,480
in the proving ground period um we are

2248
01:24:13,110 --> 01:24:10,719
going to have to figure out how to not

2249
01:24:14,709 --> 01:24:13,120
as sam and others pointed out how not to

2250
01:24:17,430 --> 01:24:14,719
do grab samples for atmospheric

2251
01:24:20,229 --> 01:24:17,440
monitoring how to do remote medicine

2252
01:24:22,149 --> 01:24:20,239
we are days from home at that point

2253
01:24:24,229 --> 01:24:22,159
in even longer duration as we step even

2254
01:24:26,229 --> 01:24:24,239
further out from cis-lunar space so how

2255
01:24:28,149 --> 01:24:26,239
do we do that we also look at advancing

2256
01:24:30,390 --> 01:24:28,159
of automation so we're utilizing space

2257
01:24:32,149 --> 01:24:30,400
station today on looking at more and

2258
01:24:33,910 --> 01:24:32,159
more systems that we can automate and

2259
01:24:35,990 --> 01:24:33,920
make things crew tended and less

2260
01:24:37,510 --> 01:24:36,000
attentive to the ground and have less

2261
01:24:40,149 --> 01:24:37,520
interactions with the ground so that the

2262
01:24:42,470 --> 01:24:40,159
vehicle can safe itself um when we're on

2263
01:24:43,990 --> 01:24:42,480

these longer duration missions

2264
01:24:45,270 --> 01:24:44,000
i already touched on environmental

2265
01:24:47,189 --> 01:24:45,280
monitoring but how do we do that in a

2266
01:24:49,110 --> 01:24:47,199
more closed-loop earth independent type

2267
01:24:51,830 --> 01:24:49,120
phase where you don't be you can't bring

2268
01:24:53,750 --> 01:24:51,840
samples back to earth and and run the

2269
01:24:55,750 --> 01:24:53,760
run the test here to ensure that the

2270
01:24:57,830 --> 01:24:55,760
quality of the atmosphere or when we get

2271
01:24:59,590 --> 01:24:57,840
to the surface of mr or the mars that

2272
01:25:01,189 --> 01:24:59,600
the actual mars environment hasn't

2273
01:25:02,790 --> 01:25:01,199
actually done something to our

2274
01:25:05,430 --> 01:25:02,800
atmosphere where our crew is living and

2275
01:25:07,510 --> 01:25:05,440
working there um so that

2276
01:25:09,510 --> 01:25:07,520
what i'm trying to show you here is that

2277
01:25:11,590 --> 01:25:09,520
we're moving away from this monolithic

2278
01:25:13,750 --> 01:25:11,600
kind of program strategy to more of this

2279
01:25:15,830 --> 01:25:13,760
evolvable campaign where every

2280
01:25:17,590 --> 01:25:15,840
contribution that the agency is putting

2281
01:25:19,830 --> 01:25:17,600
in allows us to answer these key

2282
01:25:21,669 --> 01:25:19,840
strategic knowledge gaps and enable us

2283
01:25:24,149 --> 01:25:21,679
to get to mars

2284
01:25:26,070 --> 01:25:24,159
in a very productive and efficient way

2285
01:25:28,390 --> 01:25:26,080
over a period of time so with that i

2286
01:25:29,830 --> 01:25:28,400
have my last slide um and i'll leave

2287
01:25:31,990 --> 01:25:29,840
that up for the

2288
01:25:33,350 --> 01:25:32,000

for whatever q a we have time for great

2289
01:25:35,669 --> 01:25:33,360
thank you very much uh please help me

2290
01:25:38,229 --> 01:25:35,679
thank our panel and we'll uh

2291
01:25:39,590 --> 01:25:38,239
we'll take a few questions

2292
01:25:41,030 --> 01:25:39,600
all right

2293
01:25:43,110 --> 01:25:41,040
so we have a couple of microphones in

2294
01:25:44,470 --> 01:25:43,120
the audience uh so we'll take a show of

2295
01:25:45,830 --> 01:25:44,480
hands and get to some of those then

2296
01:25:47,590 --> 01:25:45,840
we'll take some of the questions from

2297
01:25:50,470 --> 01:25:47,600
social media and we'll start down here

2298
01:25:52,310 --> 01:25:50,480
in the front with ken go ahead

2299
01:25:54,229 --> 01:25:52,320
hi thank you ken kramer for universe

2300
01:25:55,830 --> 01:25:54,239
today thanks for doing this today i have

2301
01:25:58,229 --> 01:25:55,840
a question um

2302
01:25:59,669 --> 01:25:58,239
for bill and john and maybe the others

2303
01:26:02,390 --> 01:25:59,679
too for bill

2304
01:26:04,229 --> 01:26:02,400
um can you describe a little bit you've

2305
01:26:06,390 --> 01:26:04,239
talked to talked a little about em1 and

2306
01:26:07,110 --> 01:26:06,400
em2 and getting to mars but but there's

2307
01:26:09,350 --> 01:26:07,120
not

2308
01:26:11,030 --> 01:26:09,360
a lot in between can you

2309
01:26:13,350 --> 01:26:11,040
discuss

2310
01:26:15,669 --> 01:26:13,360
when after we do the asteroid redirect

2311
01:26:17,430 --> 01:26:15,679
what what comes beyond that

2312
01:26:19,189 --> 01:26:17,440
before we get to mars

2313
01:26:20,709 --> 01:26:19,199

and for john

2314
01:26:22,709 --> 01:26:20,719
can you talk a little bit about the

2315
01:26:24,229 --> 01:26:22,719
radiation risk you're an astronaut

2316
01:26:26,070 --> 01:26:24,239
you've talked about you guys have talked

2317
01:26:27,350 --> 01:26:26,080
about having to relax the radiation

2318
01:26:28,470 --> 01:26:27,360
requirements you're going to have to

2319
01:26:31,270 --> 01:26:28,480
accept

2320
01:26:33,110 --> 01:26:31,280
a higher chance of of

2321
01:26:35,430 --> 01:26:33,120
you know radiation damage to your bodies

2322
01:26:36,870 --> 01:26:35,440
can you talk about that from

2323
01:26:38,550 --> 01:26:36,880
what is going to be acceptable and what

2324
01:26:40,709 --> 01:26:38,560
is acceptable to the astronauts thank

2325
01:26:45,189 --> 01:26:40,719
you

2326
01:26:47,110 --> 01:26:45,199
little bit about what do we do after the

2327
01:26:48,550 --> 01:26:47,120
asteroid redirect mission

2328
01:26:50,870 --> 01:26:48,560
you know we really talk about it as a

2329
01:26:52,629 --> 01:26:50,880
proving ground of space so we think we

2330
01:26:54,550 --> 01:26:52,639
need to do much more than just one

2331
01:26:56,709 --> 01:26:54,560
mission in this environment i think the

2332
01:26:58,709 --> 01:26:56,719
asteroid in itself will be compelling in

2333
01:27:01,110 --> 01:26:58,719
the fact that once it's there it's now

2334
01:27:03,189 --> 01:27:01,120
available as a resource to be used

2335
01:27:05,830 --> 01:27:03,199
as jason's talked about we need to look

2336
01:27:08,470 --> 01:27:05,840
at in-situ resource utilization

2337
01:27:10,709 --> 01:27:08,480
potentially look at putting a habitation

2338
01:27:12,470 --> 01:27:10,719

module a crew-tended habitation module

2339
01:27:13,750 --> 01:27:12,480
in the same distant retrograde orbit

2340
01:27:15,510 --> 01:27:13,760
around the moon

2341
01:27:17,350 --> 01:27:15,520
and what that's doing is again that

2342
01:27:18,709 --> 01:27:17,360
habitation module would play a role in

2343
01:27:20,550 --> 01:27:18,719
the mars mission potentially the

2344
01:27:23,030 --> 01:27:20,560
habitation module for the mars mission

2345
01:27:25,510 --> 01:27:23,040
that comes forward so what you see is

2346
01:27:27,350 --> 01:27:25,520
you see essentially a cadence of things

2347
01:27:29,590 --> 01:27:27,360
that we're doing that all are focused on

2348
01:27:31,830 --> 01:27:29,600
mars but how do we buy down the risk

2349
01:27:33,910 --> 01:27:31,840
associated with mars how do we gain the

2350
01:27:35,430 --> 01:27:33,920
experience gain the technology gain the

2351
01:27:37,750 --> 01:27:35,440
hardware experience and the operational

2352
01:27:39,750 --> 01:27:37,760
capabilities keep moving so we see you

2353
01:27:41,830 --> 01:27:39,760
know roughly a cadence of flights after

2354
01:27:43,270 --> 01:27:41,840
this em2 flight or the after the

2355
01:27:45,030 --> 01:27:43,280
asteroid redirect mission that will

2356
01:27:47,189 --> 01:27:45,040
continue to build on those

2357
01:27:49,189 --> 01:27:47,199
it's also important that if the asteroid

2358
01:27:51,110 --> 01:27:49,199
isn't there for em-2 we would still plan

2359
01:27:53,669 --> 01:27:51,120
on flying em-2 in roughly the same time

2360
01:27:55,910 --> 01:27:53,679
frame in the 2021 time frame when the

2361
01:27:57,590 --> 01:27:55,920
asteroid is there say it's one of the

2362
01:28:00,070 --> 01:27:57,600
candidates that michelle talked about it

2363
01:28:02,550 --> 01:28:00,080

could be in the 2025 time frame and then

2364
01:28:05,110 --> 01:28:02,560
we take orion to that point so again we

2365
01:28:06,790 --> 01:28:05,120
kind of let our cadence and experience

2366
01:28:09,189 --> 01:28:06,800
drive what we go do and what we move

2367
01:28:10,870 --> 01:28:09,199
forward we also let our risk tolerance

2368
01:28:12,870 --> 01:28:10,880
kind of drive what we want to go do you

2369
01:28:15,270 --> 01:28:12,880
know dan laid out a very interesting

2370
01:28:17,110 --> 01:28:15,280
mission for em2 maybe it's

2371
01:28:18,709 --> 01:28:17,120
after we see em one we may determine

2372
01:28:20,390 --> 01:28:18,719
it's too risky to go into distant

2373
01:28:22,470 --> 01:28:20,400
retrograde orbit we want to do some kind

2374
01:28:24,070 --> 01:28:22,480
of more of a lunar flyby we need to be

2375
01:28:26,149 --> 01:28:24,080
adaptable and don't say that we've

2376
01:28:27,910 --> 01:28:26,159
changed the program or we've fallen off

2377
01:28:29,669 --> 01:28:27,920
the program we need to create a

2378
01:28:32,070 --> 01:28:29,679
framework and a structure that allows us

2379
01:28:33,990 --> 01:28:32,080
to take data maximize our learning and

2380
01:28:35,270 --> 01:28:34,000
if we learn something that moves us in a

2381
01:28:36,629 --> 01:28:35,280
different direction and we need to be

2382
01:28:38,550 --> 01:28:36,639
nimble enough to move in that different

2383
01:28:41,189 --> 01:28:38,560
direction so that's that's how this

2384
01:28:43,110 --> 01:28:41,199
whole kind of framework all gets laid

2385
01:28:44,629 --> 01:28:43,120
together into essentially this

2386
01:28:48,870 --> 01:28:44,639
architecture we talk about to eventually

2387
01:28:52,550 --> 01:28:50,470
sure well ken you've asked a really

2388
01:28:54,629 --> 01:28:52,560

important question which is uh about the

2389
01:28:56,390 --> 01:28:54,639
radiation risks and that's something

2390
01:28:58,390 --> 01:28:56,400
that we're learning about with our rad

2391
01:28:59,830 --> 01:28:58,400
instrument on mars and cruise to mars

2392
01:29:01,350 --> 01:28:59,840
that we'll learn about on future

2393
01:29:02,870 --> 01:29:01,360
missions but we're also learning about

2394
01:29:05,030 --> 01:29:02,880
on the international space station now

2395
01:29:06,550 --> 01:29:05,040
we're lucky uh here on earth and in low

2396
01:29:08,629 --> 01:29:06,560
earth orbit to be protected by the

2397
01:29:10,629 --> 01:29:08,639
earth's magnetic field and on earth by

2398
01:29:12,550 --> 01:29:10,639
the atmosphere although there's a pretty

2399
01:29:14,470 --> 01:29:12,560
high natural radiation environment which

2400
01:29:17,750 --> 01:29:14,480
we evolved in and so the body has

2401
01:29:19,189 --> 01:29:17,760
mechanisms for repair of cells and

2402
01:29:21,350 --> 01:29:19,199
programmed cell death when there's

2403
01:29:23,350 --> 01:29:21,360
radiation damage for the low level of

2404
01:29:24,709 --> 01:29:23,360
radiations that we live now we really

2405
01:29:26,550 --> 01:29:24,719
don't know what's going to happen as we

2406
01:29:29,110 --> 01:29:26,560
go out into deep space we're exposed to

2407
01:29:32,070 --> 01:29:29,120
the galactic cosmic rays which are a

2408
01:29:33,189 --> 01:29:32,080
harder source of of radiation and so in

2409
01:29:35,110 --> 01:29:33,199
the proving ground that's one of the

2410
01:29:36,229 --> 01:29:35,120
things we're going to learn about now

2411
01:29:38,390 --> 01:29:36,239
you know that's saying yeah we're going

2412
01:29:39,750 --> 01:29:38,400
to put people out to be guinea pigs and

2413
01:29:41,350 --> 01:29:39,760

as a

2414
01:29:43,030 --> 01:29:41,360
guinea pig myself

2415
01:29:44,870 --> 01:29:43,040
for low-earth orbit flights you know

2416
01:29:46,950 --> 01:29:44,880
that's what it's about to be human to

2417
01:29:49,030 --> 01:29:46,960
learn to learn to explore to learn to

2418
01:29:51,110 --> 01:29:49,040
pioneer

2419
01:29:52,390 --> 01:29:51,120
in the same time frame in the 2020s and

2420
01:29:54,229 --> 01:29:52,400
2030s

2421
01:29:57,030 --> 01:29:54,239
we will also be able to take advantage

2422
01:29:59,590 --> 01:29:57,040
of really incredible medical advances

2423
01:30:01,110 --> 01:29:59,600
where we are learning at the micro level

2424
01:30:03,750 --> 01:30:01,120
the nano level

2425
01:30:06,790 --> 01:30:03,760
how to identify cancerous cells for

2426
01:30:09,990 --> 01:30:06,800
instance and how to

2427
01:30:11,910 --> 01:30:10,000
co-opt for instance the actual

2428
01:30:14,629 --> 01:30:11,920
genetic mechanisms in the cell to

2429
01:30:16,070 --> 01:30:14,639
program that particular cell to die we

2430
01:30:18,390 --> 01:30:16,080
you know there's a lot of work going on

2431
01:30:19,590 --> 01:30:18,400
around the country universities at

2432
01:30:20,550 --> 01:30:19,600
national institutes of health and

2433
01:30:23,110 --> 01:30:20,560
elsewhere

2434
01:30:25,030 --> 01:30:23,120
to help people on earth that one we may

2435
01:30:26,629 --> 01:30:25,040
learn from our space exposure but two

2436
01:30:28,390 --> 01:30:26,639
what we'll learn from improving human

2437
01:30:30,550 --> 01:30:28,400
health on earth to apply to space

2438
01:30:31,430 --> 01:30:30,560

exposure so all of that work is in front

2439
01:30:33,750 --> 01:30:31,440
of us

2440
01:30:36,070 --> 01:30:33,760
we know it's a risk but on the scale of

2441
01:30:37,750 --> 01:30:36,080
the overall risk of emission to mars you

2442
01:30:40,390 --> 01:30:37,760
know the radiation risk is just one of

2443
01:30:42,229 --> 01:30:40,400
those risks you know any anybody who

2444
01:30:44,390 --> 01:30:42,239
watches a space launch or watches a

2445
01:30:46,070 --> 01:30:44,400
human space flight launch such as a

2446
01:30:47,910 --> 01:30:46,080
space shuttle knows there's a lot of

2447
01:30:50,229 --> 01:30:47,920
energy involved so just getting to earth

2448
01:30:52,229 --> 01:30:50,239
orbit for starters is risky then the

2449
01:30:53,830 --> 01:30:52,239
cruise to mars will be risky entry

2450
01:30:55,990 --> 01:30:53,840
through the mars atmosphere and landing

2451
01:30:57,990 --> 01:30:56,000
entries descent landing for the

2452
01:30:59,990 --> 01:30:58,000
curiosity rover it was seven minutes of

2453
01:31:02,070 --> 01:31:00,000
terror that's how we describe it it was

2454
01:31:03,910 --> 01:31:02,080
a risky maneuver so we'll have to look

2455
01:31:06,390 --> 01:31:03,920
at the overall risk

2456
01:31:08,390 --> 01:31:06,400
you know as a risk taker versus a risk

2457
01:31:10,470 --> 01:31:08,400
manager i can just say i think that risk

2458
01:31:12,149 --> 01:31:10,480
would be worth it

2459
01:31:13,350 --> 01:31:12,159
let's go next to frank mooring here in

2460
01:31:15,350 --> 01:31:13,360
the front right can also see a show of

2461
01:31:17,830 --> 01:31:15,360
hands just we know how to

2462
01:31:20,470 --> 01:31:17,840
others here in the front okay so

2463
01:31:22,470 --> 01:31:20,480

here here at the bottom middle

2464
01:31:24,629 --> 01:31:22,480
hi it's frank mooring with aviation week

2465
01:31:26,470 --> 01:31:24,639
for jason i guess maybe for bill

2466
01:31:28,390 --> 01:31:26,480
gerstenmaier i was interested in what

2467
01:31:32,149 --> 01:31:28,400
you said about the

2468
01:31:33,590 --> 01:31:32,159
isru on 2020 rover and then later in cis

2469
01:31:35,990 --> 01:31:33,600
lunar could you go into a little more

2470
01:31:37,750 --> 01:31:36,000
detail about

2471
01:31:39,830 --> 01:31:37,760
what you're going to do on the rover

2472
01:31:41,750 --> 01:31:39,840
what you might be able to do in sis

2473
01:31:44,149 --> 01:31:41,760
lunar later on

2474
01:31:46,790 --> 01:31:44,159
and then also how it may be for progress

2475
01:31:48,149 --> 01:31:46,800
how it would fit into the architecture

2476
01:31:51,510 --> 01:31:48,159
yeah so for

2477
01:31:54,229 --> 01:31:51,520
for march 2020 um we're looking at um

2478
01:31:56,950 --> 01:31:54,239
the production and separation of oxygen

2479
01:31:59,270 --> 01:31:56,960
from co2 is the fundamental so going

2480
01:32:01,270 --> 01:31:59,280
back to one of the things that we need

2481
01:32:04,070 --> 01:32:01,280
for future ascent vehicles off the

2482
01:32:06,070 --> 01:32:04,080
surface of the mars a good mass fraction

2483
01:32:07,669 --> 01:32:06,080
of the of your vehicle to take back off

2484
01:32:09,750 --> 01:32:07,679
the surface is your oxidizer so we're

2485
01:32:11,669 --> 01:32:09,760
looking at the oxygen specifically and

2486
01:32:12,709 --> 01:32:11,679
separating that from the atmosphere of

2487
01:32:14,709 --> 01:32:12,719
mars

2488
01:32:17,030 --> 01:32:14,719

we're also looking at

2489
01:32:19,590 --> 01:32:17,040
as bill noted related to the asteroid

2490
01:32:22,070 --> 01:32:19,600
and or on a lunar surface

2491
01:32:23,750 --> 01:32:22,080
are there ways to harvest material

2492
01:32:25,270 --> 01:32:23,760
that could be beneficial for human space

2493
01:32:27,430 --> 01:32:25,280
flight and we haven't finished those

2494
01:32:29,990 --> 01:32:27,440
trades i mean some of it if we happen to

2495
01:32:32,470 --> 01:32:30,000
have an asteroid that has uh uh water

2496
01:32:34,629 --> 01:32:32,480
content or hydrogen in a generic sense

2497
01:32:36,070 --> 01:32:34,639
um could that help us with uh shielding

2498
01:32:39,350 --> 01:32:36,080
and answering the radiation question

2499
01:32:41,430 --> 01:32:39,360
could it could it serve as a point of

2500
01:32:43,510 --> 01:32:41,440
gathering material for propulsion

2501
01:32:46,070 --> 01:32:43,520
systems or even other consumables that

2502
01:32:47,270 --> 01:32:46,080
we have for human spaceflight and

2503
01:32:49,830 --> 01:32:47,280
opportunist

2504
01:32:52,149 --> 01:32:49,840
opportunities with the asteroid and or

2505
01:32:54,470 --> 01:32:52,159
the lunar surface may be driven more by

2506
01:32:56,070 --> 01:32:54,480
our international partners as they

2507
01:32:57,270 --> 01:32:56,080
return and do

2508
01:32:59,669 --> 01:32:57,280
trips to the moon it will give us

2509
01:33:01,510 --> 01:32:59,679
opportunities to fly instrumentation on

2510
01:33:04,550 --> 01:33:01,520
a more frequent basis than just flights

2511
01:33:07,430 --> 01:33:04,560
to mars to advance that same isru

2512
01:33:08,950 --> 01:33:07,440
capability on a regular cadence

2513
01:33:11,350 --> 01:33:08,960

with the right return on investment

2514
01:33:12,950 --> 01:33:11,360
working with partners

2515
01:33:14,950 --> 01:33:12,960
and the only thing i would add is again

2516
01:33:17,270 --> 01:33:14,960
from a big picture standpoint

2517
01:33:19,830 --> 01:33:17,280
is we're looking at insta2 resource

2518
01:33:21,990 --> 01:33:19,840
utilization very early in this sequence

2519
01:33:24,229 --> 01:33:22,000
because it has a dramatic change in the

2520
01:33:26,470 --> 01:33:24,239
way we do business about whether we can

2521
01:33:28,709 --> 01:33:26,480
use a propellant as jason talked about

2522
01:33:30,310 --> 01:33:28,719
or use that you know do we need can we

2523
01:33:31,830 --> 01:33:30,320
generate propellant on mars for the

2524
01:33:34,070 --> 01:33:31,840
return flight

2525
01:33:36,229 --> 01:33:34,080
what can we use from the moon how easy

2526
01:33:37,990 --> 01:33:36,239
is is it to do this how effective these

2527
01:33:39,910 --> 01:33:38,000
systems are what kind of return we can

2528
01:33:41,910 --> 01:33:39,920
get those are really important things

2529
01:33:43,750 --> 01:33:41,920
that once we know the answers to those

2530
01:33:45,669 --> 01:33:43,760
they can dramatically affect the

2531
01:33:47,510 --> 01:33:45,679
architecture and affect the mission

2532
01:33:49,350 --> 01:33:47,520
scenarios we put together in the future

2533
01:33:50,790 --> 01:33:49,360
so we've kind of structured the things

2534
01:33:52,629 --> 01:33:50,800
we're looking at is we want to look at

2535
01:33:54,550 --> 01:33:52,639
those things that have the biggest lever

2536
01:33:56,470 --> 01:33:54,560
or have the biggest potential of

2537
01:33:58,709 --> 01:33:56,480
changing the way we go forward look at

2538
01:34:00,390 --> 01:33:58,719

those early so we can adapt those and

2539
01:34:02,790 --> 01:34:00,400
then change our strategy as we move

2540
01:34:04,229 --> 01:34:02,800
forward

2541
01:34:05,750 --> 01:34:04,239
just reminder to those watching online

2542
01:34:07,189 --> 01:34:05,760
we'd love to get your questions we'll

2543
01:34:08,870 --> 01:34:07,199
turn to them in a second just let us

2544
01:34:11,189 --> 01:34:08,880
know if you have a question on twitter

2545
01:34:12,470 --> 01:34:11,199
using the hashtag ask nasa let's go to

2546
01:34:15,990 --> 01:34:12,480
miriam kramer

2547
01:34:17,189 --> 01:34:16,000
yeah miriamkramer with space.com uh i i

2548
01:34:20,229 --> 01:34:17,199
think this question is probably for

2549
01:34:22,070 --> 01:34:20,239
michelle or jason and i'm curious is

2550
01:34:24,709 --> 01:34:22,080
there a set time frame for when you need

2551
01:34:28,070 --> 01:34:24,719
to decide the mission profile for the

2552
01:34:29,990 --> 01:34:28,080
asteroid redirect mission and

2553
01:34:31,990 --> 01:34:30,000
within that i mean when when would the

2554
01:34:34,470 --> 01:34:32,000
spacecraft the robotic spacecraft need

2555
01:34:38,149 --> 01:34:34,480
to be built for humans to be able to get

2556
01:34:41,350 --> 01:34:39,270
so

2557
01:34:43,430 --> 01:34:41,360
the current plan

2558
01:34:46,070 --> 01:34:43,440
is to down select between the two

2559
01:34:48,310 --> 01:34:46,080
capture options the one with the small

2560
01:34:49,990 --> 01:34:48,320
free-floating asteroid and the large

2561
01:34:51,910 --> 01:34:50,000
asteroid with the coherent mass the

2562
01:34:53,910 --> 01:34:51,920
boulder

2563
01:34:57,270 --> 01:34:53,920

we're planning for that in mid-december

2564
01:34:59,510 --> 01:34:57,280
of course it depends on what we learn in

2565
01:35:00,950 --> 01:34:59,520
until then we've got the baa out and

2566
01:35:02,550 --> 01:35:00,960
we've got

2567
01:35:03,590 --> 01:35:02,560
internal risk reduction going on so

2568
01:35:05,030 --> 01:35:03,600
we're planning for that piece in

2569
01:35:07,990 --> 01:35:05,040
mid-december

2570
01:35:12,629 --> 01:35:10,790
segregate the class of asteroid targets

2571
01:35:15,990 --> 01:35:12,639
that we're looking at

2572
01:35:18,709 --> 01:35:16,000
and our plan is to keep the target the

2573
01:35:20,629 --> 01:35:18,719
final target selection open as fine as

2574
01:35:23,510 --> 01:35:20,639
long as possible

2575
01:35:24,950 --> 01:35:23,520
ideally up to a year before launch

2576
01:35:25,990 --> 01:35:24,960
if possible

2577
01:35:27,270 --> 01:35:26,000
um

2578
01:35:29,910 --> 01:35:27,280
and

2579
01:35:33,030 --> 01:35:29,920
the current plan is also um

2580
01:35:35,350 --> 01:35:33,040
for a mid to late 2019 launch of the

2581
01:35:38,470 --> 01:35:35,360
robotic mission for return

2582
01:35:41,109 --> 01:35:38,480
uh the target asteroid as early as 2023

2583
01:35:44,229 --> 01:35:41,119
but most of our uh current potential

2584
01:35:46,229 --> 01:35:44,239
candidates return and are available

2585
01:35:50,070 --> 01:35:46,239
in the dro for the crew which means it's

2586
01:35:52,149 --> 01:35:50,080
settled in the dro in 2024 or 2025.

2587
01:35:54,149 --> 01:35:52,159
thanks let me just take podium privilege

2588
01:35:55,189 --> 01:35:54,159

here for for folks watching what's the

2589
01:35:57,750 --> 01:35:55,199
dro

2590
01:35:59,990 --> 01:35:57,760
sorry the lunar distant retrograde orbit

2591
01:36:02,070 --> 01:36:00,000
okay and and can can you jason say a

2592
01:36:03,910 --> 01:36:02,080
couple more words about baa where things

2593
01:36:04,870 --> 01:36:03,920
currently stand what the timeline is

2594
01:36:07,270 --> 01:36:04,880
because that's that's a unique

2595
01:36:08,629 --> 01:36:07,280
opportunity for for others not nasa to

2596
01:36:09,910 --> 01:36:08,639
participate in advancing some of the

2597
01:36:13,109 --> 01:36:09,920
technologies you're looking for

2598
01:36:14,470 --> 01:36:13,119
proposals are due may 5th okay and for

2599
01:36:16,070 --> 01:36:14,480
more information on the broad agency

2600
01:36:19,109 --> 01:36:16,080
announcements baa

2601
01:36:21,510 --> 01:36:19,119
nasa.gov asteroid initiative

2602
01:36:23,510 --> 01:36:21,520
redirect mission baa is what it's called

2603
01:36:25,990 --> 01:36:23,520
right you can find it online exactly

2604
01:36:27,830 --> 01:36:26,000
okay thanks uh let's go to social

2605
01:36:29,669 --> 01:36:27,840
what do we have lauren we have a lot of

2606
01:36:32,629 --> 01:36:29,679
engineering questions coming in from

2607
01:36:34,790 --> 01:36:32,639
twitter here so i'm going to try to

2608
01:36:36,550 --> 01:36:34,800
start with some of those first question

2609
01:36:38,629 --> 01:36:36,560
and this may be for dan

2610
01:36:41,910 --> 01:36:38,639
from carl murray why does orion look a

2611
01:36:46,709 --> 01:36:43,910
well that's pretty simple physics hasn't

2612
01:36:48,149 --> 01:36:46,719
changed um since the apollo era not that

2613
01:36:51,830 --> 01:36:48,159

i'm aware of

2614
01:36:53,189 --> 01:36:51,840
the the real issue is when we come back

2615
01:36:54,870 --> 01:36:53,199
when we look at the overall mission

2616
01:36:57,830 --> 01:36:54,880
trades

2617
01:36:59,590 --> 01:36:57,840
weight is very important and you have to

2618
01:37:01,350 --> 01:36:59,600
look at how you're going to get the crew

2619
01:37:03,350 --> 01:37:01,360
home safely

2620
01:37:06,470 --> 01:37:03,360
what we know is

2621
01:37:09,189 --> 01:37:06,480
essentially a ballistic reentry

2622
01:37:11,430 --> 01:37:09,199
is easier to do it has its own

2623
01:37:13,350 --> 01:37:11,440
challenges but it's better to do it that

2624
01:37:16,310 --> 01:37:13,360
way on a mission out to the moon and

2625
01:37:18,149 --> 01:37:16,320
beyond because of the reentry velocities

2626
01:37:20,470 --> 01:37:18,159
so that we don't have to carry a winged

2627
01:37:22,709 --> 01:37:20,480
surface all the way out and all the way

2628
01:37:24,709 --> 01:37:22,719
back so it becomes a mass trade a

2629
01:37:26,790 --> 01:37:24,719
reliability trade

2630
01:37:29,669 --> 01:37:26,800
and a performance trade

2631
01:37:32,629 --> 01:37:29,679
we have grown up orion

2632
01:37:35,590 --> 01:37:32,639
apollo was designed for three crew

2633
01:37:39,590 --> 01:37:35,600
we are designing orion for four to six

2634
01:37:41,189 --> 01:37:39,600
crew so it is bigger uh and we have to

2635
01:37:43,109 --> 01:37:41,199
eventually prepare it for the re-entry

2636
01:37:45,350 --> 01:37:43,119
velocities that we will need from for a

2637
01:37:47,510 --> 01:37:45,360
mars reentry which are faster

2638
01:37:48,470 --> 01:37:47,520

and more energetic than a lunar re-entry

2639
01:37:51,189 --> 01:37:48,480
so

2640
01:37:55,830 --> 01:37:51,199
basically the physics is is dictating it

2641
01:38:00,870 --> 01:37:57,669
great thanks

2642
01:38:03,189 --> 01:38:00,880
and uh on that speaking now more about

2643
01:38:05,270 --> 01:38:03,199
uh the rocket um

2644
01:38:07,590 --> 01:38:05,280
how are the how's the space launch

2645
01:38:10,149 --> 01:38:07,600
system compared to the the saturn

2646
01:38:12,149 --> 01:38:10,159
rockets used on the apollo missions

2647
01:38:14,070 --> 01:38:12,159
once we get to the 130 metric ton

2648
01:38:16,070 --> 01:38:14,080
version we will have about 10 percent

2649
01:38:18,310 --> 01:38:16,080
more mass

2650
01:38:19,109 --> 01:38:18,320
payload delivery capability than apollo

2651
01:38:21,669 --> 01:38:19,119
had

2652
01:38:23,430 --> 01:38:21,679
we will have much more volume capability

2653
01:38:24,870 --> 01:38:23,440
particularly when we go to a cargo

2654
01:38:27,590 --> 01:38:24,880
version

2655
01:38:30,310 --> 01:38:27,600
with the with the payload fairing

2656
01:38:33,350 --> 01:38:30,320
keep in mind that even the what we refer

2657
01:38:34,390 --> 01:38:33,360
to as the block 1 our em-1

2658
01:38:37,990 --> 01:38:34,400
vehicle

2659
01:38:39,990 --> 01:38:38,000
still

2660
01:38:41,590 --> 01:38:40,000
significantly more payload capability

2661
01:38:42,470 --> 01:38:41,600
than we had with shuttle

2662
01:38:44,709 --> 01:38:42,480
so

2663
01:38:48,149 --> 01:38:44,719

we're building it bigger and we will

2664
01:38:50,870 --> 01:38:48,159
evolve the 70 to about 105 metric tons

2665
01:38:53,189 --> 01:38:50,880
out to 130. once we get to that 130

2666
01:38:57,270 --> 01:38:53,199
we're about 10 percent larger mass wise

2667
01:38:57,280 --> 01:39:01,430
other questions in the audience

2668
01:39:01,440 --> 01:39:04,870
okay anything else from social

2669
01:39:12,229 --> 01:39:06,310
i'm getting lots of attention here thank

2670
01:39:15,030 --> 01:39:13,830
yeah this is a this is a great question

2671
01:39:17,109 --> 01:39:15,040
i think you guys are enjoying this one

2672
01:39:19,109 --> 01:39:17,119
so if what if we use this is from chris

2673
01:39:20,070 --> 01:39:19,119
fleet xcfleet47

2674
01:39:22,149 --> 01:39:20,080
on twitter

2675
01:39:25,189 --> 01:39:22,159
could we use the earth and our moon for

2676
01:39:29,910 --> 01:39:25,199
a figure eight slingshot effect

2677
01:39:29,920 --> 01:39:35,189
140 characters cruzan

2678
01:39:38,870 --> 01:39:37,669
in in essence i mean trajectories that

2679
01:39:40,950 --> 01:39:38,880
utilize

2680
01:39:42,229 --> 01:39:40,960
uh the lunar i mean the moon and or

2681
01:39:44,229 --> 01:39:42,239
earth have been used for many missions

2682
01:39:46,470 --> 01:39:44,239
over uh years in fact our science

2683
01:39:49,189 --> 01:39:46,480
colleagues frequently use lunar flyby

2684
01:39:51,189 --> 01:39:49,199
and earth flyby maneuvers in order to

2685
01:39:52,870 --> 01:39:51,199
increase relative velocities to get out

2686
01:39:55,590 --> 01:39:52,880
to further destinations and use it to

2687
01:39:56,790 --> 01:39:55,600
assist so yeah those are just

2688
01:39:59,270 --> 01:39:56,800

other trajectories that could be in

2689
01:40:01,830 --> 01:39:59,280
consideration as we extend out there to

2690
01:40:04,950 --> 01:40:01,840
mars some of our mars scenarios do

2691
01:40:07,510 --> 01:40:04,960
actually um depart the uh like a direct

2692
01:40:10,229 --> 01:40:07,520
retrograde orbit the dro orbit and into

2693
01:40:12,550 --> 01:40:10,239
a near earth flyby or highly elliptical

2694
01:40:14,229 --> 01:40:12,560
flyby of earth on its departure to mars

2695
01:40:15,910 --> 01:40:14,239
so um it doesn't quite look like a

2696
01:40:17,669 --> 01:40:15,920
figure eight potentially but uh the

2697
01:40:18,629 --> 01:40:17,679
concept is the one that's been used a

2698
01:40:21,109 --> 01:40:18,639
lot

2699
01:40:22,790 --> 01:40:21,119
if if i may we could and it's harder as

2700
01:40:25,510 --> 01:40:22,800
jason's pointed out

2701
01:40:27,669 --> 01:40:25,520
one of the reasons that we have sls

2702
01:40:29,030 --> 01:40:27,679
sized the way we do is it provides us

2703
01:40:30,149 --> 01:40:29,040
the capability

2704
01:40:33,510 --> 01:40:30,159
to take

2705
01:40:35,350 --> 01:40:33,520
missions and go to them more directly

2706
01:40:37,590 --> 01:40:35,360
which is more efficient from a time and

2707
01:40:42,229 --> 01:40:37,600
cost perspective as its point as it's

2708
01:40:45,430 --> 01:40:43,590
okay thank you very much please help me

2709
01:40:47,189 --> 01:40:45,440
think our panel and we'll uh

2710
01:40:48,870 --> 01:40:47,199
ask our next speaker today

2711
01:40:50,629 --> 01:40:48,880
let's just come up

2712
01:40:51,590 --> 01:40:50,639
thanks everybody

2713
01:40:53,750 --> 01:40:51,600

and again you can find out more

2714
01:40:55,990 --> 01:40:53,760
information about uh nasa's exploration

2715
01:40:57,830 --> 01:40:56,000
program human exploration at nasa.gov

2716
01:40:59,830 --> 01:40:57,840
exploration if you really want to drill

2717
01:41:01,830 --> 01:40:59,840
down deeper into what uh

2718
01:41:02,790 --> 01:41:01,840
what the the plan looks like for orion's

2719
01:41:05,590 --> 01:41:02,800
upcoming

2720
01:41:06,629 --> 01:41:05,600
test flight and what uh what sls work

2721
01:41:08,950 --> 01:41:06,639
looks like as the rocket and the

2722
01:41:11,430 --> 01:41:08,960
spacecraft start to come together nasa i

2723
01:41:13,430 --> 01:41:11,440
guess exploration is the place for it i

2724
01:41:15,189 --> 01:41:13,440
think there you can also find the video

2725
01:41:16,870 --> 01:41:15,199
that dan showed that showcases some of

2726
01:41:18,390 --> 01:41:16,880
that hardware work that's happening

2727
01:41:20,310 --> 01:41:18,400
around the country on these

2728
01:41:22,709 --> 01:41:20,320
so now i'm pleased to

2729
01:41:24,629 --> 01:41:22,719
introduce our next speaker randy lillard

2730
01:41:26,550 --> 01:41:24,639
is the program executive for technology

2731
01:41:28,470 --> 01:41:26,560
demonstration missions the space

2732
01:41:30,950 --> 01:41:28,480
technology mission directorate since

2733
01:41:32,149 --> 01:41:30,960
joining nasa in 2000 he has supported

2734
01:41:34,149 --> 01:41:32,159
headquarters the jet propulsion

2735
01:41:35,590 --> 01:41:34,159
laboratory and the johnson space center

2736
01:41:37,590 --> 01:41:35,600
his previous work includes supporting

2737
01:41:39,270 --> 01:41:37,600
the columbia accident investigation and

2738
01:41:41,350 --> 01:41:39,280

nasa's return to flight efforts it's

2739
01:41:43,030 --> 01:41:41,360
also led a multi-agency team to develop

2740
01:41:44,550 --> 01:41:43,040
the aerothermodynamic

2741
01:41:46,870 --> 01:41:44,560
environments for orion i didn't mess

2742
01:41:48,790 --> 01:41:46,880
that up and supported the juno program

2743
01:41:50,790 --> 01:41:48,800
office during its launch campaign any

2744
01:41:52,790 --> 01:41:50,800
opportunity to plug juno a very cool

2745
01:41:55,669 --> 01:41:52,800
mission on its way to jupiter i think it

2746
01:41:56,950 --> 01:41:55,679
gets their 2016 uh nasa.gov slash so

2747
01:42:04,790 --> 01:41:56,960
let's just more information about that

2748
01:42:07,830 --> 01:42:06,070
i didn't know i'd help you plug juno

2749
01:42:09,030 --> 01:42:07,840
while i was up here so

2750
01:42:10,709 --> 01:42:09,040
thank you there's been some really

2751
01:42:12,709 --> 01:42:10,719
interesting presentations earlier so

2752
01:42:14,629 --> 01:42:12,719
hopefully we'll uh we'll continue with

2753
01:42:16,229 --> 01:42:14,639
space tech uh space light admission

2754
01:42:17,830 --> 01:42:16,239
directorate showing some of the uh be a

2755
01:42:20,149 --> 01:42:17,840
lot of overlap between what you just

2756
01:42:21,830 --> 01:42:20,159
heard from our uh our he omd friends

2757
01:42:23,750 --> 01:42:21,840
which i think is a very good

2758
01:42:28,390 --> 01:42:23,760
uh stance for how we are investing for

2759
01:42:32,790 --> 01:42:30,950
in order to execute an asteroid mission

2760
01:42:35,270 --> 01:42:32,800
or in the future return of the moon or

2761
01:42:37,350 --> 01:42:35,280
land humans on mars

2762
01:42:39,109 --> 01:42:37,360
we need a substantial and sustained

2763
01:42:40,390 --> 01:42:39,119

investment in technology

2764
01:42:42,470 --> 01:42:40,400
without this investment in space

2765
01:42:44,310 --> 01:42:42,480
technology we're not going to be able to

2766
01:42:46,229 --> 01:42:44,320
execute these missions when we uh when

2767
01:42:47,750 --> 01:42:46,239
we're ready to go in other words we

2768
01:42:49,830 --> 01:42:47,760
either have to sustain the development

2769
01:42:51,669 --> 01:42:49,840
now or we're not going to be ready the

2770
01:42:52,790 --> 01:42:51,679
space technology mission directorate was

2771
01:42:54,229 --> 01:42:52,800
formed

2772
01:42:56,950 --> 01:42:54,239
to make to keep that sustained

2773
01:42:57,990 --> 01:42:56,960
development moving forward

2774
01:42:59,510 --> 01:42:58,000
this chart

2775
01:43:01,350 --> 01:42:59,520
indicates how

2776
01:43:02,790 --> 01:43:01,360
the programs where we have we have nine

2777
01:43:04,229 --> 01:43:02,800
space technology programs in the

2778
01:43:06,310 --> 01:43:04,239
directorate

2779
01:43:08,310 --> 01:43:06,320
organized into three areas the first

2780
01:43:09,830 --> 01:43:08,320
area on the far right is how we are

2781
01:43:11,350 --> 01:43:09,840
working to create a market for the

2782
01:43:13,030 --> 01:43:11,360
growing economy

2783
01:43:14,950 --> 01:43:13,040
we have centennial challenges i think

2784
01:43:16,390 --> 01:43:14,960
you've seen a lot of the uh the

2785
01:43:18,229 --> 01:43:16,400
rovers and

2786
01:43:19,350 --> 01:43:18,239
electric airplane

2787
01:43:20,790 --> 01:43:19,360
challenges those have been very

2788
01:43:22,310 --> 01:43:20,800

successful we have flight opportunities

2789
01:43:23,910 --> 01:43:22,320
program

2790
01:43:26,790 --> 01:43:23,920
and small business research and this is

2791
01:43:28,790 --> 01:43:26,800
sbir utilizing small companies

2792
01:43:30,390 --> 01:43:28,800
uh we have our innovative concepts uh

2793
01:43:32,310 --> 01:43:30,400
you know the niacc guys we always call

2794
01:43:34,070 --> 01:43:32,320
the ones who are pushing the state of

2795
01:43:36,310 --> 01:43:34,080
the art uh breaking the laws of physics

2796
01:43:38,470 --> 01:43:36,320
come up with new ideas for the future

2797
01:43:40,070 --> 01:43:38,480
and along those lines we have grants

2798
01:43:42,629 --> 01:43:40,080
with many universities engaging all the

2799
01:43:44,709 --> 01:43:42,639
universities we can around the country

2800
01:43:46,070 --> 01:43:44,719
and our center of asian fund where we uh

2801
01:43:47,990 --> 01:43:46,080
get all the best and brightest at nasa

2802
01:43:49,990 --> 01:43:48,000
to put ideas forward for technology

2803
01:43:53,189 --> 01:43:50,000
innovation

2804
01:43:55,750 --> 01:43:53,199
and finally what we call our last

2805
01:43:57,510 --> 01:43:55,760
area of investment is the

2806
01:43:59,189 --> 01:43:57,520
demonstration for cross-cutting and

2807
01:44:01,189 --> 01:43:59,199
demonstrations we have a

2808
01:44:03,430 --> 01:44:01,199
tdm technology demonstration missions

2809
01:44:05,109 --> 01:44:03,440
which is where i work we have small

2810
01:44:06,629 --> 01:44:05,119
spacecraft which is sort of flight

2811
01:44:08,629 --> 01:44:06,639
demonstrations but geared towards small

2812
01:44:10,390 --> 01:44:08,639
spacecraft you know microsets and small

2813
01:44:13,030 --> 01:44:10,400

sets and we have the game changing

2814
01:44:15,350 --> 01:44:13,040
project which is pushing uh lab

2815
01:44:17,510 --> 01:44:15,360
built to develop in the lab to get it

2816
01:44:19,510 --> 01:44:17,520
ready for demonstration

2817
01:44:21,510 --> 01:44:19,520
within these nine programs

2818
01:44:24,550 --> 01:44:21,520
in the last few years since our

2819
01:44:26,950 --> 01:44:24,560
inception we have conducted nearly 50

2820
01:44:29,270 --> 01:44:26,960
external competitions evaluated more

2821
01:44:31,030 --> 01:44:29,280
than 9000 proposals and i believe we

2822
01:44:33,350 --> 01:44:31,040
actually have one person who's read just

2823
01:44:34,870 --> 01:44:33,360
about 9 000 of those proposals and we've

2824
01:44:37,270 --> 01:44:34,880
selected more than two thousand of those

2825
01:44:39,510 --> 01:44:37,280
proposals for award uh within those two

2826
01:44:41,430 --> 01:44:39,520
thousand proposals we've selected

2827
01:44:43,430 --> 01:44:41,440
that comes to about 900 million dollars

2828
01:44:46,470 --> 01:44:43,440
in in funds going to industry and

2829
01:44:48,550 --> 01:44:46,480
academia within those proposals

2830
01:44:50,470 --> 01:44:48,560
now we believe these uh investments are

2831
01:44:52,629 --> 01:44:50,480
addressing the high priority challenges

2832
01:44:55,270 --> 01:44:52,639
for us achieving safe and affordable

2833
01:44:57,189 --> 01:44:55,280
deep space exploration in fact

2834
01:44:58,790 --> 01:44:57,199
in the next 24 months and you need to

2835
01:45:01,510 --> 01:44:58,800
keep you keeping on our website to watch

2836
01:45:03,910 --> 01:45:01,520
this nasa.gov space tech we're going to

2837
01:45:05,669 --> 01:45:03,920
launch seven technology demonstrations

2838
01:45:07,350 --> 01:45:05,679

four within the small spacecraft

2839
01:45:08,709 --> 01:45:07,360
technology program and three within the

2840
01:45:10,629 --> 01:45:08,719
technology demonstration missions

2841
01:45:12,950 --> 01:45:10,639
program and actually we'll go through

2842
01:45:16,870 --> 01:45:12,960
some more details on that

2843
01:45:20,870 --> 01:45:18,709
how we have organized ourselves for the

2844
01:45:22,470 --> 01:45:20,880
near term how our investment strategy is

2845
01:45:24,149 --> 01:45:22,480
we've grouped these investments into

2846
01:45:25,990 --> 01:45:24,159
eight technology thrust areas for deep

2847
01:45:27,750 --> 01:45:26,000
space exploration

2848
01:45:29,510 --> 01:45:27,760
today

2849
01:45:30,390 --> 01:45:29,520
we will uh i'll go through some of these

2850
01:45:31,510 --> 01:45:30,400
in detail

2851
01:45:32,470 --> 01:45:31,520
not all of them we don't have time for

2852
01:45:33,990 --> 01:45:32,480
that

2853
01:45:35,669 --> 01:45:34,000
but these technology thrusters are

2854
01:45:37,750 --> 01:45:35,679
tightly coupled and aligned

2855
01:45:39,189 --> 01:45:37,760
with the nasa's technology roadmaps that

2856
01:45:41,109 --> 01:45:39,199
the office of chief technologist puts

2857
01:45:42,790 --> 01:45:41,119
out the space technology investment plan

2858
01:45:44,390 --> 01:45:42,800
or the stip and also the national

2859
01:45:46,229 --> 01:45:44,400
resource council recommendations on

2860
01:45:48,229 --> 01:45:46,239
those roadmaps so all our areas are

2861
01:45:49,830 --> 01:45:48,239
tightly coupled with with all of our we

2862
01:45:51,990 --> 01:45:49,840
see as our customers of where we want to

2863
01:45:53,590 --> 01:45:52,000

go

2864
01:45:55,030 --> 01:45:53,600
the first area which i'll highlight in

2865
01:45:57,189 --> 01:45:55,040
more detail you've already heard a lot

2866
01:45:58,550 --> 01:45:57,199
about today is solar electric propulsion

2867
01:46:00,550 --> 01:45:58,560
here we're looking at building a high

2868
01:46:03,030 --> 01:46:00,560
powered soil electrical repulsion system

2869
01:46:06,310 --> 01:46:03,040
using uh high power

2870
01:46:08,229 --> 01:46:06,320
flexible arrays and high and a new uh

2871
01:46:09,830 --> 01:46:08,239
thrusters for high power uh we'll go

2872
01:46:12,070 --> 01:46:09,840
into detail again on that

2873
01:46:14,070 --> 01:46:12,080
the next area is space optical com i

2874
01:46:16,390 --> 01:46:14,080
think uh sam talked about the need for

2875
01:46:18,550 --> 01:46:16,400
optical for communications so what we're

2876
01:46:21,109 --> 01:46:18,560
doing is a very interesting uh topic is

2877
01:46:23,590 --> 01:46:21,119
uh human exploration had done the lunar

2878
01:46:25,590 --> 01:46:23,600
laner lunar laser communications demo

2879
01:46:27,270 --> 01:46:25,600
llcd we're building on that

2880
01:46:29,669 --> 01:46:27,280
demonstration taking that hardware they

2881
01:46:31,109 --> 01:46:29,679
show that optical com works

2882
01:46:33,109 --> 01:46:31,119
optical com can increase the comp

2883
01:46:34,709 --> 01:46:33,119
capability from 10 to 100 times over the

2884
01:46:36,229 --> 01:46:34,719
current system so we take what they did

2885
01:46:37,430 --> 01:46:36,239
on llcd

2886
01:46:39,669 --> 01:46:37,440
we're going to do that with our

2887
01:46:41,109 --> 01:46:39,679
demonstration partner with heo to show

2888
01:46:42,390 --> 01:46:41,119

how to do an assist lunar and we're

2889
01:46:43,990 --> 01:46:42,400
going to develop that capability and

2890
01:46:45,750 --> 01:46:44,000
give it to industry give it to other

2891
01:46:47,189 --> 01:46:45,760
other government agencies and then we'll

2892
01:46:49,350 --> 01:46:47,199
take that knowledge and move it for

2893
01:46:51,030 --> 01:46:49,360
towards deep space optical calm so we

2894
01:46:52,550 --> 01:46:51,040
can move that optical comp capability

2895
01:46:54,629 --> 01:46:52,560
all the way to mars so we can get a

2896
01:46:57,590 --> 01:46:54,639
trunk line back from mars and many of

2897
01:46:59,270 --> 01:46:57,600
the images that that

2898
01:47:00,709 --> 01:46:59,280
curiosity has taken never get to leave

2899
01:47:01,990 --> 01:47:00,719
mars so the hope is we can get that

2900
01:47:04,629 --> 01:47:02,000
trunk line back to mars and actually

2901
01:47:05,590 --> 01:47:04,639
pull all the images back

2902
01:47:08,390 --> 01:47:05,600
the next

2903
01:47:10,709 --> 01:47:08,400
area is advanced life support i think

2904
01:47:12,629 --> 01:47:10,719
after the talk today i'm going to

2905
01:47:15,189 --> 01:47:12,639
skip that everybody knows how important

2906
01:47:17,109 --> 01:47:15,199
that is with this crowd

2907
01:47:18,470 --> 01:47:17,119
and then move on to introducing landing

2908
01:47:21,189 --> 01:47:18,480
this is an area that we are heavily

2909
01:47:25,030 --> 01:47:22,950
not only doing computational modeling

2910
01:47:27,189 --> 01:47:25,040
analytical models but also inflatable

2911
01:47:29,830 --> 01:47:27,199
structures and new propulsion techniques

2912
01:47:31,669 --> 01:47:29,840
to land large payloads on mars

2913
01:47:34,229 --> 01:47:31,679

curiosity was an amazing seven it's a

2914
01:47:36,709 --> 01:47:34,239
tear it was a one metric ton payload to

2915
01:47:39,830 --> 01:47:36,719
the surface so on the order of a

2916
01:47:41,750 --> 01:47:39,840
large a car we need to land

2917
01:47:43,430 --> 01:47:41,760
15 to 20 to 40 metric tons on the

2918
01:47:44,790 --> 01:47:43,440
surface for human missions so we're

2919
01:47:47,109 --> 01:47:44,800
looking at lining one to two story

2920
01:47:48,390 --> 01:47:47,119
buildings so we need new technologies to

2921
01:47:49,430 --> 01:47:48,400
get there and we have investments in

2922
01:47:51,030 --> 01:47:49,440
that and i'll show you one of those

2923
01:47:52,229 --> 01:47:51,040
today

2924
01:47:54,390 --> 01:47:52,239
and then the final one i'll talk about

2925
01:47:56,470 --> 01:47:54,400
today is lightweight structures we have

2926
01:47:59,030 --> 01:47:56,480
a very big interest in composites to

2927
01:48:01,430 --> 01:47:59,040
help sls move forward we think that

2928
01:48:03,430 --> 01:48:01,440
if we can replace a upper stage for sls

2929
01:48:05,750 --> 01:48:03,440
with composites you could save 25 to 50

2930
01:48:07,270 --> 01:48:05,760
percent of the mass in that upper stage

2931
01:48:09,270 --> 01:48:07,280
which can translate right back to

2932
01:48:11,510 --> 01:48:09,280
payload which would be a huge gain for

2933
01:48:13,510 --> 01:48:11,520
getting more payload to leo and to

2934
01:48:15,270 --> 01:48:13,520
explore the solar system and the the

2935
01:48:17,830 --> 01:48:15,280
other areas i won't go over today spaces

2936
01:48:19,109 --> 01:48:17,840
robotics deep space nav and observatory

2937
01:48:20,709 --> 01:48:19,119
systems that there's more information on

2938
01:48:24,550 --> 01:48:20,719

our website and and we can get you that

2939
01:48:27,910 --> 01:48:26,149
so one of our big investment areas in

2940
01:48:29,350 --> 01:48:27,920
the coming years especially this year

2941
01:48:30,390 --> 01:48:29,360
and next year is a soil electric

2942
01:48:31,910 --> 01:48:30,400
propulsion

2943
01:48:34,310 --> 01:48:31,920
we are planning an affordable

2944
01:48:35,270 --> 01:48:34,320
demonstration of a 30 to 50 kilowatt scp

2945
01:48:37,270 --> 01:48:35,280
system

2946
01:48:39,189 --> 01:48:37,280
which includes lightweight solar rays

2947
01:48:42,310 --> 01:48:39,199
and a soil electric propulsion module of

2948
01:48:43,510 --> 01:48:42,320
maybe 10 to 12 kilowatt thrusters

2949
01:48:45,189 --> 01:48:43,520
and you can see

2950
01:48:46,950 --> 01:48:45,199
it's it's very a cross-cutting

2951
01:48:48,709 --> 01:48:46,960
demonstration not only are what we're

2952
01:48:50,709 --> 01:48:48,719
developing is pushing the envelope for

2953
01:48:52,390 --> 01:48:50,719
arm but it's also pushing it for

2954
01:48:55,430 --> 01:48:52,400
industry and other government agencies

2955
01:48:57,510 --> 01:48:55,440
in terms of many many applications

2956
01:49:00,950 --> 01:48:57,520
around our plan right now is to

2957
01:49:03,270 --> 01:49:00,960
demonstrate the sep module uh our tech

2958
01:49:04,790 --> 01:49:03,280
demo mission on the arm mission so we

2959
01:49:06,629 --> 01:49:04,800
would use the arm mission to validate

2960
01:49:08,149 --> 01:49:06,639
the the sap system the arrays and the

2961
01:49:10,310 --> 01:49:08,159
thrusters

2962
01:49:13,109 --> 01:49:10,320
uh the the impressive thing about what

2963
01:49:15,109 --> 01:49:13,119

we're developing are thro our arrays uh

2964
01:49:16,629 --> 01:49:15,119
these state are

2965
01:49:18,149 --> 01:49:16,639
half the mass

2966
01:49:21,430 --> 01:49:18,159
and one-third the packaging volume of

2967
01:49:23,669 --> 01:49:21,440
standard arrays today so once we replace

2968
01:49:25,189 --> 01:49:23,679
these arrays not only for nasa but for

2969
01:49:27,669 --> 01:49:25,199
commercial industry we can either

2970
01:49:29,189 --> 01:49:27,679
provide more power and better volume

2971
01:49:31,589 --> 01:49:29,199
packaging for at the same price point

2972
01:49:33,270 --> 01:49:31,599
for industry or we can provide for say a

2973
01:49:34,950 --> 01:49:33,280
science mission we replace the arrays

2974
01:49:37,109 --> 01:49:34,960
with the ones we give them

2975
01:49:39,510 --> 01:49:37,119
and these arrays can provide ample power

2976
01:49:41,430 --> 01:49:39,520
to space missions

2977
01:49:44,070 --> 01:49:41,440
you know all the way out to jupiter in

2978
01:49:44,950 --> 01:49:44,080
essence we still use our rays in jupiter

2979
01:49:46,390 --> 01:49:44,960
so

2980
01:49:47,350 --> 01:49:46,400
these arrays are going to be a big deal

2981
01:49:49,990 --> 01:49:47,360
for the industry and they're going to

2982
01:49:52,310 --> 01:49:50,000
revolutionize the market

2983
01:49:54,550 --> 01:49:52,320
also we're developing

2984
01:49:56,550 --> 01:49:54,560
electric thrusters at nasa glenn

2985
01:49:59,030 --> 01:49:56,560
research center with jpl and these

2986
01:50:01,030 --> 01:49:59,040
thrusters when coupled with these arrays

2987
01:50:02,390 --> 01:50:01,040
are going to really enable all these new

2988
01:50:04,470 --> 01:50:02,400

missions

2989
01:50:06,950 --> 01:50:04,480
in the next 18 months

2990
01:50:08,870 --> 01:50:06,960
we have some big plans in scp

2991
01:50:12,229 --> 01:50:08,880
the first one is begin the design and

2992
01:50:13,750 --> 01:50:12,239
test of the large-scale solar rays and

2993
01:50:15,189 --> 01:50:13,760
what we'll do is leverage the work we've

2994
01:50:17,189 --> 01:50:15,199
been doing

2995
01:50:19,109 --> 01:50:17,199
within it started in our game changing

2996
01:50:21,430 --> 01:50:19,119
project in fiscal year 12

2997
01:50:23,109 --> 01:50:21,440
where we went out with a contract for a

2998
01:50:26,709 --> 01:50:23,119
baa and

2999
01:50:29,510 --> 01:50:26,719
awarded two two vendors atk and dss uh

3000
01:50:33,589 --> 01:50:29,520
out of california to build large uh on

3001
01:50:35,669 --> 01:50:33,599
the order of of 10 to 15 kilowatt arrays

3002
01:50:37,990 --> 01:50:35,679
to deploy in grounds on the ground uh

3003
01:50:41,189 --> 01:50:38,000
atk just finished their deployment in

3004
01:50:43,270 --> 01:50:41,199
march very successfully and dss

3005
01:50:45,350 --> 01:50:43,280
deployment is coming up in may and both

3006
01:50:47,430 --> 01:50:45,360
those deployments are both of those

3007
01:50:50,390 --> 01:50:47,440
designs can be used for the arm mission

3008
01:50:53,270 --> 01:50:50,400
or for for industry

3009
01:50:54,709 --> 01:50:53,280
the second area we're doing in scp is

3010
01:50:55,990 --> 01:50:54,719
developing these arrays we're going to

3011
01:50:57,910 --> 01:50:56,000
be going out looking for design and

3012
01:51:00,390 --> 01:50:57,920
build engineering units for these high

3013
01:51:02,470 --> 01:51:00,400

power electronics and the thrusters for

3014
01:51:03,990 --> 01:51:02,480
scp and again we'll be leveraging the

3015
01:51:05,589 --> 01:51:04,000
investment we've been making

3016
01:51:06,950 --> 01:51:05,599
inside our game changing project and

3017
01:51:08,149 --> 01:51:06,960
inside our technology demonstration

3018
01:51:10,950 --> 01:51:08,159
missions

3019
01:51:13,589 --> 01:51:10,960
uh the last two areas for sap are

3020
01:51:15,270 --> 01:51:13,599
large quantity propellant tanks so if so

3021
01:51:17,990 --> 01:51:15,280
the our mission has a need for on the

3022
01:51:19,510 --> 01:51:18,000
order of uh i think it's

3023
01:51:21,589 --> 01:51:19,520
two thousand ten thousand kilograms of

3024
01:51:24,629 --> 01:51:21,599
helium so very large

3025
01:51:26,550 --> 01:51:24,639
uh excuse me xenon sorry

3026
01:51:28,149 --> 01:51:26,560
wrong one uh so

3027
01:51:29,030 --> 01:51:28,159
we had to have huge tanks to get that

3028
01:51:30,870 --> 01:51:29,040
done so we're gonna be going with the

3029
01:51:32,709 --> 01:51:30,880
design on that and we're also looking to

3030
01:51:35,189 --> 01:51:32,719
engage academia for ideas and concepts

3031
01:51:36,310 --> 01:51:35,199
as michelle talked about the baa the baa

3032
01:51:37,430 --> 01:51:36,320
she she

3033
01:51:38,870 --> 01:51:37,440
sort of listed the dates when the

3034
01:51:40,950 --> 01:51:38,880
proposals were due but we're looking for

3035
01:51:42,709 --> 01:51:40,960
industry-led studies of how existing

3036
01:51:44,790 --> 01:51:42,719
commercial capabilities can be used to

3037
01:51:47,030 --> 01:51:44,800
leverage we could leverage those to help

3038
01:51:48,790 --> 01:51:47,040

the armed mission and

3039
01:51:50,550 --> 01:51:48,800
improve our set capabilities to enable

3040
01:51:53,270 --> 01:51:50,560
all these missions

3041
01:51:57,510 --> 01:51:54,709
the other demonstration we wanted to

3042
01:51:58,790 --> 01:51:57,520
talk about today was the ldsd project

3043
01:52:00,870 --> 01:51:58,800
which is called the low density

3044
01:52:02,390 --> 01:52:00,880
supersonic decelerator project

3045
01:52:05,750 --> 01:52:02,400
i think everybody remembers the seven

3046
01:52:07,270 --> 01:52:05,760
minutes of tear for msl

3047
01:52:08,790 --> 01:52:07,280
and again i spoke earlier the state of

3048
01:52:10,790 --> 01:52:08,800
the art for that is one metric ton to

3049
01:52:12,550 --> 01:52:10,800
the surface

3050
01:52:14,629 --> 01:52:12,560
going from one metric ton to 40 metric

3051
01:52:16,229 --> 01:52:14,639
ton is probably inconceivable at this

3052
01:52:17,830 --> 01:52:16,239
moment so we're going to take a stepwise

3053
01:52:19,189 --> 01:52:17,840
approach and how to add more capability

3054
01:52:22,229 --> 01:52:19,199
to get to mars

3055
01:52:24,149 --> 01:52:22,239
ldsd is developing

3056
01:52:26,709 --> 01:52:24,159
three new decelerator technologies to

3057
01:52:28,310 --> 01:52:26,719
try to go beyond what msl did the first

3058
01:52:30,709 --> 01:52:28,320
two are inflatable aerodynamic

3059
01:52:32,790 --> 01:52:30,719
decelerators they're called sciads

3060
01:52:34,310 --> 01:52:32,800
supersonic inflatable aerodynamic

3061
01:52:36,790 --> 01:52:34,320
cellular devices

3062
01:52:39,030 --> 01:52:36,800
they are essentially

3063
01:52:40,790 --> 01:52:39,040

parachutes or inflatables that attach to

3064
01:52:42,470 --> 01:52:40,800
the outside of a heat shield and just

3065
01:52:44,310 --> 01:52:42,480
make it larger so you can still stow

3066
01:52:47,350 --> 01:52:44,320
them you still sell your heat shield

3067
01:52:49,510 --> 01:52:47,360
looks much like orion or msl in the same

3068
01:52:50,629 --> 01:52:49,520
shroud but these inflatables can once

3069
01:52:51,910 --> 01:52:50,639
you get into orbit and get ready to

3070
01:52:54,550 --> 01:52:51,920
enter they can

3071
01:52:56,629 --> 01:52:54,560
they can grow out so you have more

3072
01:52:58,950 --> 01:52:56,639
area for drag so these are the two of

3073
01:53:00,070 --> 01:52:58,960
the devices there's not a great picture

3074
01:53:01,990 --> 01:53:00,080
on this chart

3075
01:53:03,270 --> 01:53:02,000
and the other device is a 30.5 meter

3076
01:53:08,070 --> 01:53:03,280
parachute

3077
01:53:10,229 --> 01:53:08,080
entry the msl used the viking heritage

3078
01:53:13,189 --> 01:53:10,239
parachute now if i can use a 16 and a

3079
01:53:15,830 --> 01:53:13,199
half meter i believe parachute msl used

3080
01:53:17,750 --> 01:53:15,840
scaled it to about 21 22 meters

3081
01:53:19,270 --> 01:53:17,760
to to deliver these larger payloads we

3082
01:53:22,070 --> 01:53:19,280
need bigger parachutes so we're going

3083
01:53:25,189 --> 01:53:22,080
through a development effort now to

3084
01:53:26,550 --> 01:53:25,199
build a 30 meter parachute

3085
01:53:28,709 --> 01:53:26,560
this test

3086
01:53:30,709 --> 01:53:28,719
is uh is this summer in june we have one

3087
01:53:31,910 --> 01:53:30,719
test this june and hopefully two tests

3088
01:53:34,390 --> 01:53:31,920

next summer

3089
01:53:35,830 --> 01:53:34,400
of this technology the trick for testing

3090
01:53:38,390 --> 01:53:35,840
this technology

3091
01:53:40,310 --> 01:53:38,400
is that mars the the density is so much

3092
01:53:41,510 --> 01:53:40,320
different than earth testing these uh

3093
01:53:43,109 --> 01:53:41,520
dropping them out of airplanes or

3094
01:53:44,470 --> 01:53:43,119
testing them on the ground they don't

3095
01:53:46,470 --> 01:53:44,480
reach the same loads at the same

3096
01:53:49,750 --> 01:53:46,480
conditions so the project came up with a

3097
01:53:51,830 --> 01:53:49,760
unique way to test this where you take a

3098
01:53:53,669 --> 01:53:51,840
a balloon i think the largest balloon

3099
01:53:55,750 --> 01:53:53,679
the science directorate has for their

3100
01:53:59,270 --> 01:53:55,760
balloon science program it's on the

3101
01:54:01,430 --> 01:53:59,280
order of 180

3102
01:54:03,350 --> 01:54:01,440
34 million cubic feet of helium in the

3103
01:54:05,189 --> 01:54:03,360
balloon the balloon takes a 3 000

3104
01:54:06,470 --> 01:54:05,199
kilogram payload

3105
01:54:09,030 --> 01:54:06,480
which is the

3106
01:54:10,149 --> 01:54:09,040
heat shield a a full scale 4.7 meter

3107
01:54:12,390 --> 01:54:10,159
heat shield

3108
01:54:14,709 --> 01:54:12,400
that looks like orion

3109
01:54:15,589 --> 01:54:14,719
with a star 48 motor in the in the back

3110
01:54:18,550 --> 01:54:15,599
of it

3111
01:54:20,390 --> 01:54:18,560
it floats that to 120 000 feet

3112
01:54:22,390 --> 01:54:20,400
as you can see the blue line as we we

3113
01:54:23,990 --> 01:54:22,400

move up it flows to 120 000 feet out of

3114
01:54:25,910 --> 01:54:24,000
hawaii this is at the pacific missile

3115
01:54:28,470 --> 01:54:25,920
range

3116
01:54:31,350 --> 01:54:28,480
at that point the uh star 48 motor

3117
01:54:34,470 --> 01:54:31,360
ignites and takes the uh the capsule

3118
01:54:35,589 --> 01:54:34,480
that looks just like a msl orion 280 000

3119
01:54:38,310 --> 01:54:35,599
feet

3120
01:54:40,629 --> 01:54:38,320
about mach 3 and a half

3121
01:54:42,790 --> 01:54:40,639
where you see a burnout the syad deploys

3122
01:54:45,589 --> 01:54:42,800
so you go from heat shield to the side

3123
01:54:47,270 --> 01:54:45,599
comes out and then that cruises to about

3124
01:54:49,189 --> 01:54:47,280
mach 2 where it slows down because the

3125
01:54:50,790 --> 01:54:49,199
side slows it down then the parachute

3126
01:54:51,589 --> 01:54:50,800
comes out at mach 2 and then it lands in

3127
01:54:53,830 --> 01:54:51,599
the

3128
01:54:55,350 --> 01:54:53,840
ocean for recovery

3129
01:54:56,870 --> 01:54:55,360
now this project

3130
01:54:58,229 --> 01:54:56,880
is is very exciting because it's going

3131
01:54:59,990 --> 01:54:58,239
to

3132
01:55:02,550 --> 01:55:00,000
enable

3133
01:55:04,550 --> 01:55:02,560
double the payload increase in mass to

3134
01:55:06,310 --> 01:55:04,560
the surface but also

3135
01:55:09,030 --> 01:55:06,320
not only do we add more massive surface

3136
01:55:11,189 --> 01:55:09,040
but we cover more elevations at mars

3137
01:55:13,270 --> 01:55:11,199
the surface of mars is obviously very

3138
01:55:15,430 --> 01:55:13,280

very hilly and has mountains

3139
01:55:17,510 --> 01:55:15,440
this capability can give you 25 percent

3140
01:55:19,189 --> 01:55:17,520
access to 25 higher access to higher

3141
01:55:21,510 --> 01:55:19,199
elevations that's about 50 of the

3142
01:55:23,350 --> 01:55:21,520
surface on mars so you get to

3143
01:55:25,589 --> 01:55:23,360
higher scientific areas of interest with

3144
01:55:27,430 --> 01:55:25,599
this capability it also reduces the

3145
01:55:29,189 --> 01:55:27,440
landing ellipse by a factor of three so

3146
01:55:31,189 --> 01:55:29,199
in other words uh the current landing

3147
01:55:33,109 --> 01:55:31,199
ellipse for msl we can shrink that by a

3148
01:55:34,790 --> 01:55:33,119
factor of three by using these new

3149
01:55:36,629 --> 01:55:34,800
technologies so for trying to land

3150
01:55:38,149 --> 01:55:36,639
multiple payloads together we don't have

3151
01:55:41,350 --> 01:55:38,159
to

3152
01:55:42,950 --> 01:55:41,360
them back and forth we just land them

3153
01:55:44,790 --> 01:55:42,960
closer to each other

3154
01:55:46,550 --> 01:55:44,800
and this technology again we'll be

3155
01:55:47,669 --> 01:55:46,560
testing in june this summer and we'll be

3156
01:55:49,589 --> 01:55:47,679
ready for

3157
01:55:52,310 --> 01:55:49,599
uh infusion into missions as early as

3158
01:55:53,990 --> 01:55:52,320
2020 uh with with the hope that it could

3159
01:55:55,350 --> 01:55:54,000
really enable sample return or some of

3160
01:56:01,830 --> 01:55:55,360
the precursor missions that our hero

3161
01:56:04,550 --> 01:56:03,109
so

3162
01:56:06,070 --> 01:56:04,560
he's heard of all the thrust areas and

3163
01:56:07,750 --> 01:56:06,080

some of the investment areas we're in

3164
01:56:09,189 --> 01:56:07,760
what i think everybody is always

3165
01:56:11,030 --> 01:56:09,199
interested in what are the opportunities

3166
01:56:13,109 --> 01:56:11,040
for business and industry and how can

3167
01:56:15,109 --> 01:56:13,119
you mean to work with us so this chart

3168
01:56:17,350 --> 01:56:15,119
is is sort of our where we see our

3169
01:56:18,950 --> 01:56:17,360
investments for the next 18 months

3170
01:56:20,149 --> 01:56:18,960
and where those opportunities are for

3171
01:56:22,390 --> 01:56:20,159
partnership

3172
01:56:24,070 --> 01:56:22,400
so as always we we are looking to

3173
01:56:25,910 --> 01:56:24,080
solicit the nation's best and brightest

3174
01:56:28,950 --> 01:56:25,920
in academia industry and other

3175
01:56:30,709 --> 01:56:28,960
government agencies to help us

3176
01:56:31,910 --> 01:56:30,719
push these envelope and push these

3177
01:56:33,750 --> 01:56:31,920
technologies where we need to be for

3178
01:56:36,149 --> 01:56:33,760
de-space exploration

3179
01:56:39,109 --> 01:56:36,159
these areas align very well with the

3180
01:56:40,149 --> 01:56:39,119
thrust areas we discussed earlier

3181
01:56:42,229 --> 01:56:40,159
i'm not going to go through that in

3182
01:56:44,629 --> 01:56:42,239
detail but we will be having

3183
01:56:47,030 --> 01:56:44,639
solicitations out in the next 18 months

3184
01:56:48,870 --> 01:56:47,040
on soil electric propulsion

3185
01:56:51,589 --> 01:56:48,880
in space power we actually have one out

3186
01:56:53,750 --> 01:56:51,599
right now for space power which is uh

3187
01:56:55,270 --> 01:56:53,760
seeking proposals for the development

3188
01:56:56,550 --> 01:56:55,280

of new more capable energy storage

3189
01:56:58,390 --> 01:56:56,560
technology so we're looking for two

3190
01:57:00,390 --> 01:56:58,400
things one to improve our current

3191
01:57:01,910 --> 01:57:00,400
capabilities so at the system level can

3192
01:57:03,669 --> 01:57:01,920
we do better packaging can we use better

3193
01:57:05,189 --> 01:57:03,679
chemistry better cells

3194
01:57:06,709 --> 01:57:05,199
to to

3195
01:57:08,310 --> 01:57:06,719
increase the density

3196
01:57:10,229 --> 01:57:08,320
and crank up the power for space

3197
01:57:13,030 --> 01:57:10,239
batteries and then the other one area

3198
01:57:14,950 --> 01:57:13,040
for this is a very high specific energy

3199
01:57:18,070 --> 01:57:14,960
devices that will go past the

3200
01:57:20,149 --> 01:57:18,080
theoretical limits of lithium ion so

3201
01:57:22,950 --> 01:57:20,159
both areas are out right now

3202
01:57:25,430 --> 01:57:22,960
out of our game changing program

3203
01:57:27,750 --> 01:57:25,440
uh we'll be going out in life support

3204
01:57:31,350 --> 01:57:27,760
and resource utilization uh jason talked

3205
01:57:34,950 --> 01:57:31,360
about the mars 2020 uh

3206
01:57:38,149 --> 01:57:34,960
ao there's a joint smd hero and stmd

3207
01:57:40,709 --> 01:57:38,159
proposal out for isru on march 2020. to

3208
01:57:43,030 --> 01:57:40,719
break co2 into oxygen and i think we

3209
01:57:44,550 --> 01:57:43,040
talked about how critical that was

3210
01:57:46,950 --> 01:57:44,560
and also we have one out right now for

3211
01:57:48,709 --> 01:57:46,960
advanced oxygen recovery so as we move

3212
01:57:51,350 --> 01:57:48,719
forward with exploring we're going to

3213
01:57:53,510 --> 01:57:51,360

have to recycle our air as we as we get

3214
01:57:55,270 --> 01:57:53,520
our astronauts out in space so we we

3215
01:57:57,990 --> 01:57:55,280
have a call out right now on the street

3216
01:58:01,830 --> 01:57:58,000
for um advanced oxygen recovery to

3217
01:58:06,070 --> 01:58:03,830
and then we have we'll be going out with

3218
01:58:08,310 --> 01:58:06,080
more intrinsic landing work space

3219
01:58:10,070 --> 01:58:08,320
robotic systems

3220
01:58:12,629 --> 01:58:10,080
more optical com work and maybe some

3221
01:58:16,149 --> 01:58:12,639
deep space optical stuff on discovery

3222
01:58:17,990 --> 01:58:16,159
there's a call out for the discovery 13

3223
01:58:20,550 --> 01:58:18,000
which is a 2014 discovery mission called

3224
01:58:21,990 --> 01:58:20,560
an smd for deep space optical com in

3225
01:58:23,990 --> 01:58:22,000
partnership with them

3226
01:58:25,510 --> 01:58:24,000
lightweight space structures and space

3227
01:58:27,030 --> 01:58:25,520
observatory systems again more work

3228
01:58:30,629 --> 01:58:27,040
there with smd

3229
01:58:33,270 --> 01:58:32,070
all right so i thank you for the

3230
01:58:34,870 --> 01:58:33,280
opportunity

3231
01:58:36,709 --> 01:58:34,880
we've got a lot of interesting stuff

3232
01:58:38,629 --> 01:58:36,719
going on this summer

3233
01:58:40,149 --> 01:58:38,639
you should watch our website nasa.gov

3234
01:58:41,830 --> 01:58:40,159
space tech you should

3235
01:58:43,430 --> 01:58:41,840
keep an eye we've got

3236
01:58:44,629 --> 01:58:43,440
the ldsd test is going to be really

3237
01:58:46,470 --> 01:58:44,639
exciting we're going to have a lot of

3238
01:58:48,390 --> 01:58:46,480

hopefully a live feed from

3239
01:58:51,430 --> 01:58:48,400
from a pmrf so keep watching that and

3240
01:58:53,750 --> 01:58:51,440
watch our website and again uh we look

3241
01:58:55,030 --> 01:58:53,760
forward to helping our exploration

3242
01:59:01,109 --> 01:58:55,040
partners and and doing these

3243
01:59:03,990 --> 01:59:02,550
i'd like to start if we could with uh

3244
01:59:05,109 --> 01:59:04,000
social i think there's a technology

3245
01:59:07,910 --> 01:59:05,119
question there

3246
01:59:09,750 --> 01:59:07,920
sure um at cl underscore meyer wants to

3247
01:59:11,830 --> 01:59:09,760
know if we've done any further work on

3248
01:59:14,229 --> 01:59:11,840
nuclear reactors and improve propulsion

3249
01:59:15,910 --> 01:59:14,239
to get people to mars faster

3250
01:59:17,990 --> 01:59:15,920
we're we are looking at sort of

3251
01:59:20,149 --> 01:59:18,000
component work on nuclear systems but we

3252
01:59:22,229 --> 01:59:20,159
haven't

3253
01:59:23,990 --> 01:59:22,239
yet made a large investment in nuclear

3254
01:59:25,589 --> 01:59:24,000
thermal propulsion um

3255
01:59:26,790 --> 01:59:25,599
so the answer would be we're looking at

3256
01:59:27,910 --> 01:59:26,800
it but we haven't done it yet and i

3257
01:59:31,270 --> 01:59:27,920
believe uh

3258
01:59:33,510 --> 01:59:31,280
is jason still here yeah jason i believe

3259
01:59:35,589 --> 01:59:33,520
we're working with aes on on that

3260
01:59:37,270 --> 01:59:35,599
endeavor if jason wants to add anything

3261
01:59:40,310 --> 01:59:37,280
about that

3262
01:59:41,589 --> 01:59:40,320
yeah one addition to that is that we are

3263
01:59:43,109 --> 01:59:41,599

advancing

3264
01:59:45,030 --> 01:59:43,119
um

3265
01:59:46,550 --> 01:59:45,040
basically the fuels development that is

3266
01:59:48,070 --> 01:59:46,560
the kind of critical port of nuclear

3267
01:59:50,070 --> 01:59:48,080
thermal propulsion so we've been

3268
01:59:51,510 --> 01:59:50,080
advancing to try to recover our ability

3269
01:59:53,510 --> 01:59:51,520
to create the fuel sources that are

3270
01:59:55,830 --> 01:59:53,520
needed for that in collaboration with

3271
01:59:57,189 --> 01:59:55,840
the department of energy um so our main

3272
01:59:59,030 --> 01:59:57,199
focus has been on fuels development

3273
02:00:01,589 --> 01:59:59,040
today not on the actual engine systems

3274
02:00:03,830 --> 02:00:01,599
uh to date but uh we are looking at as

3275
02:00:05,669 --> 02:00:03,840
as as i was describing earlier kind of

3276
02:00:07,589 --> 02:00:05,679
near-term high technology readiness

3277
02:00:09,109 --> 02:00:07,599
level whether solar electric propulsion

3278
02:00:15,430 --> 02:00:09,119
while keeping a balanced portfolio of

3279
02:00:19,270 --> 02:00:17,350
go to frank

3280
02:00:21,990 --> 02:00:19,280
hi it's it's frank moore with aviation

3281
02:00:23,510 --> 02:00:22,000
week um on your inflatable uh

3282
02:00:25,750 --> 02:00:23,520
decelerators

3283
02:00:27,589 --> 02:00:25,760
are they scalable to the to the size

3284
02:00:32,550 --> 02:00:27,599
that you would need for a human mars

3285
02:00:36,310 --> 02:00:34,550
not not with current launch shrouds

3286
02:00:38,470 --> 02:00:36,320
because you would need you know uh we

3287
02:00:39,510 --> 02:00:38,480
need you probably 11 12 up to 20 meter

3288
02:00:43,030 --> 02:00:39,520

diameter

3289
02:00:45,109 --> 02:00:43,040
rigid heat shield for re-entry so

3290
02:00:47,270 --> 02:00:45,119
we think we can do we can take a current

3291
02:00:49,510 --> 02:00:47,280
the current 4.7 meter heat shield that

3292
02:00:51,910 --> 02:00:49,520
we've been using and probably get an 8

3293
02:00:53,430 --> 02:00:51,920
to 10 meter siad with that so we could

3294
02:00:54,390 --> 02:00:53,440
probably scale it to 8 to 10 meters

3295
02:00:55,830 --> 02:00:54,400
right now

3296
02:00:57,669 --> 02:00:55,840
we would have to do some work on if

3297
02:01:00,550 --> 02:00:57,679
there's a way to

3298
02:01:01,510 --> 02:01:00,560
get a larger rigid heat shield in orbit

3299
02:01:04,070 --> 02:01:01,520
before we could have a larger

3300
02:01:07,270 --> 02:01:04,080
decelerator so it's probably not going

3301
02:01:09,990 --> 02:01:07,280
to have a a 20 meter

3302
02:01:10,000 --> 02:01:13,589
some other questions

3303
02:01:18,070 --> 02:01:15,750
go ahead ken

3304
02:01:19,430 --> 02:01:18,080
hi ken kramer for universe today um a

3305
02:01:20,790 --> 02:01:19,440
question about the solar electric

3306
02:01:23,030 --> 02:01:20,800
propulsion i think you mentioned it

3307
02:01:24,310 --> 02:01:23,040
could have applicability in other areas

3308
02:01:26,790 --> 02:01:24,320
of the government

3309
02:01:28,950 --> 02:01:26,800
is this just a nasa program or do you

3310
02:01:30,870 --> 02:01:28,960
receive funding from from other uh

3311
02:01:32,629 --> 02:01:30,880
government agencies

3312
02:01:35,030 --> 02:01:32,639
uh we're exploring looking for other

3313
02:01:36,709 --> 02:01:35,040

government agencies but as of right now

3314
02:01:40,229 --> 02:01:36,719
the major investments in

3315
02:01:42,870 --> 02:01:40,239
scp that we discussed today are ours

3316
02:01:44,310 --> 02:01:42,880
nasa alone but we have been working with

3317
02:01:45,750 --> 02:01:44,320
other other government agents to see if

3318
02:01:48,629 --> 02:01:45,760
there's a collaboration we've sort of

3319
02:01:50,950 --> 02:01:48,639
been waiting to see when

3320
02:01:52,709 --> 02:01:50,960
moving towards arm that we would do it

3321
02:01:54,790 --> 02:01:52,719
within our own funds and if if something

3322
02:01:58,950 --> 02:01:54,800
did happen with arm we would move

3323
02:02:02,629 --> 02:02:01,109
private endeavors like spacex or orbital

3324
02:02:04,390 --> 02:02:02,639
or anything like that

3325
02:02:06,629 --> 02:02:04,400
there's a lot of interest from private

3326
02:02:08,790 --> 02:02:06,639
companies in industry on this it it has

3327
02:02:09,990 --> 02:02:08,800
to do more with the the the providers

3328
02:02:12,390 --> 02:02:10,000
the

3329
02:02:14,229 --> 02:02:12,400
commercial spacecraft providers who want

3330
02:02:15,910 --> 02:02:14,239
the arrays or who want the thrusters

3331
02:02:18,870 --> 02:02:15,920
than say that we've had discussions with

3332
02:02:21,189 --> 02:02:18,880
spacex but there there is a very strong

3333
02:02:23,109 --> 02:02:21,199
uh interest from from those companies

3334
02:02:24,790 --> 02:02:23,119
who want to fly these arrays

3335
02:02:26,149 --> 02:02:24,800
uh i think

3336
02:02:28,149 --> 02:02:26,159
uh you know i don't think we've got

3337
02:02:28,950 --> 02:02:28,159
anyone to to commit to kicking in money

3338
02:02:30,229 --> 02:02:28,960

yet

3339
02:02:32,950 --> 02:02:30,239
but they do they will be interested in

3340
02:02:35,270 --> 02:02:32,960
flying the arrays

3341
02:02:37,830 --> 02:02:35,280
rainy why is solar electric propulsion

3342
02:02:39,750 --> 02:02:37,840
such an enabling technology why is this

3343
02:02:41,109 --> 02:02:39,760
so important or future exploration

3344
02:02:43,669 --> 02:02:41,119
endeavors

3345
02:02:45,270 --> 02:02:43,679
uh it well i think is a great uh example

3346
02:02:46,709 --> 02:02:45,280
from heo is that

3347
02:02:48,709 --> 02:02:46,719
when you include soil electric

3348
02:02:50,870 --> 02:02:48,719
propulsion to um

3349
02:02:52,790 --> 02:02:50,880
uh to to take missions to mars it cut

3350
02:02:54,709 --> 02:02:52,800
the number of missions in half for cargo

3351
02:02:56,550 --> 02:02:54,719
so it's so mass efficient

3352
02:02:58,629 --> 02:02:56,560
it's slower so it's not great to take

3353
02:03:01,109 --> 02:02:58,639
humans to mars but it's so mass

3354
02:03:02,629 --> 02:03:01,119
efficient because it just uses uh you

3355
02:03:04,470 --> 02:03:02,639
don't have to have the chemical oxygen

3356
02:03:05,990 --> 02:03:04,480
oxidizer and fuel there it is since it

3357
02:03:07,910 --> 02:03:06,000
uses just the uh

3358
02:03:09,430 --> 02:03:07,920
ionize it's so efficient it ionizes the

3359
02:03:10,950 --> 02:03:09,440
atom's movement so efficiently that it's

3360
02:03:13,109 --> 02:03:10,960
uh it just cuts the mass down by a

3361
02:03:14,470 --> 02:03:13,119
factor two for what you need it launches

3362
02:03:16,709 --> 02:03:14,480
to mars

3363
02:03:19,430 --> 02:03:16,719

so i think it's just its efficiency is

3364
02:03:22,470 --> 02:03:19,440
uh is good it's the only downside is it

3365
02:03:24,550 --> 02:03:22,480
just takes a little longer time

3366
02:03:26,709 --> 02:03:24,560
thank you very much any other questions

3367
02:03:28,390 --> 02:03:26,719
let's go back to frank

3368
02:03:29,510 --> 02:03:28,400
i just noticed that john grunsfeld is

3369
02:03:33,669 --> 02:03:29,520
still here

3370
02:03:36,790 --> 02:03:33,679
with um an increase in the uh elevation

3371
02:03:38,870 --> 02:03:36,800
that you can hit with these advanced edl

3372
02:03:46,470 --> 02:03:38,880
technologies what's some of the science

3373
02:03:50,390 --> 02:03:48,390
that's a great question when we uh

3374
02:03:51,430 --> 02:03:50,400
looked at flying the mars exploration

3375
02:03:53,270 --> 02:03:51,440
rovers

3376
02:03:54,470 --> 02:03:53,280
there was a site selection team of

3377
02:03:56,870 --> 02:03:54,480
scientists and engineers who got

3378
02:03:59,189 --> 02:03:56,880
together and tried to find the safest

3379
02:04:00,790 --> 02:03:59,199
places for us to land

3380
02:04:02,229 --> 02:04:00,800
because you know we wanted to make sure

3381
02:04:03,589 --> 02:04:02,239
that we got at least one rover on the

3382
02:04:05,830 --> 02:04:03,599
surface and with spirit and opportunity

3383
02:04:07,669 --> 02:04:05,840
we were lucky to get two

3384
02:04:11,510 --> 02:04:07,679
however from orbit they kind of looked

3385
02:04:13,669 --> 02:04:11,520
like boring places and ones that were

3386
02:04:15,990 --> 02:04:13,679
relatively speaking easily accessible

3387
02:04:18,629 --> 02:04:16,000
with curiosity we tried with the smaller

3388
02:04:20,390 --> 02:04:18,639

landing ellipse a much harder place but

3389
02:04:23,030 --> 02:04:20,400
still one that was within the

3390
02:04:25,669 --> 02:04:23,040
performance envelope of the sky crane

3391
02:04:27,510 --> 02:04:25,679
and the supersonic parachute we're now

3392
02:04:30,550 --> 02:04:27,520
having discussions in fact michael myers

3393
02:04:32,550 --> 02:04:30,560
here about landing site selection

3394
02:04:35,830 --> 02:04:32,560
for future mars missions including mars

3395
02:04:37,510 --> 02:04:35,840
2020 and partly because we now know the

3396
02:04:39,589 --> 02:04:37,520
performance of the heat shield due to

3397
02:04:42,229 --> 02:04:39,599
the medley instrumentation that was a

3398
02:04:43,910 --> 02:04:42,239
cooperative effort and the the parachute

3399
02:04:46,390 --> 02:04:43,920
and also just the mars atmosphere

3400
02:04:49,030 --> 02:04:46,400
seasonally will be able to go to an even

3401
02:04:50,629 --> 02:04:49,040
more challenging place higher elevation

3402
02:04:54,629 --> 02:04:50,639
perhaps

3403
02:04:57,189 --> 02:04:54,639
and that's very important because you

3404
02:04:59,030 --> 02:04:57,199
want the rover to get close to the place

3405
02:05:01,589 --> 02:04:59,040
that from orbit at any rate the

3406
02:05:03,750 --> 02:05:01,599
mineralogy and the other

3407
02:05:05,109 --> 02:05:03,760
applications that you want are close

3408
02:05:07,430 --> 02:05:05,119
we're going to spend the better part of

3409
02:05:08,950 --> 02:05:07,440
two years driving to mount sharp

3410
02:05:10,709 --> 02:05:08,960
along the way doing science but getting

3411
02:05:12,310 --> 02:05:10,719
to the place we really want to be and

3412
02:05:13,669 --> 02:05:12,320
certainly for a human space flight in

3413
02:05:15,990 --> 02:05:13,679

the future you want to be very close to

3414
02:05:17,589 --> 02:05:16,000
whatever habitat or fuel systems you've

3415
02:05:19,270 --> 02:05:17,599
already in place

3416
02:05:21,430 --> 02:05:19,280
and so the supersonic decelerator is

3417
02:05:24,149 --> 02:05:21,440
really critical for future science

3418
02:05:25,910 --> 02:05:24,159
missions to get to higher elevations or

3419
02:05:27,350 --> 02:05:25,920
perhaps in some cases to get to very

3420
02:05:28,470 --> 02:05:27,360
small landing ellipses at lower

3421
02:05:30,069 --> 02:05:28,480
elevations

3422
02:05:32,310 --> 02:05:30,079
vallas marineris for instance if you

3423
02:05:33,910 --> 02:05:32,320
wanted to go down to the bottom and and

3424
02:05:35,990 --> 02:05:33,920
measure you know like we do in the grand

3425
02:05:37,430 --> 02:05:36,000
canyon the history of mars these kind of

3426
02:05:39,669 --> 02:05:37,440
places will require small landing

3427
02:05:44,390 --> 02:05:39,679
ellipses so that you land on mars and

3428
02:05:48,709 --> 02:05:46,229
i'll ask our chiefs to take the stage as

3429
02:05:57,189 --> 02:05:48,719
we help thank uh randy lillard for his

3430
02:06:00,950 --> 02:05:59,350
and again we have some as randy said

3431
02:06:02,629 --> 02:06:00,960
just some incredible testing coming up

3432
02:06:04,470 --> 02:06:02,639
on space technology and of course we'll

3433
02:06:06,390 --> 02:06:04,480
uh you can find out more information

3434
02:06:08,790 --> 02:06:06,400
about that as rainy said at nasa.gov

3435
02:06:10,870 --> 02:06:08,800
space tech when those tests come around

3436
02:06:12,550 --> 02:06:10,880
i know we in public affairs are

3437
02:06:14,069 --> 02:06:12,560
looking forward to helping tell the

3438
02:06:16,950 --> 02:06:14,079

story and you'll of course find out more

3439
02:06:19,189 --> 02:06:16,960
information on nasa.gov as we get closer

3440
02:06:21,589 --> 02:06:19,199
to some of those incredible tests so i'm

3441
02:06:23,270 --> 02:06:21,599
pleased to now introduce our our chief

3442
02:06:25,750 --> 02:06:23,280
scientist and chief technologist we're

3443
02:06:27,589 --> 02:06:25,760
presenting together alan stoffen was

3444
02:06:30,550 --> 02:06:27,599
appointed nasa's chief scientist in

3445
02:06:32,709 --> 02:06:30,560
august of 2013. she serves as principal

3446
02:06:34,390 --> 02:06:32,719
advisor on the agency science programs

3447
02:06:36,390 --> 02:06:34,400
science-related strategic planning and

3448
02:06:37,830 --> 02:06:36,400
investments previously she was vice

3449
02:06:39,830 --> 02:06:37,840
president of proximi research in

3450
02:06:41,510 --> 02:06:39,840
maryland an honorary professor in the

3451
02:06:43,750 --> 02:06:41,520
department of earth sciences the

3452
02:06:45,430 --> 02:06:43,760
university of college london in england

3453
02:06:47,669 --> 02:06:45,440
her research is focused on the geology

3454
02:06:49,510 --> 02:06:47,679
of venus mars saturn's moon's titan and

3455
02:06:51,990 --> 02:06:49,520
earth she's an associate member of the

3456
02:06:53,589 --> 02:06:52,000
cassini mission to saturn radar team and

3457
02:06:55,270 --> 02:06:53,599
co-investigator on the mars express

3458
02:06:57,109 --> 02:06:55,280
mission's marxist sounder her

3459
02:06:58,390 --> 02:06:57,119
appointment as chief scientist at

3460
02:07:01,669 --> 02:06:58,400
marshall returned

3461
02:07:03,109 --> 02:07:01,679
to nasa for her from 1991 through 2000

3462
02:07:05,910 --> 02:07:03,119
she held a number of senior scientist

3463
02:07:08,069 --> 02:07:05,920

positions at nasa's jpl including chief

3464
02:07:09,510 --> 02:07:08,079
scientist for the new millennium program

3465
02:07:11,589 --> 02:07:09,520
deputy project scientist for the

3466
02:07:13,830 --> 02:07:11,599
magellan mission venus an experiment

3467
02:07:15,750 --> 02:07:13,840
scientist for cersei an instrument that

3468
02:07:17,510 --> 02:07:15,760
provided radar images of earth onto

3469
02:07:20,229 --> 02:07:17,520
shuttle flights

3470
02:07:21,669 --> 02:07:20,239
uh next to her is as we just announced

3471
02:07:23,030 --> 02:07:21,679
last month as a matter of fact uh we

3472
02:07:25,270 --> 02:07:23,040
just announced david miller is the

3473
02:07:27,189 --> 02:07:25,280
agency's new chief technologist most

3474
02:07:28,709 --> 02:07:27,199
recently he was professor and director

3475
02:07:30,149 --> 02:07:28,719
of the space systems laboratory the

3476
02:07:32,390 --> 02:07:30,159
massachusetts institute of technology

3477
02:07:34,310 --> 02:07:32,400
mit prior to this appointment he held

3478
02:07:35,750 --> 02:07:34,320
various positions on nasa projects

3479
02:07:38,149 --> 02:07:35,760
including principal investigator for the

3480
02:07:41,030 --> 02:07:38,159
regolith x-ray imaging spectrometer the

3481
02:07:43,030 --> 02:07:41,040
cyrus rex asteroid sample return mission

3482
02:07:45,109 --> 02:07:43,040
plan to launch uh here soon the next

3483
02:07:46,470 --> 02:07:45,119
couple years he also was the principal

3484
02:07:48,950 --> 02:07:46,480
investigator for the synchronized

3485
02:07:50,550 --> 02:07:48,960
position hold engage and reorient

3486
02:07:52,950 --> 02:07:50,560
experimental satellites you might know

3487
02:07:54,790 --> 02:07:52,960
it as spheres uh very cool project we

3488
02:07:56,229 --> 02:07:54,800

have great video of spheres moving

3489
02:07:57,430 --> 02:07:56,239
autonomously on the international space

3490
02:07:59,189 --> 02:07:57,440
station

3491
02:08:00,790 --> 02:07:59,199
and most recently he served as the vice

3492
02:08:02,950 --> 02:08:00,800
chair of the air force scientific

3493
02:08:09,910 --> 02:08:02,960
advisory board please help me welcome

3494
02:08:14,310 --> 02:08:11,669
well thank you and ellen and i are going

3495
02:08:16,069 --> 02:08:14,320
to tag team this presentation

3496
02:08:17,669 --> 02:08:16,079
so what you've seen here today is that

3497
02:08:19,510 --> 02:08:17,679
the road to mars really involves much

3498
02:08:20,870 --> 02:08:19,520
more than one mission directorate at

3499
02:08:22,870 --> 02:08:20,880
nasa

3500
02:08:24,629 --> 02:08:22,880
it it involves the careful integration

3501
02:08:26,790 --> 02:08:24,639
of scientific discovery

3502
02:08:29,350 --> 02:08:26,800
technological innovation commercial

3503
02:08:32,149 --> 02:08:29,360
development international collaboration

3504
02:08:34,229 --> 02:08:32,159
and the human imperative to explore

3505
02:08:36,310 --> 02:08:34,239
therefore all five of these endeavors

3506
02:08:37,910 --> 02:08:36,320
have essential roles to play on this

3507
02:08:40,550 --> 02:08:37,920
human road to mars

3508
02:08:43,030 --> 02:08:40,560
i have the next oh can you go forward

3509
02:08:44,709 --> 02:08:43,040
two slides now

3510
02:08:46,310 --> 02:08:44,719
thank you

3511
02:08:47,910 --> 02:08:46,320
so while i was growing up i was very

3512
02:08:49,510 --> 02:08:47,920
fortunate to be able to watch first hand

3513
02:08:51,589 --> 02:08:49,520

nasa's development of a lunar

3514
02:08:54,069 --> 02:08:51,599
exploration program

3515
02:08:56,229 --> 02:08:54,079
and while many differences exist between

3516
02:08:58,629 --> 02:08:56,239
now and then there are some important

3517
02:09:00,950 --> 02:08:58,639
parallels that i think we can draw

3518
02:09:02,550 --> 02:09:00,960
for example during the

3519
02:09:04,950 --> 02:09:02,560
during the mercury program nasa

3520
02:09:07,669 --> 02:09:04,960
developed the capability to get to and

3521
02:09:09,750 --> 02:09:07,679
survive in low earth orbit

3522
02:09:12,470 --> 02:09:09,760
through the through earth reliant we're

3523
02:09:14,229 --> 02:09:12,480
identifying and solving the challenges

3524
02:09:16,950 --> 02:09:14,239
of long-duration space flight and doing

3525
02:09:19,350 --> 02:09:16,960
that through the activities on the iss

3526
02:09:21,270 --> 02:09:19,360
during the gemini program nasa developed

3527
02:09:22,790 --> 02:09:21,280
the capability to live and work in space

3528
02:09:24,310 --> 02:09:22,800
and develop the technologies to help

3529
02:09:26,709 --> 02:09:24,320
them do so

3530
02:09:28,629 --> 02:09:26,719
in the proving ground nasa will develop

3531
02:09:31,109 --> 02:09:28,639
the capabilities to live and work during

3532
02:09:33,510 --> 02:09:31,119
long duration space flight

3533
02:09:34,870 --> 02:09:33,520
during the apollo program nasa developed

3534
02:09:36,950 --> 02:09:34,880
the systems that allowed humans to

3535
02:09:39,030 --> 02:09:36,960
explore the moon

3536
02:09:40,709 --> 02:09:39,040
and in the earth independent we're

3537
02:09:41,589 --> 02:09:40,719
developing the capability to explore

3538
02:09:43,830 --> 02:09:41,599

mars

3539
02:09:46,629 --> 02:09:43,840
except there's one key difference

3540
02:09:48,069 --> 02:09:46,639
and that is this time unlike apollo

3541
02:09:50,470 --> 02:09:48,079
we're taking a sustainable and

3542
02:09:53,589 --> 02:09:50,480
pioneering approach to that endeavor

3543
02:09:55,830 --> 02:09:53,599
so all five endeavors

3544
02:09:58,790 --> 02:09:55,840
science technology commercial

3545
02:10:00,950 --> 02:09:58,800
international and and human

3546
02:10:04,790 --> 02:10:00,960
play coherent and essential roles in

3547
02:10:04,800 --> 02:10:07,750
next slide

3548
02:10:11,589 --> 02:10:09,830
as you've been hearing today

3549
02:10:13,109 --> 02:10:11,599
the road to mars is extremely

3550
02:10:14,550 --> 02:10:13,119
scientifically rich

3551
02:10:16,390 --> 02:10:14,560
starting right here

3552
02:10:17,430 --> 02:10:16,400
in the earth reliant phase where the

3553
02:10:19,750 --> 02:10:17,440
research

3554
02:10:21,270 --> 02:10:19,760
that we were talking about earlier

3555
02:10:23,430 --> 02:10:21,280
that's being done right now on the

3556
02:10:25,589 --> 02:10:23,440
international space station

3557
02:10:27,350 --> 02:10:25,599
to try to better understand the effects

3558
02:10:29,430 --> 02:10:27,360
of microgravity the long-term effects of

3559
02:10:31,430 --> 02:10:29,440
human space flight on the human body

3560
02:10:33,510 --> 02:10:31,440
that's helping us not just get ready for

3561
02:10:35,430 --> 02:10:33,520
mars but it's also teaching us a lot

3562
02:10:37,189 --> 02:10:35,440
about the human body the way that our

3563
02:10:40,310 --> 02:10:37,199

our systems function so different in

3564
02:10:42,390 --> 02:10:40,320
microgravity is something that that

3565
02:10:44,550 --> 02:10:42,400
we're able to then turn around and apply

3566
02:10:47,270 --> 02:10:44,560
back to earth from loss of bone density

3567
02:10:50,069 --> 02:10:47,280
to muscle wasting that occurs on earth

3568
02:10:52,790 --> 02:10:50,079
orbit uh we're able to start to address

3569
02:10:54,550 --> 02:10:52,800
those risks uh that that we need to get

3570
02:10:56,470 --> 02:10:54,560
humans to mars but we can turn around

3571
02:10:58,310 --> 02:10:56,480
and take that information to help us

3572
02:10:59,990 --> 02:10:58,320
back here on earth

3573
02:11:01,589 --> 02:11:00,000
in the proving ground michelle was

3574
02:11:03,750 --> 02:11:01,599
talking about the asteroid mission and

3575
02:11:05,350 --> 02:11:03,760
the survey that we're doing uh the

3576
02:11:07,510 --> 02:11:05,360
detailed survey that we're doing to try

3577
02:11:09,990 --> 02:11:07,520
to better understand the population of

3578
02:11:12,149 --> 02:11:10,000
near-earth asteroids asteroids are such

3579
02:11:13,910 --> 02:11:12,159
an interesting uh

3580
02:11:15,830 --> 02:11:13,920
solar system materials because they're

3581
02:11:18,550 --> 02:11:15,840
that that materials that we're all that

3582
02:11:20,629 --> 02:11:18,560
we're made of the earth is made of of

3583
02:11:22,870 --> 02:11:20,639
that that basic material that's found in

3584
02:11:24,229 --> 02:11:22,880
comets and asteroids and to be able to

3585
02:11:25,750 --> 02:11:24,239
go out and have a much better

3586
02:11:27,669 --> 02:11:25,760
understanding of the population of

3587
02:11:29,270 --> 02:11:27,679
asteroids we can then start asking what

3588
02:11:31,109 --> 02:11:29,280

they're made of and then better

3589
02:11:33,030 --> 02:11:31,119
understand those materials that actually

3590
02:11:35,189 --> 02:11:33,040
made up the earth

3591
02:11:37,430 --> 02:11:35,199
and in terms of mars as john grunsfeld

3592
02:11:39,510 --> 02:11:37,440
explained earlier we are already

3593
02:11:41,350 --> 02:11:39,520
pioneering mars we have been for years

3594
02:11:43,669 --> 02:11:41,360
we've landed seven times successfully on

3595
02:11:45,669 --> 02:11:43,679
the surface uh we've learned so much

3596
02:11:47,589 --> 02:11:45,679
about mars and we're gaining more and

3597
02:11:49,990 --> 02:11:47,599
more confident that

3598
02:11:52,550 --> 02:11:50,000
mars did have habitable environments in

3599
02:11:53,830 --> 02:11:52,560
the past and to take that next step and

3600
02:11:55,669 --> 02:11:53,840
figure out

3601
02:11:57,750 --> 02:11:55,679
did life evolve on mars what is the

3602
02:11:59,750 --> 02:11:57,760
nature of that life if it did

3603
02:12:01,669 --> 02:11:59,760
is extremely scientifically compelling

3604
02:12:02,550 --> 02:12:01,679
and we are making progress on that every

3605
02:12:04,550 --> 02:12:02,560
day

3606
02:12:05,750 --> 02:12:04,560
with curiosity as it moves up mount

3607
02:12:07,830 --> 02:12:05,760
sharp

3608
02:12:09,910 --> 02:12:07,840
getting better and better science

3609
02:12:11,669 --> 02:12:09,920
that's just extremely important and

3610
02:12:13,030 --> 02:12:11,679
groundbreaking with the insight mission

3611
02:12:14,790 --> 02:12:13,040
that we'll have

3612
02:12:16,870 --> 02:12:14,800
in a few years understanding more about

3613
02:12:18,870 --> 02:12:16,880

the interior of mars the maven mission

3614
02:12:20,709 --> 02:12:18,880
looking at water loss we're really again

3615
02:12:22,470 --> 02:12:20,719
looking at mars as a system from the

3616
02:12:25,430 --> 02:12:22,480
interior all the way out to the top of

3617
02:12:27,189 --> 02:12:25,440
the atmosphere to better understand what

3618
02:12:29,589 --> 02:12:27,199
happened to that habitable environment

3619
02:12:31,430 --> 02:12:29,599
on mars can we better understand it

3620
02:12:34,709 --> 02:12:31,440
in order to answer that very very

3621
02:12:35,589 --> 02:12:34,719
fundamental question of of are we alone

3622
02:12:38,950 --> 02:12:35,599
uh

3623
02:12:42,229 --> 02:12:38,960
and so going to 2020 again going that

3624
02:12:44,950 --> 02:12:42,239
next step possibly caching materials uh

3625
02:12:47,270 --> 02:12:44,960
looking forward to can we at some point

3626
02:12:49,589 --> 02:12:47,280
near in the future return samples back

3627
02:12:51,990 --> 02:12:49,599
to the earth how can we use the mars

3628
02:12:53,910 --> 02:12:52,000
2020 mission not only to do amazingly

3629
02:12:55,430 --> 02:12:53,920
high quality science

3630
02:12:57,990 --> 02:12:55,440
at mars getting at this question of

3631
02:13:00,310 --> 02:12:58,000
habitability but how can we also then

3632
02:13:01,910 --> 02:13:00,320
move to that next important step of

3633
02:13:03,189 --> 02:13:01,920
getting astrobiologists getting

3634
02:13:05,910 --> 02:13:03,199
geologists

3635
02:13:09,189 --> 02:13:05,920
onto the surface of of mars to to find

3636
02:13:11,430 --> 02:13:09,199
that evidence of past life uh so moving

3637
02:13:13,510 --> 02:13:11,440
forward as we have with curiosity as we

3638
02:13:16,790 --> 02:13:13,520

will with 2020 and then in the missions

3639
02:13:19,030 --> 02:13:16,800
that we formulate beyond that using mars

3640
02:13:21,189 --> 02:13:19,040
missions not just to advance our science

3641
02:13:23,350 --> 02:13:21,199
of understanding mars but using them to

3642
02:13:24,950 --> 02:13:23,360
take those next steps to close those

3643
02:13:26,470 --> 02:13:24,960
strategic

3644
02:13:28,709 --> 02:13:26,480
knowledge gaps from the nature of the

3645
02:13:30,069 --> 02:13:28,719
dust to the nature of the atmosphere to

3646
02:13:32,470 --> 02:13:30,079
make sure that we can get those

3647
02:13:34,470 --> 02:13:32,480
scientists uh safely to the surface of

3648
02:13:37,189 --> 02:13:34,480
mars and i will say all that work is not

3649
02:13:39,109 --> 02:13:37,199
just taking place uh out at spacecraft

3650
02:13:40,870 --> 02:13:39,119
it's taking place in laboratories all

3651
02:13:42,790 --> 02:13:40,880
around the country there's a huge amount

3652
02:13:44,629 --> 02:13:42,800
of of earth-based research that goes

3653
02:13:47,189 --> 02:13:44,639
into not just effect understanding the

3654
02:13:49,030 --> 02:13:47,199
effects of radiation on the human body

3655
02:13:49,910 --> 02:13:49,040
but to our fundamental research that we

3656
02:13:52,229 --> 02:13:49,920
do

3657
02:13:55,510 --> 02:13:52,239
trying to understand mars extremely rich

3658
02:13:58,069 --> 02:13:55,520
science going on uh and it's a key part

3659
02:14:00,310 --> 02:13:58,079
and an integral part of why and how we

3660
02:14:02,950 --> 02:14:00,320
will pioneer mars

3661
02:14:07,270 --> 02:14:05,510
so to pave the way to uh to mars nasa's

3662
02:14:09,030 --> 02:14:07,280
technology investments are answering a

3663
02:14:10,550 --> 02:14:09,040

number of questions

3664
02:14:12,629 --> 02:14:10,560
you've seen a lot of the technology

3665
02:14:14,550 --> 02:14:12,639
portfolio that nasa is working on now

3666
02:14:16,229 --> 02:14:14,560
over the last few talks

3667
02:14:18,629 --> 02:14:16,239
something i'd like to add is that nasa

3668
02:14:20,629 --> 02:14:18,639
is being careful to ensure that these

3669
02:14:22,950 --> 02:14:20,639
technology investments are being made in

3670
02:14:25,830 --> 02:14:22,960
a way that not only helps pave that way

3671
02:14:28,310 --> 02:14:25,840
and enable that mission that exploration

3672
02:14:30,550 --> 02:14:28,320
and pioneering of mars but it also

3673
02:14:33,350 --> 02:14:30,560
supports other space sectors as well as

3674
02:14:34,950 --> 02:14:33,360
applications here on earth

3675
02:14:36,550 --> 02:14:34,960
i want to point out also that these

3676
02:14:38,629 --> 02:14:36,560
technology investments are not just

3677
02:14:40,709 --> 02:14:38,639
plants these things are happening right

3678
02:14:43,830 --> 02:14:40,719
now as we speak

3679
02:14:48,550 --> 02:14:46,310
so to grow the space economy nasa is

3680
02:14:50,550 --> 02:14:48,560
partnering with commercial sector to

3681
02:14:53,350 --> 02:14:50,560
answer some key questions

3682
02:14:55,910 --> 02:14:53,360
as we transition from exploration to

3683
02:14:59,189 --> 02:14:55,920
sustainable pioneering is essential that

3684
02:15:01,030 --> 02:14:59,199
nasa partner with the commercial sector

3685
02:15:03,189 --> 02:15:01,040
for many reasons three of which are to

3686
02:15:06,550 --> 02:15:03,199
lean out through commercial practices

3687
02:15:08,470 --> 02:15:06,560
the cost of traveling the road to mars

3688
02:15:11,270 --> 02:15:08,480

second to provide more opportunities for

3689
02:15:12,790 --> 02:15:11,280
innovation by emerging entrepreneurs

3690
02:15:14,709 --> 02:15:12,800
third to spin off discoveries

3691
02:15:17,830 --> 02:15:14,719
capabilities and technologies for the

3692
02:15:19,750 --> 02:15:17,840
benefit of sectors back here on earth

3693
02:15:20,709 --> 02:15:19,760
so i'd like to draw an example where as

3694
02:15:24,470 --> 02:15:20,719
in the

3695
02:15:26,550 --> 02:15:24,480
in comparison to uh the days of the naca

3696
02:15:28,790 --> 02:15:26,560
when collaboration between government

3697
02:15:31,510 --> 02:15:28,800
and industry was essential in recovering

3698
02:15:33,189 --> 02:15:31,520
aeronautics for the united states

3699
02:15:34,310 --> 02:15:33,199
basically a leadership we had lost at

3700
02:15:36,149 --> 02:15:34,320
one point

3701
02:15:39,589 --> 02:15:36,159
such collaboration is essential today to

3702
02:15:42,709 --> 02:15:39,599
sustaining our role in space exploration

3703
02:15:47,270 --> 02:15:44,950
as we've heard about today

3704
02:15:49,750 --> 02:15:47,280
this is not just a path for the united

3705
02:15:51,350 --> 02:15:49,760
states it's an international path

3706
02:15:53,830 --> 02:15:51,360
we will not do this

3707
02:15:56,229 --> 02:15:53,840
alone we must do it with the nations of

3708
02:15:57,669 --> 02:15:56,239
the world and we are are actively

3709
02:15:59,350 --> 02:15:57,679
working with those other nations and

3710
02:16:02,390 --> 02:15:59,360
formulating the global exploration

3711
02:16:04,870 --> 02:16:02,400
roadmap other countries are anxious

3712
02:16:06,390 --> 02:16:04,880
to participate and again this isn't

3713
02:16:08,149 --> 02:16:06,400

something that's theoretical it's

3714
02:16:10,550 --> 02:16:08,159
something that's occurring right now

3715
02:16:12,550 --> 02:16:10,560
today from the international space

3716
02:16:14,229 --> 02:16:12,560
station where we work very closely with

3717
02:16:16,229 --> 02:16:14,239
our international partners on this

3718
02:16:19,189 --> 02:16:16,239
research that i've been talking about to

3719
02:16:22,069 --> 02:16:19,199
understand the fundamental effects of

3720
02:16:24,069 --> 02:16:22,079
microgravity not just on the human body

3721
02:16:27,270 --> 02:16:24,079
but doing all these uh preparatory

3722
02:16:28,790 --> 02:16:27,280
research re research to get us uh out

3723
02:16:31,270 --> 02:16:28,800
out to mars that international

3724
02:16:32,790 --> 02:16:31,280
collaboration is is taking place even as

3725
02:16:34,629 --> 02:16:32,800
we speak

3726
02:16:37,110 --> 02:16:34,639
the search for near earth asteroids is

3727
02:16:40,070 --> 02:16:37,120
an international effort it's not just a

3728
02:16:42,549 --> 02:16:40,080
u.s effort to the international work

3729
02:16:44,469 --> 02:16:42,559
that we have done for years in in

3730
02:16:47,110 --> 02:16:44,479
exploring mars from the mars express

3731
02:16:50,870 --> 02:16:47,120
mission to the the many many examples of

3732
02:16:53,030 --> 02:16:50,880
international participation uh on on our

3733
02:16:55,910 --> 02:16:53,040
or many other science uh missions at

3734
02:16:57,669 --> 02:16:55,920
mars so this this is not a u.s path it's

3735
02:16:59,509 --> 02:16:57,679
an international path and we're working

3736
02:17:02,549 --> 02:16:59,519
very closely with our partners to try to

3737
02:17:04,309 --> 02:17:02,559
best understand how to use everyone's

3738
02:17:07,270 --> 02:17:04,319

capabilities

3739
02:17:08,469 --> 02:17:07,280
everyone's resources to try to do this

3740
02:17:10,389 --> 02:17:08,479
together

3741
02:17:11,509 --> 02:17:10,399
and and i will say also you know david

3742
02:17:13,270 --> 02:17:11,519
was talking about commercial

3743
02:17:14,549 --> 02:17:13,280
partnerships these are international

3744
02:17:16,950 --> 02:17:14,559
partnerships

3745
02:17:18,389 --> 02:17:16,960
every time i go out to a school

3746
02:17:19,509 --> 02:17:18,399
i look out at them and say you know

3747
02:17:21,270 --> 02:17:19,519
we're going to be doing this in the

3748
02:17:22,790 --> 02:17:21,280
2030s

3749
02:17:24,309 --> 02:17:22,800
and you guys need to come help us you

3750
02:17:26,389 --> 02:17:24,319
need to go back to your math class in

3751
02:17:27,429 --> 02:17:26,399
your physics class and and work hard

3752
02:17:29,270 --> 02:17:27,439
because

3753
02:17:32,309 --> 02:17:29,280
i think this is an also extremely

3754
02:17:34,070 --> 02:17:32,319
motivating uh

3755
02:17:36,790 --> 02:17:34,080
program

3756
02:17:39,030 --> 02:17:36,800
to to engage kids in science technology

3757
02:17:41,589 --> 02:17:39,040
engineering and mathematics

3758
02:17:45,910 --> 02:17:43,990
so nasa's human road to mars entails a

3759
02:17:48,309 --> 02:17:45,920
methodical development of capabilities

3760
02:17:50,549 --> 02:17:48,319
that answers a number of questions

3761
02:17:52,469 --> 02:17:50,559
no one can expect to successfully

3762
02:17:55,429 --> 02:17:52,479
complete a challenging task if they

3763
02:17:57,669 --> 02:17:55,439

haven't studied and practiced first

3764
02:18:00,070 --> 02:17:57,679
so we need to understand what works what

3765
02:18:01,990 --> 02:18:00,080
doesn't work and how to deal with things

3766
02:18:04,070 --> 02:18:02,000
that no longer work

3767
02:18:05,990 --> 02:18:04,080
this takes practice

3768
02:18:08,870 --> 02:18:06,000
and this practice must be enough in an

3769
02:18:11,270 --> 02:18:08,880
authentic done in an authentic way

3770
02:18:13,830 --> 02:18:11,280
and needs to be done across all five of

3771
02:18:15,910 --> 02:18:13,840
these endeavors

3772
02:18:17,509 --> 02:18:15,920
so like the mercury program the

3773
02:18:19,830 --> 02:18:17,519
international space station allows us to

3774
02:18:21,750 --> 02:18:19,840
study what works and what doesn't work

3775
02:18:23,990 --> 02:18:21,760
like the gemini program the proving

3776
02:18:26,309 --> 02:18:24,000
ground allows us to practice with those

3777
02:18:27,429 --> 02:18:26,319
capabilities that do work honing our

3778
02:18:29,349 --> 02:18:27,439
skills

3779
02:18:32,230 --> 02:18:29,359
and deal with them when they no longer

3780
02:18:34,309 --> 02:18:32,240
work this is key

3781
02:18:36,150 --> 02:18:34,319
this methodical interplay between

3782
02:18:38,230 --> 02:18:36,160
science technology commercial and

3783
02:18:41,509 --> 02:18:38,240
international endeavors is essential in

3784
02:18:44,469 --> 02:18:41,519
successfully and sustainably

3785
02:18:52,230 --> 02:18:44,479
moving humanity along the road to mars

3786
02:18:59,270 --> 02:18:54,950
questions in the audience for our chiefs

3787
02:19:02,790 --> 02:19:01,030
ken currently for universe today ellen

3788
02:19:05,270 --> 02:19:02,800

yeah you raised exactly the question i

3789
02:19:07,190 --> 02:19:05,280
want to to ask about um

3790
02:19:09,030 --> 02:19:07,200
international participation okay so the

3791
02:19:12,070 --> 02:19:09,040
us is going to provide the sls and the

3792
02:19:13,830 --> 02:19:12,080
orion can you give some examples of what

3793
02:19:16,790 --> 02:19:13,840
the international partners could provide

3794
02:19:18,230 --> 02:19:16,800
what are they interested in providing

3795
02:19:20,070 --> 02:19:18,240
well that's something that's a subject

3796
02:19:21,589 --> 02:19:20,080
of ongoing discussions and and gerst

3797
02:19:24,070 --> 02:19:21,599
could probably give you more specifics

3798
02:19:26,150 --> 02:19:24,080
than i i could but for example again the

3799
02:19:28,150 --> 02:19:26,160
the work that we're doing right now on

3800
02:19:30,469 --> 02:19:28,160
the international space station in terms

3801
02:19:33,669 --> 02:19:30,479
of looking at the long-term effects uh

3802
02:19:35,429 --> 02:19:33,679
of of space flight on the the human body

3803
02:19:36,790 --> 02:19:35,439
uh with the one year mission that were

3804
02:19:39,429 --> 02:19:36,800
the twin study that we're about to

3805
02:19:40,790 --> 02:19:39,439
embark on uh we are working very closely

3806
02:19:42,709 --> 02:19:40,800
with our international partners and

3807
02:19:44,469 --> 02:19:42,719
they're very interested um in that

3808
02:19:46,870 --> 02:19:44,479
research and in participating in any way

3809
02:19:48,870 --> 02:19:46,880
they can so that that's a near term

3810
02:19:50,790 --> 02:19:48,880
again on curiosity we have we have

3811
02:19:52,309 --> 02:19:50,800
foreign investigators or investigators

3812
02:19:53,670 --> 02:19:52,319
from many countries participating in

3813
02:19:55,510 --> 02:19:53,680

that

3814
02:19:57,270 --> 02:19:55,520
some of our partners have looked at

3815
02:19:58,790 --> 02:19:57,280
maybe being interested in going back to

3816
02:20:00,230 --> 02:19:58,800
the surface of the moon which is not

3817
02:20:02,309 --> 02:20:00,240
something that we see on a critical

3818
02:20:03,510 --> 02:20:02,319
capability path if they are interested

3819
02:20:06,150 --> 02:20:03,520
in doing that

3820
02:20:07,670 --> 02:20:06,160
we're certainly interested in in um

3821
02:20:09,510 --> 02:20:07,680
aiding them in any way we can even

3822
02:20:11,750 --> 02:20:09,520
though that's not on that's not on our

3823
02:20:13,750 --> 02:20:11,760
main path so um gerst i don't know if

3824
02:20:15,510 --> 02:20:13,760
you want to amp no he's shaking his head

3825
02:20:17,990 --> 02:20:15,520
no those are the sorts of things that

3826
02:20:19,270 --> 02:20:18,000
we're we're talking with them about um

3827
02:20:21,990 --> 02:20:19,280
but again we're very much in the

3828
02:20:23,510 --> 02:20:22,000
discussion stage but the in the there is

3829
02:20:25,349 --> 02:20:23,520
a booklet that you can get somewhere on

3830
02:20:27,429 --> 02:20:25,359
the web the global exploration roadmap

3831
02:20:31,670 --> 02:20:27,439
and that very much is a multi-agency

3832
02:20:33,270 --> 02:20:31,680
product it's not just a nasa product

3833
02:20:34,550 --> 02:20:33,280
okay i think we we have a really tight

3834
02:20:35,670 --> 02:20:34,560
schedule for our next speakers

3835
02:20:37,349 --> 02:20:35,680
unfortunately i think i'm going to have

3836
02:20:38,550 --> 02:20:37,359
to leave it at one question maybe if the

3837
02:20:40,550 --> 02:20:38,560
chiefs can stick around if we didn't get

3838
02:20:42,230 --> 02:20:40,560

to anybody's in the audience we'll ask

3839
02:20:49,190 --> 02:20:42,240
them to but please help me thank our

3840
02:20:54,550 --> 02:20:52,150
so here to provide concluding remarks uh

3841
02:20:56,309 --> 02:20:54,560
is robert lightfoot he is the associate

3842
02:20:57,750 --> 02:20:56,319
administrator for nasa which is the

3843
02:20:59,190 --> 02:20:57,760
agency's highest highest-ranking civil

3844
02:21:00,630 --> 02:20:59,200
servant position

3845
02:21:03,270 --> 02:21:00,640
and he took this position in september

3846
02:21:05,110 --> 02:21:03,280
of 2012. previously he was director of

3847
02:21:06,950 --> 02:21:05,120
nasa's marshall space flight center in

3848
02:21:08,790 --> 02:21:06,960
huntsville alabama that of course is one

3849
02:21:10,870 --> 02:21:08,800
of nasa's largest field installations

3850
02:21:12,710 --> 02:21:10,880
playing a critical role in nasa space

3851
02:21:14,710 --> 02:21:12,720
operations exploration

3852
02:21:16,790 --> 02:21:14,720
uh and in science missions uh he's

3853
02:21:18,469 --> 02:21:16,800
managed a broad range of propulsion

3854
02:21:19,910 --> 02:21:18,479
scientific and space transportation

3855
02:21:23,030 --> 02:21:19,920
activities contributing to the nation's

3856
02:21:24,790 --> 02:21:23,040
space program from 2007 to 2009 he was

3857
02:21:26,630 --> 02:21:24,800
deputy director of marshall in previous

3858
02:21:28,950 --> 02:21:26,640
capacities he's managed the space

3859
02:21:30,070 --> 02:21:28,960
shuttle propulsion office at marshall

3860
02:21:31,830 --> 02:21:30,080
he was the assistant associate

3861
02:21:34,550 --> 02:21:31,840
administrator of the space shuttle

3862
02:21:36,870 --> 02:21:34,560
program uh here at nasa headquarters he

3863
02:21:38,950 --> 02:21:36,880

directed the propulsion test directorate

3864
02:21:41,270 --> 02:21:38,960
at nasa stennis space center and he

3865
02:21:43,349 --> 02:21:41,280
began his nasa career in 1989 at

3866
02:21:44,870 --> 02:21:43,359
marshall as a test engineer and program

3867
02:21:57,270 --> 02:21:44,880
manager please help me welcome robert

3868
02:21:59,910 --> 02:21:58,710
well good afternoon

3869
02:22:01,910 --> 02:21:59,920
i want to thank you all for being here

3870
02:22:02,950 --> 02:22:01,920
today i know you heard from charlie this

3871
02:22:04,630 --> 02:22:02,960
morning

3872
02:22:06,389 --> 02:22:04,640
you know today was intended to provide

3873
02:22:08,389 --> 02:22:06,399
you the insight

3874
02:22:10,630 --> 02:22:08,399
into our ongoing exploration efforts and

3875
02:22:12,870 --> 02:22:10,640
i caught the last part of ellen and

3876
02:22:14,309 --> 02:22:12,880
david's presentation and i think that uh

3877
02:22:16,309 --> 02:22:14,319
you've got plenty of insight into what

3878
02:22:18,870 --> 02:22:16,319
we're thinking our stepping stone

3879
02:22:20,630 --> 02:22:18,880
approach um to take humans to mars

3880
02:22:22,550 --> 02:22:20,640
includes efforts in all our mission

3881
02:22:24,389 --> 02:22:22,560
directorates the space mission director

3882
02:22:26,230 --> 02:22:24,399
science space technology and human

3883
02:22:28,630 --> 02:22:26,240
exploration

3884
02:22:30,230 --> 02:22:28,640
this integrated approach offers us some

3885
02:22:31,830 --> 02:22:30,240
interesting challenges from time to time

3886
02:22:33,510 --> 02:22:31,840
as we as we do with our budgets and we

3887
02:22:35,110 --> 02:22:33,520
deal with the process we go forward

3888
02:22:37,110 --> 02:22:35,120

especially in an environment where we as

3889
02:22:39,030 --> 02:22:37,120
a team think a lot about one-off

3890
02:22:40,469 --> 02:22:39,040
missions right we think about it this

3891
02:22:41,670 --> 02:22:40,479
mission that mission but the way the

3892
02:22:42,870 --> 02:22:41,680
guys have put this together and the way

3893
02:22:44,790 --> 02:22:42,880
the teams have put it together it's a

3894
02:22:45,990 --> 02:22:44,800
really integrated approach to how we're

3895
02:22:47,349 --> 02:22:46,000
going to attack this and when you see

3896
02:22:48,710 --> 02:22:47,359
how we're approaching this you see this

3897
02:22:50,150 --> 02:22:48,720
path to mars

3898
02:22:51,670 --> 02:22:50,160
you begin to see how each effort is

3899
02:22:53,670 --> 02:22:51,680
stitched together

3900
02:22:55,750 --> 02:22:53,680
you know each each piece has a common

3901
02:22:58,550 --> 02:22:55,760
goal of getting humans to mars

3902
02:22:59,670 --> 02:22:58,560
um so that we are ready to get there so

3903
02:23:00,790 --> 02:22:59,680
when you think about it and i'll just

3904
02:23:02,070 --> 02:23:00,800
kind of repeat some of the things you've

3905
02:23:03,590 --> 02:23:02,080
heard today

3906
02:23:05,110 --> 02:23:03,600
you talk about earth dependent you talk

3907
02:23:06,230 --> 02:23:05,120
about the international space station

3908
02:23:08,870 --> 02:23:06,240
and what we're learning there with the

3909
02:23:11,190 --> 02:23:08,880
technology the science and what and the

3910
02:23:12,469 --> 02:23:11,200
reaction of the human body to to being

3911
02:23:13,910 --> 02:23:12,479
in space those kind of things are

3912
02:23:16,710 --> 02:23:13,920
critical for us if we're going to take

3913
02:23:18,150 --> 02:23:16,720

explorers beyond low earth orbit

3914
02:23:19,590 --> 02:23:18,160
that of course is supported by our

3915
02:23:20,950 --> 02:23:19,600
commercial cargo and hopefully our

3916
02:23:22,630 --> 02:23:20,960
commercial crew

3917
02:23:24,150 --> 02:23:22,640
efforts soon right this is this is what

3918
02:23:26,630 --> 02:23:24,160
we're doing this is how that allows us

3919
02:23:28,070 --> 02:23:26,640
to tackle those critical challenges

3920
02:23:30,389 --> 02:23:28,080
then you look at the proving ground as

3921
02:23:32,550 --> 02:23:30,399
we talk here the area around around the

3922
02:23:34,070 --> 02:23:32,560
moon our asteroid redirect mission fits

3923
02:23:35,830 --> 02:23:34,080
right in there it allows us to try

3924
02:23:37,429 --> 02:23:35,840
operations and practice and do things

3925
02:23:38,950 --> 02:23:37,439
that we're going to need to do but we're

3926
02:23:41,190 --> 02:23:38,960
close enough to home to get back if we

3927
02:23:42,790 --> 02:23:41,200
need to and that's that's another piece

3928
02:23:43,990 --> 02:23:42,800
that's critical in that area what do we

3929
02:23:45,349 --> 02:23:44,000
do we get to test a lot of the things

3930
02:23:47,429 --> 02:23:45,359
that the space technology mission

3931
02:23:49,030 --> 02:23:47,439
director is working on i mean the things

3932
02:23:50,550 --> 02:23:49,040
that we need for solar electric

3933
02:23:52,870 --> 02:23:50,560
propulsion things that are going to

3934
02:23:54,630 --> 02:23:52,880
advance us and allow us to go to mars

3935
02:23:56,550 --> 02:23:54,640
in that arena we also think about things

3936
02:23:57,990 --> 02:23:56,560
like radiation protection

3937
02:23:59,270 --> 02:23:58,000
we think about entry descent landing

3938
02:24:00,469 --> 02:23:59,280

we've got a big challenge there if we're

3939
02:24:01,510 --> 02:24:00,479
going to mars with humans what are we

3940
02:24:03,030 --> 02:24:01,520
going to do there so our space

3941
02:24:04,469 --> 02:24:03,040
technology mission director just really

3942
02:24:05,750 --> 02:24:04,479
involved in that

3943
02:24:08,710 --> 02:24:05,760
and then when you start talking about

3944
02:24:09,990 --> 02:24:08,720
earth independent or mars ready right

3945
02:24:11,190 --> 02:24:10,000
we're going to be ready to go to mars

3946
02:24:12,150 --> 02:24:11,200
what are the things that we've got to go

3947
02:24:14,150 --> 02:24:12,160
do

3948
02:24:15,349 --> 02:24:14,160
all our efforts today all our efforts

3949
02:24:16,469 --> 02:24:15,359
that you guys that you heard from these

3950
02:24:18,630 --> 02:24:16,479
guys are we're trying to make sure

3951
02:24:20,150 --> 02:24:18,640
they're extensible uh we sit in meetings

3952
02:24:21,670 --> 02:24:20,160
all the time and my question to them all

3953
02:24:23,110 --> 02:24:21,680
the time is this a one-off or is this

3954
02:24:25,910 --> 02:24:23,120
going to help us is this that takes that

3955
02:24:28,150 --> 02:24:25,920
next step as we go to mars um and so

3956
02:24:30,230 --> 02:24:28,160
it's all about optimizing around the

3957
02:24:32,070 --> 02:24:30,240
goal of getting humans to mars

3958
02:24:33,110 --> 02:24:32,080
as opposed to maybe opera optimizing

3959
02:24:34,230 --> 02:24:33,120
around a given mission and that's

3960
02:24:35,270 --> 02:24:34,240
something that's a challenge for us

3961
02:24:37,190 --> 02:24:35,280
that's a challenge in our thinking and

3962
02:24:38,389 --> 02:24:37,200
the way we go but this team's ready and

3963
02:24:39,750 --> 02:24:38,399

they're up to that challenge and i think

3964
02:24:40,870 --> 02:24:39,760
you heard it today from every one of

3965
02:24:42,309 --> 02:24:40,880
them

3966
02:24:43,910 --> 02:24:42,319
they're thinking this way and we're

3967
02:24:45,590 --> 02:24:43,920
pressing so

3968
02:24:47,429 --> 02:24:45,600
so i hope today was useful for you in

3969
02:24:49,429 --> 02:24:47,439
terms of providing that integrated

3970
02:24:51,270 --> 02:24:49,439
insight into this into this exploration

3971
02:24:52,550 --> 02:24:51,280
strategy um

3972
02:24:54,469 --> 02:24:52,560
we want to hear your feedback and

3973
02:24:57,190 --> 02:24:54,479
comments i mean honestly that's why we

3974
02:24:58,790 --> 02:24:57,200
have you here from that standpoint to us

3975
02:25:00,309 --> 02:24:58,800
this is the beginning of a continual

3976
02:25:04,150 --> 02:25:00,319
dialogue

3977
02:25:05,190 --> 02:25:04,160
we take these steps

3978
02:25:07,190 --> 02:25:05,200
you know

3979
02:25:08,630 --> 02:25:07,200
if you look that the journey we're about

3980
02:25:10,070 --> 02:25:08,640
to take will take many steps we talk

3981
02:25:11,750 --> 02:25:10,080
about the international space station as

3982
02:25:13,110 --> 02:25:11,760
one of those steps we talked you heard

3983
02:25:15,030 --> 02:25:13,120
today what that does for us we talk

3984
02:25:17,190 --> 02:25:15,040
about our advanced exploration

3985
02:25:18,790 --> 02:25:17,200
initiatives that jason's working on

3986
02:25:20,230 --> 02:25:18,800
those are the things that those are a

3987
02:25:22,469 --> 02:25:20,240
set of steps we talk about the asteroid

3988
02:25:24,309 --> 02:25:22,479

redirect mission that provides us a set

3989
02:25:25,110 --> 02:25:24,319
of steps though all those steps are

3990
02:25:26,389 --> 02:25:25,120
going to be important and they're going

3991
02:25:28,230 --> 02:25:26,399
to be more you know there will be more

3992
02:25:29,750 --> 02:25:28,240
that we're not done on our on our plate

3993
02:25:31,750 --> 02:25:29,760
today but all of them will be focused on

3994
02:25:33,510 --> 02:25:31,760
getting humans to mars and i think

3995
02:25:35,110 --> 02:25:33,520
that's going to be real important so i

3996
02:25:36,630 --> 02:25:35,120
want to thank you all for joining us

3997
02:25:37,990 --> 02:25:36,640
here today and i want to thank the

3998
02:25:39,590 --> 02:25:38,000
speakers these guys took a lot of time

3999
02:25:41,990 --> 02:25:39,600
and did their did their talks this

4000
02:25:43,830 --> 02:25:42,000
morning and i hope you got to see

4001
02:25:46,070 --> 02:25:43,840
you could see that in

4002
02:25:47,110 --> 02:25:46,080
that that insight and understand what

4003
02:25:50,389 --> 02:25:47,120
we're trying to do from a strategy

4004
02:25:52,230 --> 02:25:50,399
standpoint and i'll just close with this

4005
02:25:53,910 --> 02:25:52,240
we're on a path to mars and getting

4006
02:25:56,630 --> 02:25:53,920
humans there that's what we want to go

4007
02:25:58,790 --> 02:25:56,640
do is that bold yeah it's very bold it's

4008
02:26:00,230 --> 02:25:58,800
what we should be doing as an agency and

4009
02:26:02,230 --> 02:26:00,240
all we ask is that you come along for

4010
02:26:03,670 --> 02:26:02,240
the ride and join us in that in that

4011
02:26:05,110 --> 02:26:03,680
strategy and that journey so thanks

4012
02:26:08,389 --> 02:26:05,120
again for being here today and thanks to

4013
02:26:13,110 --> 02:26:10,630

do you have time for one question

4014
02:26:14,950 --> 02:26:13,120
time for a question sure

4015
02:26:17,830 --> 02:26:14,960
i'm sure the jpss team will be glad that

4016
02:26:21,190 --> 02:26:17,840
i'm down here one one question uh

4017
02:26:23,429 --> 02:26:21,200
frank do you have one

4018
02:26:24,309 --> 02:26:23,439
don't give it don't don't force him on

4019
02:26:26,070 --> 02:26:24,319
trent

4020
02:26:27,190 --> 02:26:26,080
actually i wanted to ask charlie you

4021
02:26:28,550 --> 02:26:27,200
know

4022
02:26:29,990 --> 02:26:28,560
you're talking about

4023
02:26:32,309 --> 02:26:30,000
way out in the future and there's a lot

4024
02:26:33,750 --> 02:26:32,319
of discussion about

4025
02:26:35,910 --> 02:26:33,760
international cooperation commercial

4026
02:26:37,590 --> 02:26:35,920
cooperation at a time when

4027
02:26:38,469 --> 02:26:37,600
neither one of those things seems to be

4028
02:26:40,870 --> 02:26:38,479
uh

4029
02:26:42,790 --> 02:26:40,880
in the forefront particularly with this

4030
02:26:45,110 --> 02:26:42,800
with your russian partners

4031
02:26:46,950 --> 02:26:45,120
uh the commercial sector is kind of in

4032
02:26:50,070 --> 02:26:46,960
an uproar this week

4033
02:26:52,309 --> 02:26:50,080
how do you get past the the short-term

4034
02:26:54,230 --> 02:26:52,319
blips let's hope they are

4035
02:26:56,309 --> 02:26:54,240
to do the long-term objectives that

4036
02:26:57,830 --> 02:26:56,319
you're talking about i think it's for us

4037
02:26:59,510 --> 02:26:57,840
it's pretty simple frank is is a

4038
02:27:01,590 --> 02:26:59,520

consistent approach and a consistent

4039
02:27:03,270 --> 02:27:01,600
message and a consistent cadence toward

4040
02:27:04,710 --> 02:27:03,280
making each one of these objectives

4041
02:27:06,230 --> 02:27:04,720
become real

4042
02:27:07,750 --> 02:27:06,240
i believe our international partners

4043
02:27:10,150 --> 02:27:07,760
have been very participatory in this

4044
02:27:11,750 --> 02:27:10,160
regardless of what you what you hear

4045
02:27:13,110 --> 02:27:11,760
from a space standpoint we seem to have

4046
02:27:16,070 --> 02:27:13,120
great participation and haven't really

4047
02:27:18,150 --> 02:27:16,080
seen a change at all so for us it's just

4048
02:27:19,110 --> 02:27:18,160
that consistent approach that consistent

4049
02:27:21,910 --> 02:27:19,120
challenge

4050
02:27:23,349 --> 02:27:21,920
um between the three space based uh

4051
02:27:25,910 --> 02:27:23,359
mission directorates to make sure we're

4052
02:27:27,910 --> 02:27:25,920
focused on the same thing

4053
02:27:29,510 --> 02:27:27,920
okay please help me thank nasa associate

4054
02:27:36,150 --> 02:27:29,520
administrator robert lightfoot thanks

4055
02:27:41,110 --> 02:27:38,870
and just reminder that you can find out

4056
02:27:45,510 --> 02:27:41,120
more information about nasa's human

4057
02:27:47,590 --> 02:27:45,520
exploration path to mars at www.nasa.gov

4058
02:27:49,830 --> 02:27:47,600
exploration it's our goal to have all

4059
02:27:52,870 --> 02:27:49,840
the presentations you saw uh here today

4060
02:27:54,550 --> 02:27:52,880
up on nasa.gov exploration later as the

4061
02:27:56,150 --> 02:27:54,560
as the electrons allow and we'll see how

4062
02:27:58,469 --> 02:27:56,160
fast we can do it

4063
02:28:01,429 --> 02:27:58,479

and of course we'll have archive video

4064
02:28:03,830 --> 02:28:01,439
of this event uh available on nasa.gov

4065
02:28:05,830 --> 02:28:03,840
and on nasa's youtube channel uh later

4066
02:28:07,429 --> 02:28:05,840
today as well that of course is

4067
02:28:10,630 --> 02:28:07,439
youtube.com

4068
02:28:12,309 --> 02:28:10,640
nasa television um thanks to all of you

4069
02:28:14,550 --> 02:28:12,319
for participating really want to just

4070
02:28:16,150 --> 02:28:14,560
take a special uh moment here to thank

4071
02:28:17,990 --> 02:28:16,160
our our speakers it was an awful lot of

4072
02:28:19,190 --> 02:28:18,000
uh time and you know a lot of a lot of

4073
02:28:21,510 --> 02:28:19,200
leadership here in this room really

4074
02:28:23,270 --> 02:28:21,520
appreciate you uh making the time to to

4075
02:28:25,670 --> 02:28:23,280
come tell us all about the the human

4076
02:28:27,670 --> 02:28:25,680
path to mars uh so that's going to do it

4077
02:28:29,510 --> 02:28:27,680
for today's event from nasa headquarters

4078
02:28:31,110 --> 02:28:29,520
on public affairs officer trim parado