1
00:00:06,470 --> 00:00:04,630
the spheres satellites uh flyboard

2
00:00:07,909 --> 00:00:06,480
international space station so we can

3
00:00:09,190 --> 00:00:07,919
learn more about how to control

4
00:00:11,509 --> 00:00:09,200
satellites

5
00:00:13,669 --> 00:00:11,519
specifically how can we learn how

6
00:00:16,950 --> 00:00:13,679
multiple satellites work together

7
00:00:19,670 --> 00:00:16,960
instead of just one satellite at a time

8
00:00:21,990 --> 00:00:19,680
with this we can do future things like

9
00:00:23,750 --> 00:00:22,000
in-space robotic assembly instead of

10
00:00:25,910 --> 00:00:23,760
needing to send a bunch of space

11
00:00:28,790 --> 00:00:25,920
shuttles which we don't have anymore to

12
00:00:30,710 --> 00:00:28,800
build the next space station or the next

13
00:00:32,150 --> 00:00:30,720

interplanetary transport vehicle like

14
00:00:33,670 --> 00:00:32,160
going to mars

15
00:00:35,590 --> 00:00:33,680
we want to learn how can we get

16
00:00:37,670 --> 00:00:35,600
satellites working together to do all

17
00:00:39,750 --> 00:00:37,680
that assembly so that we don't send

18
00:00:42,950 --> 00:00:39,760
humans every time we send a bunch of

19
00:00:44,549 --> 00:00:42,960
robots they assemble the next big thing

20
00:00:46,310 --> 00:00:44,559
and then we send humans when the next we

21
00:00:48,630 --> 00:00:46,320
think it's ready to go that should make

22
00:00:50,150 --> 00:00:48,640
it a lot cheaper and a lot safer and

23
00:00:54,549 --> 00:00:50,160
should be able to do it with all the

24
00:00:56,950 --> 00:00:54,559
resources we currently have in the plans

25
00:00:59,189 --> 00:00:56,960
for future space exploration the sphere

26
00:01:00,950 --> 00:00:59,199
satellites are nano satellites aboard

27
00:01:03,750 --> 00:01:00,960
the international space station they

28
00:01:05,910 --> 00:01:03,760
tend to fly only inside they look like

29
00:01:08,310 --> 00:01:05,920
little volleyballs they're about 20

30
00:01:09,510 --> 00:01:08,320
centimeters in diameter um they're

31
00:01:11,670 --> 00:01:09,520
pretty massive they're almost four

32
00:01:13,270 --> 00:01:11,680
kilograms but they're in space so they

33
00:01:15,109 --> 00:01:13,280
don't weigh right there they're four

34
00:01:16,469 --> 00:01:15,119
kilometers floating around

35
00:01:18,390 --> 00:01:16,479
and um

36
00:01:20,149 --> 00:01:18,400
we designed them with the idea of being

37
00:01:21,510 --> 00:01:20,159
able to test a lot of different things

38
00:01:23,990 --> 00:01:21,520

in space station

39
00:01:25,670 --> 00:01:24,000
so we did not advance

40
00:01:27,990 --> 00:01:25,680
the technology of the satellite itself

41
00:01:31,030 --> 00:01:28,000
very much actually to the opposite we

42
00:01:32,469 --> 00:01:31,040
use very common technology um one of the

43
00:01:34,630 --> 00:01:32,479
things we're very proud of is that the

44
00:01:36,950 --> 00:01:34,640
majority of our propulsion system

45
00:01:39,510 --> 00:01:36,960
is based on either a lot of medical

46
00:01:41,429 --> 00:01:39,520
devices which is just the tubing is what

47
00:01:42,310 --> 00:01:41,439
is used in the medical device world

48
00:01:44,950 --> 00:01:42,320
and

49
00:01:45,990 --> 00:01:44,960
the pressure tank is actually the same

50
00:01:47,749 --> 00:01:46,000
tank that you would use when you're

51
00:01:49,670 --> 00:01:47,759
going to paintball if you go play

52
00:01:52,389 --> 00:01:49,680
paintball the same tank we send out to

53
00:01:55,749 --> 00:01:52,399
space it's very safe and we're very

54
00:01:57,910 --> 00:01:55,759
happy to have done a project that uses

55
00:01:59,590 --> 00:01:57,920
normal technology of space station in

56
00:02:01,590 --> 00:01:59,600
many ways

57
00:02:04,310 --> 00:02:01,600
there are some custom things

58
00:02:06,550 --> 00:02:04,320
like what we call the metrology system

59
00:02:08,949 --> 00:02:06,560
metrology means knowing where you are

60
00:02:10,790 --> 00:02:08,959
basically so that is a custom system it

61
00:02:12,470 --> 00:02:10,800
uses a combination of infrared and

62
00:02:14,790 --> 00:02:12,480
ultrasound signals

63
00:02:15,990 --> 00:02:14,800

to triangulate the location of the

64
00:02:17,510 --> 00:02:16,000
satellite

65
00:02:19,350 --> 00:02:17,520
and then we have a computer called a

66
00:02:21,270 --> 00:02:19,360
digital signal processor

67
00:02:23,190 --> 00:02:21,280
so it's processing digital signals

68
00:02:25,190 --> 00:02:23,200
creating from all this to know where it

69
00:02:27,430 --> 00:02:25,200
is and determining what thrusters to

70
00:02:29,350 --> 00:02:27,440
fire so it knows how to move

71
00:02:32,390 --> 00:02:29,360
so basically we have this little

72
00:02:35,270 --> 00:02:32,400
satellite about this size that can move

73
00:02:37,910 --> 00:02:35,280
all around our dedicated area inside

74
00:02:42,550 --> 00:02:40,470
in every direction that we wanted to

75
00:02:45,270 --> 00:02:42,560
and at the same time we designed it so

76
00:02:46,150 --> 00:02:45,280
that the thrust is small enough

77
00:02:48,150 --> 00:02:46,160
that

78
00:02:49,990 --> 00:02:48,160
there are there are no safety concerns

79
00:02:52,470 --> 00:02:50,000
on what the satellite is doing it will

80
00:02:53,509 --> 00:02:52,480
never be able to go faster

81
00:02:55,910 --> 00:02:53,519
and

82
00:02:58,630 --> 00:02:55,920
have contact with anything space station

83
00:03:00,710 --> 00:02:58,640
of any forces higher than an astronaut

84
00:03:03,589 --> 00:03:00,720
pushing themselves off a wall

85
00:03:04,390 --> 00:03:03,599
so our satellites are very agile and yet

86
00:03:06,390 --> 00:03:04,400
they're

87
00:03:08,070 --> 00:03:06,400
weak enough to never present a safety

88
00:03:11,509 --> 00:03:08,080

issue and that's why we can do many

89
00:03:13,910 --> 00:03:11,519
different things with them we have about

90
00:03:15,910 --> 00:03:13,920
six to eight different type of projects

91
00:03:18,470 --> 00:03:15,920
we've done a pretty nice results on

92
00:03:20,869 --> 00:03:18,480
formation flight when the satellites are

93
00:03:22,470 --> 00:03:20,879
maintaining a formation

94
00:03:24,070 --> 00:03:22,480
when they're doing things like collision

95
00:03:26,070 --> 00:03:24,080
avoidance making sure that as the

96
00:03:28,550 --> 00:03:26,080
formation changes so sometimes the

97
00:03:30,149 --> 00:03:28,560
satellites are in a straight line but if

98
00:03:32,470 --> 00:03:30,159
they change formation as they move

99
00:03:34,869 --> 00:03:32,480
around they don't collide to each other

100
00:03:36,949 --> 00:03:34,879
that's been a really successful work so

101
00:03:38,789 --> 00:03:36,959
far

102
00:03:40,789 --> 00:03:38,799
we've also done some very interesting

103
00:03:42,630 --> 00:03:40,799
docking maneuvers in other words the

104
00:03:43,670 --> 00:03:42,640
satellites separate apart coming

105
00:03:44,710 --> 00:03:43,680
together

106
00:03:46,309 --> 00:03:44,720
that

107
00:03:47,750 --> 00:03:46,319
not only coming together straight next

108
00:03:50,470 --> 00:03:47,760
to each other which other people have

109
00:03:52,550 --> 00:03:50,480
done before the the amazing thing of the

110
00:03:54,949 --> 00:03:52,560
project working inside space station is

111
00:03:56,789 --> 00:03:54,959
we can do risky things we can try things

112
00:03:59,110 --> 00:03:56,799
that you would not try with a real

113
00:04:00,710 --> 00:03:59,120

satellite out on space because you're

114
00:04:02,630 --> 00:04:00,720
going to be worried about losing it

115
00:04:05,110 --> 00:04:02,640
inside space station we have one

116
00:04:07,110 --> 00:04:05,120
satellite rotating spinning around and

117
00:04:09,190 --> 00:04:07,120
the other one docking to it and we can

118
00:04:10,550 --> 00:04:09,200
try it multiple times

119
00:04:13,030 --> 00:04:10,560
it actually worked on the second try

120
00:04:14,789 --> 00:04:13,040
which we're really happy about but even

121
00:04:17,110 --> 00:04:14,799
if it didn't we can try it multiple

122
00:04:19,110 --> 00:04:17,120
times over and over again

123
00:04:21,909 --> 00:04:19,120
and we're doing all of that in in true

124
00:04:23,749 --> 00:04:21,919
microgravity full six degrees of freedom

125
00:04:26,310 --> 00:04:23,759
so when the satellites can move out in

126
00:04:27,670 --> 00:04:26,320
any direction we can still try it and

127
00:04:29,430 --> 00:04:27,680
show that

128
00:04:30,950 --> 00:04:29,440
the algorithms that we're using to

129
00:04:33,110 --> 00:04:30,960
docker satellites

130
00:04:33,990 --> 00:04:33,120
are reasonably

131
00:04:36,550 --> 00:04:34,000
uh

132
00:04:39,590 --> 00:04:36,560
advanced to be able to work in the

133
00:04:41,430 --> 00:04:39,600
future on real big missions so those are

134
00:04:43,270 --> 00:04:41,440
some of our very interesting

135
00:04:45,110 --> 00:04:43,280
results so far

136
00:04:46,950 --> 00:04:45,120
the last set of results we have this

137
00:04:48,310 --> 00:04:46,960
from this year kind of fresh out of the

138
00:04:50,629 --> 00:04:48,320

space station

139
00:04:53,270 --> 00:04:50,639
is on vision-based navigation so using

140
00:04:55,030 --> 00:04:53,280
cameras to detect the presence of other

141
00:04:57,030 --> 00:04:55,040
satellites and to be able to dock to

142
00:04:59,430 --> 00:04:57,040
other satellites with cameras

143
00:05:01,110 --> 00:04:59,440
so we're just starting that research

144
00:05:03,590 --> 00:05:01,120
but we have some very interesting things

145
00:05:04,550 --> 00:05:03,600
going on where we can make one satellite

146
00:05:08,070 --> 00:05:04,560
turn

147
00:05:09,430 --> 00:05:08,080
the earth because they can they're

148
00:05:11,749 --> 00:05:09,440
floating

149
00:05:13,510 --> 00:05:11,759
and be able to really identify all that

150
00:05:15,830 --> 00:05:13,520
motion of the satellites just with

151
00:05:17,830 --> 00:05:15,840
cameras without any other sensor

152
00:05:19,590 --> 00:05:17,840
from the perspective of in-space robotic

153
00:05:21,990 --> 00:05:19,600
assembly and servicing

154
00:05:24,629 --> 00:05:22,000
we will benefit in the earth by making

155
00:05:26,710 --> 00:05:24,639
it easier and cheaper to get

156
00:05:28,950 --> 00:05:26,720
new communication satellites to upgrade

157
00:05:30,950 --> 00:05:28,960
satellites in space that let us have a

158
00:05:33,749 --> 00:05:30,960
much better

159
00:05:35,830 --> 00:05:33,759
life on earth right we depend a lot on

160
00:05:37,350 --> 00:05:35,840
satellites today so we want to

161
00:05:40,390 --> 00:05:37,360
understand how to get them better and

162
00:05:43,510 --> 00:05:41,510
and

163
00:05:46,310 --> 00:05:43,520

for the exploration side

164
00:05:48,310 --> 00:05:46,320
we are hoping that we're helping keep

165
00:05:51,590 --> 00:05:48,320
the whole idea of space exploration

166
00:05:53,430 --> 00:05:51,600
alive as one of those

167
00:05:55,270 --> 00:05:53,440
top

168
00:05:56,790 --> 00:05:55,280
things that humans want to do which is

169
00:05:59,270 --> 00:05:56,800
exploration

170
00:06:01,749 --> 00:05:59,280
so that we keep the society knowing that