1
00:00:00,000 --> 00:00:11,400

2
00:00:11,400 --> 00:00:11,866
All right.

3
00:00:11,866 --> 00:00:12,133

4
00:00:12,133 --> 00:00:13,266
Good afternoon everyone.

5
00:00:13,266 --> 00:00:14,466
My name is Nicole Dawkins.

6
00:00:14,466 --> 00:00:24,133
I'm the systems engineer for the national campaign, airspace test and infrastructure team, and I'm joined today by Tim Bagnall, who's gonna be your primary speaker.

7
00:00:24,133 --> 00:00:24,333

8
00:00:24,333 --> 00:00:29,433
And he's going to be presenting the national campaign tech talk on integrated data products.

9
00:00:29,433 --> 00:00:30,833

10
00:00:30,833 --> 00:00:31,700
Next slide 10.

11
00:00:31,700 --> 00:00:35,700

12
00:00:35,700 --> 00:00:37,533
OK, just a few.

13
00:00:37,533 --> 00:00:51,900
We have not had a tech talk in quite some time for the ATI team, so I'm just gonna go over a couple of ground rules and then I'll turn it over to Tim at the purpose of these tech talks is to engage with the community and both NASA internal and external technologies.

14
00:00:51,900 --> 00:00:53,766

15
00:00:53,766 --> 00:01:00,800
Tim is going to present quite a few slides, I think when we did the dry run, it takes about 40 minutes plus having time for questions.

16
00:01:00,800 --> 00:01:01,066

17
00:01:01,066 --> 00:01:09,566

So as your as you're listening to him, just to note that some of the answers to your question might be an upcoming slides, but feel free to to ask a question if you have one.

18
00:01:09,566 --> 00:01:10,966

19
00:01:10,966 --> 00:01:18,100
It's OK to ask an important question, but Please wait until he gets to the end of the slide if possible, mute your mic, please.

20
00:01:18,100 --> 00:01:18,133

21
00:01:18,133 --> 00:01:23,633
Unless you need to talk, this is gonna be recorded, and we're gonna keep a questions parking lot.

22
00:01:23,633 --> 00:01:24,200

23
00:01:24,200 --> 00:01:30,100
Where we'll collect actions or questions that the audience has to keep the tech talk on point and on time.

24
00:01:30,100 --> 00:01:31,600

25
00:01:31,600 --> 00:01:34,166
And so with that, I wanna introduce Tim Bagnall.

26
00:01:34,166 --> 00:01:34,200

27
00:01:34,200 --> 00:01:46,700
Tim is the data services lead part of the ATI team supporting the national campaign, and he and his team have done quite a lot of work producing these integrated data products.

28
00:01:46,700 --> 00:01:48,766
And with that, Tim, I'll turn it over to you.

29
00:01:48,766 --> 00:01:50,933

30
00:01:50,933 --> 00:01:51,666
Thank you, Nicole.

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00:01:51,666 --> 00:01:51,733

32
00:01:51,733 --> 00:01:53,766
Thank you for that warm introduction.

33
00:01:53,766 --> 00:01:54,233

34
00:01:54,233 --> 00:01:54,766
Hi everyone.

35
00:01:54,766 --> 00:02:01,933
As Nicole mentioned, I'm Tim Bagnall, the data services lead under ATI and under national campaign as it were.

36
00:02:01,933 --> 00:02:13,133
So it's a pleasure to be here today with you to talk about the integrated data product, which sometimes I'll just refer to as the IDP since it's a mouthful and that's the shorthand way of doing it.

37
00:02:13,133 --> 00:02:14,733

38
00:02:14,733 --> 00:02:19,900
So here's the agenda and this is what I plan on talking to you today about Nicole did mention.

39
00:02:19,900 --> 00:02:24,433
I'll be speaking for approximately 40 minutes or so, and it's quite technical.

40
00:02:24,433 --> 00:02:25,033

41
00:02:25,033 --> 00:02:30,500
She just went over the ground rules and although they they seem strict, they're not quite as strict.

42
00:02:30,500 --> 00:02:30,533

43
00:02:30,533 --> 00:02:34,400
So if you have a burning desire to ask a question, please do so.

44
00:02:34,400 --> 00:02:34,766

45
00:02:34,766 --> 00:02:42,266
We're fortunate enough to have Billy Red supporting on the side too, so she can help manage any hands that might be raised.

46
00:02:42,266 --> 00:02:42,300

47
00:02:42,300 --> 00:02:44,433
Billy, go ahead and interrupt me or interject.

48
00:02:44,433 --> 00:02:44,633

49
00:02:44,633 --> 00:02:54,400
Please just to get my attention and then if you don't feel like asking a question during the talk, you can always just put your question in the chat and we'll get to it towards the end.

50
00:02:54,400 --> 00:02:54,933

51
00:02:54,933 --> 00:02:58,933
So I'll speak for about 40 minutes and then we'll open it up to questions.

52
00:02:58,933 --> 00:03:00,566

53
00:03:00,566 --> 00:03:17,533
So today's agenda we are talking about the IDP or the integrated data product, but I first wanted to put it into context within the national campaign as a subproject and then also the kind of the governing project, Advanced air mobility.

54
00:03:17,533 --> 00:03:17,566

55
00:03:17,566 --> 00:03:26,400
So we'll just talk a bit about NASA's vision there and how it sees a unfolding and the national campaign fit into that.

56
00:03:26,400 --> 00:03:26,433

57
00:03:26,433 --> 00:04:01,200
So what I understand how the IDP is used to support flight test research with all these research partners that NASA has partnered with after that kind of context, I'll jump into an overview of the integrated data product and we'll talk about how it's tailored in this next section towards the research partner really to towards the goals and objectives of that particular flight test or event, talk about access for analysts that use the IT, excuse me, the IDP to support the research.

58
00:04:01,200 --> 00:04:01,633

59
00:04:01,633 --> 00:04:17,066
You'll see that we've got a very qualified, vetted way to gain access, both on the NASA side and also on the research partner side that after this all actually deep dive into a technology focus.

60
00:04:17,066 --> 00:04:17,100

61
00:04:17,100 --> 00:04:24,133
This is where kind of open up the hood and take a look at how we make the IDP will include a detailed description.

62
00:04:24,133 --> 00:04:24,333

63
00:04:24,333 --> 00:04:25,766
I'll cover the architecture.

64
00:04:25,766 --> 00:04:26,300

65
00:04:26,300 --> 00:04:30,500
We'll talk about the technology stack that we're using to produce the IDP.

66
00:04:30,500 --> 00:04:31,066

67
00:04:31,066 --> 00:04:33,066
We have a chart on the data flow.

68
00:04:33,066 --> 00:04:33,666

69
00:04:33,666 --> 00:04:36,466
We'll look at the design patterns that we're using under the hood.

70
00:04:36,466 --> 00:04:41,300
As I said then, we'll take a look at some of the applications that we're using the IDP for.

71
00:04:41,300 --> 00:04:43,333
So the UDP is.

72
00:04:43,333 --> 00:04:53,433
You could think about it as a time synchronized consolidated data table and we use that to produce some artifacts that support research and analysis.

73
00:04:53,433 --> 00:05:00,266
And so we've got 2 examples in that application section of how we've used the IDP in the past to support that research.

74
00:05:00,266 --> 00:05:00,966

75
00:05:00,966 --> 00:05:08,666
And then lastly, is kind of the nature of the tech talk put together a few slides and this is where I hope I still have everyone's attention.

76
00:05:08,666 --> 00:05:08,700

77
00:05:08,700 --> 00:05:15,200
But a few slides on how you can try to put an IDP together at home and it's not too complicated.

78
00:05:15,200 --> 00:05:16,400
This is very reductive.

79
00:05:16,400 --> 00:05:30,600
This example here or a simplification of it, but you can try if you're an aspiring data scientist or an artificial intelligence researcher to do this at home to support your own research activities, or at your obviously your office workspace.

80
00:05:30,600 --> 00:05:34,266

81
00:05:34,266 --> 00:05:40,200
OK, as I mentioned, I'm gonna try to put the IDP into context of the Advanced air mobility.

82
00:05:40,200 --> 00:05:41,966

83
00:05:41,966 --> 00:06:06,233
Project and also the national campaign, so NASA's vision for AM is really all about this transformational local and interregional missions for aviation, with an I towards safe, sustainable, accessible and affordable trips and missions and operations and what we mean by that in terms of a category of transportation.

84
00:06:06,233 --> 00:06:06,700

85
00:06:06,700 --> 00:06:22,533
We're looking at passenger types of transportation, so shuttling passengers back and forth cargo where you're delivering packages to persons or businesses and also aerial work missions such as infrastructure inspections.

86
00:06:22,533 --> 00:06:31,933
So for instance, railway inspection or power line inspection or bigger infrastructure, it also includes search and rescue operations.

87
00:06:31,933 --> 00:06:50,000
So finding citizens of the United States and making those kind of rescue operations to protect the citizens in terms of operations, we're talking about both kind of the the smaller local transportation of the 50 nautical mile range or less.

88
00:06:50,000 --> 00:06:50,366

89
00:06:50,366 --> 00:06:56,233
So you could think of suburban and urban type of transportation, and then that extends all steps.

90
00:06:56,233 --> 00:06:56,333

91
00:06:56,333 --> 00:06:58,600
So excuse me also to sub.

92
00:06:58,600 --> 00:06:58,633

93
00:06:58,633 --> 00:07:21,100
Sorry, interregional types of transportation missions too, where you might have someone from the exurbs transporting into, say, the the suburbs or the urban area, so that's the AM vision for, for NASA, and then how national campaign fit into that was obviously an extension to that.

94
00:07:21,100 --> 00:07:21,500

95
00:07:21,500 --> 00:07:32,400
It was really all about promoting public confidence in am safety, so a lot of the research

was oriented towards proving that these emerging vehicles are safe for operation.

96
00:07:32,400 --> 00:07:33,766

97
00:07:33,766 --> 00:07:44,100
It gave air vehicle manufacturers and air spread airspace service providers kind of a future look into the regulatory and operational environment.

98
00:07:44,100 --> 00:07:51,433
So the first look at how those are going to work and what it means in terms of the impacts on industry.

99
00:07:51,433 --> 00:07:52,466

100
00:07:52,466 --> 00:07:58,000
And then lastly this bullet, this sub bullet under the national campaign is really what this tech talks all about.

101
00:07:58,000 --> 00:07:58,266

102
00:07:58,266 --> 00:08:05,866
It's facilitating this community wide learning experience through these types of talks and just ongoing communication.

103
00:08:05,866 --> 00:08:06,600

104
00:08:06,600 --> 00:08:09,000
I mentioned that none of this is easy.

105
00:08:09,000 --> 00:08:09,033

106
00:08:09,033 --> 00:08:14,466
These emerging vehicles are difficult to figure out how they're gonna work, and the national airspace system.

107
00:08:14,466 --> 00:08:14,933

108
00:08:14,933 --> 00:08:24,433
So one way to reach consensus is all about these open conversations and sharing the technology, looking at regulations, so on and so forth.

109
00:08:24,433 --> 00:08:26,000

110
00:08:26,000 --> 00:08:40,366
So today, the national campaign has featured over a dozen state of the art flight tests, and you could imagine there's quite a lot of data that goes along with those flight tests to support the research behind it.

111

00:08:40,366 --> 00:08:42,966

112
00:08:42,966 --> 00:08:51,266
This next slide covers some of the research partners that NASA has collaborated with, and then they're in arbitrary or order.

113
00:08:51,266 --> 00:08:51,733

114
00:08:51,733 --> 00:08:59,266
But the partners include whisk blah, the robotics jobi and Sikorsky, as well as a few others.

115
00:08:59,266 --> 00:08:59,833

116
00:08:59,833 --> 00:09:04,366
Let's say that NASA's really appreciated these collaborations with these partners.

117
00:09:04,366 --> 00:09:04,733

118
00:09:04,733 --> 00:09:09,666
Has really valued the knowledge sharing and interaction between industry and NASA.

119
00:09:09,666 --> 00:09:09,900

120
00:09:09,900 --> 00:09:25,966
I feel like it's a very symbiotic relationship, so at these flight tests, whether they feature a live vehicle or include a simulation, there is a lot of data to be managed, and that's where this integrated data product comes along.

121
00:09:25,966 --> 00:09:29,066

122
00:09:29,066 --> 00:09:33,200
So that was the context within AM and national campaign.

123
00:09:33,200 --> 00:09:40,766
And so now I'm gonna dovetail here into the actual IDP going to read this first bullet to you because it's a mouthful.

124
00:09:40,766 --> 00:09:40,800

125
00:09:40,800 --> 00:09:43,933
And then I'll tell you how I kind of simplify what the IDP is.

126
00:09:43,933 --> 00:09:45,166

127
00:09:45,166 --> 00:09:57,166
So what is this suite of software and infrastructure that combines data produced by

disparate flight test instruments that are both ground based and airborne into a single analysis ready product?

128
00:09:57,166 --> 00:09:57,766

129
00:09:57,766 --> 00:10:11,566
That's quite a lot of words, but the way I simplify this and think about it is that it is a data table, almost like an Excel file, that consolidates data across an array of instruments into a time synchronized file to facilitate research.

130
00:10:11,566 --> 00:10:11,933

131
00:10:11,933 --> 00:10:19,033
And that point will become more clear over the next couple of slides and you'll understand what we're doing with the IDP and how we make it.

132
00:10:19,033 --> 00:10:20,733

133
00:10:20,733 --> 00:10:36,933
So the second major bullet here, the IDP processing this is to get the point across that there's a lot of rigor and structure to how we create the IDP and how we can extend the software that produces it to accommodate other flight tests in the future.

134
00:10:36,933 --> 00:10:38,900

135
00:10:38,900 --> 00:10:40,966
The third bullet here is really important.

136
00:10:40,966 --> 00:10:52,500
I wanna just focus on this, that the infrastructure that we're using to produce the IDP really enforces data protection, so it protects the data even within NASA itself.

137
00:10:52,500 --> 00:10:52,766

138
00:10:52,766 --> 00:11:07,033
And then from outside NASA premises, the data is only seen by qualified people within NASA and then also qualified research partners for that particular flight test event.

139
00:11:07,033 --> 00:11:07,366

140
00:11:07,366 --> 00:11:13,466
So it's very controlled, very safe and that's just something that we have set out on from the very beginning.

141
00:11:13,466 --> 00:11:14,900

142
00:11:14,900 --> 00:11:24,233
This last major bullet mentioned before it Dottie P really supports answering these research questions for between the various different flight tests.

143
00:11:24,233 --> 00:11:25,400

144
00:11:25,400 --> 00:11:31,500
Then at the bottom of this slide is one of my favorite quotes on data and how you can't have information without it.

145
00:11:31,500 --> 00:11:33,400

146
00:11:33,400 --> 00:11:34,466
I'm going to continue here.

147
00:11:34,466 --> 00:11:35,600

148
00:11:35,600 --> 00:11:40,800
Oh, really love this slide because it's simplifies in my mind, what we're going after with the IDP.

149
00:11:40,800 --> 00:11:42,233

150
00:11:42,233 --> 00:11:56,466
These events or flight tests events that we we help coordinate or we help conduct the research partners, they really feature quite a lot of the instrumentation simplified here just to show four different types of data.

151
00:11:56,466 --> 00:11:56,800

152
00:11:56,800 --> 00:12:15,900
But there are often many different types of data, so on the left we have different categories that represent raw post flight data files that are produced from telemetry systems and aircraft to other instrumentation that you find on some of the the grounds of Air Force.

153
00:12:15,900 --> 00:12:16,100

154
00:12:16,100 --> 00:12:26,066
Sorry, the Armstrong Flight Research Center at NASA, so if you look at this just a few, you might have some telemetry systems that are installed in.

155
00:12:26,066 --> 00:12:31,700
The aircraft includes things like time, position and velocity and inertial information.

156
00:12:31,700 --> 00:12:32,733

157
00:12:32,733 --> 00:12:43,100
You might have 80 USB input devices that are receiving ADSB broadcasts of the vehicle of interest, and then other intruders or traffic in the area.

158

00:12:43,100 --> 00:12:46,500
So you have an idea of the state of the air space.

159
00:12:46,500 --> 00:12:48,000

160
00:12:48,000 --> 00:12:58,833
You might have some radar systems and that includes terrestrial radar systems like airport surveillance radar systems or airborne radar systems that are installed or mounted on the air vehicles.

161
00:12:58,833 --> 00:12:59,800

162
00:12:59,800 --> 00:13:03,133
And then you have wind and atmospheric data too it.

163
00:13:03,133 --> 00:13:03,300

164
00:13:03,300 --> 00:13:09,833
That Armstrong Flight Research Center that I mentioned, they have some fantastic instrumentation including these sodar machines.

165
00:13:09,833 --> 00:13:10,300

166
00:13:10,300 --> 00:13:10,800
Excuse me?

167
00:13:10,800 --> 00:13:10,833

168
00:13:10,833 --> 00:13:20,733
Sodar machines, they look like these big Zamboni machines that use LIDAR to measure the different win conditions at elevations above the ground.

169
00:13:20,733 --> 00:13:22,266

170
00:13:22,266 --> 00:13:27,733
So you have all this post flight data that comes off in different files and formats.

171
00:13:27,733 --> 00:13:30,733
You can imagine the gears in the center of this chart.

172
00:13:30,733 --> 00:13:31,700

173
00:13:31,700 --> 00:13:45,500
Process those files one at a time in our IDP software and it is really this extraction transformation and loading system that creates this IDP or this data table on the right.

174
00:13:45,500 --> 00:13:45,833

175
00:13:45,833 --> 00:13:55,333
We're gonna jump into a better example of the IDP in just a second, but this is the general thrust of the IDP and how we create it.

176
00:13:55,333 --> 00:13:59,566

177
00:13:59,566 --> 00:14:03,133
So here on this slide, we have an abbreviated sample IDP.

178
00:14:03,133 --> 00:14:04,300

179
00:14:04,300 --> 00:14:06,300
It only has nine fields.

180
00:14:06,300 --> 00:14:17,833
Oftentimes our flight tests have Idps that feature over 100 fields and they're really tailored towards the goals and constraints of a particular flight test.

181
00:14:17,833 --> 00:14:20,033

182
00:14:20,033 --> 00:14:27,900
For consistency, what we try to do with the IDP column names is standardize on a naming convention.

183
00:14:27,900 --> 00:14:32,600
That way, latitude, for instance, is always abbreviated as lat.

184
00:14:32,600 --> 00:14:33,000

185
00:14:33,000 --> 00:14:37,566
Same thing with longitude as low on for altitude means sea level.

186
00:14:37,566 --> 00:14:37,633

187
00:14:37,633 --> 00:14:42,100
It will always be in feet and we'll abbreviate it as altitude, underscore, MSL.

188
00:14:42,100 --> 00:14:44,066

189
00:14:44,066 --> 00:14:47,066
So in this particular example here, this is a good one.

190
00:14:47,066 --> 00:14:55,766
Here, IDP's often include redundant data sources, so we have redundant sensors on the position.

191
00:14:55,766 --> 00:14:56,333

Information.

192
00:14:56,333 --> 00:15:00,566
You'll notice there's two sources for latitude, longitude and altitude.

193
00:15:00,566 --> 00:15:00,600

194
00:15:00,600 --> 00:15:04,966
That's pretty common and we have redundant sources for the horizontal wind speed.

195
00:15:04,966 --> 00:15:05,800

196
00:15:05,800 --> 00:15:09,033
Those are often there can be often research projects in themselves.

197
00:15:09,033 --> 00:15:09,066

198
00:15:09,066 --> 00:15:12,933
If you're looking at position information, how do you know what the truth is?

199
00:15:12,933 --> 00:15:13,000

200
00:15:13,000 --> 00:15:15,866
How do you know if your sensors accurate but the IDP?

201
00:15:15,866 --> 00:15:15,900

202
00:15:15,900 --> 00:15:19,566
That's just one example of what the IDP can help support.

203
00:15:19,566 --> 00:15:23,300

204
00:15:23,300 --> 00:15:37,733
OK, so now we're dovetailing into how the IDP is tailored between flight test and research partners, and I mentioned this before, but you can imagine that no to flight tests are the same.

205
00:15:37,733 --> 00:15:37,900

206
00:15:37,900 --> 00:15:52,666
So NASA does its best to coordinate with the research partners, talk about the research goals and objectives, and then tailor the IDP to collect the data that is required to answer those research objectives.

207
00:15:52,666 --> 00:15:54,000

208

00:15:54,000 --> 00:16:01,000
There's kind of a what you need to have in terms of data to what you can collect to support those research questions.

209
00:16:01,000 --> 00:16:02,600

210
00:16:02,600 --> 00:16:29,766
Then this last major bullet on this slide just goes over kind of the work that's required to coordinate with the research partners to really nail down kind of a contract of how post flight data is going to be supplied to NASA and the format content file name, et cetera, because if it changes between flight to us or between flights of a test, it becomes unwieldy and the IDP processing will break down.

211
00:16:29,766 --> 00:16:37,166
So there's kind of this formal contract that we enter into so that NASA could properly process the data.

212
00:16:37,166 --> 00:16:41,000

213
00:16:41,000 --> 00:16:49,566
So this is an example of how we would collaborate and tailor the IDP with our research partners, the dark blue on the left.

214
00:16:49,566 --> 00:16:53,533
Those two columns represent this standardized IDP data fields.

215
00:16:53,533 --> 00:16:53,766

216
00:16:53,766 --> 00:16:56,900
This is a simplified example here too, but hopefully gets the point across.

217
00:16:56,900 --> 00:16:57,266

218
00:16:57,266 --> 00:17:13,300
Point across on the lower right and the light blue is what the NPC research partner would help define, and sometimes it, depending on where the data is coming from, it's either the research partner or it could be experts down at the Armstrong Flight Research Center.

219
00:17:13,300 --> 00:17:13,566

220
00:17:13,566 --> 00:17:19,333
For instance, using the sodar machines that define file names and so on and so forth.

221
00:17:19,333 --> 00:17:20,300

222
00:17:20,300 --> 00:17:23,833
So just focus on a few fields here to get the point across.

223
00:17:23,833 --> 00:17:24,166

224
00:17:24,166 --> 00:17:33,300
So if you take a look at the dark blue and you look at the position, velocity and time category, you'll have latitude and longitude.

225
00:17:33,300 --> 00:17:34,000

226
00:17:34,000 --> 00:17:52,333
As most people have sure on the audience understand, the partner then would help define the expected rate that their interpretation records that at and you'll have sometimes instrumentation that will record it at frequencies of 40 to 60 Hertz, which is quite a lot of data to manage.

227
00:17:52,333 --> 00:17:52,633

228
00:17:52,633 --> 00:17:57,333
So they define an expected rate that the recording, they'll tell us the file name.

229
00:17:57,333 --> 00:17:58,000

230
00:17:58,000 --> 00:18:01,700
They'll tell us their field name for it and then their field units.

231
00:18:01,700 --> 00:18:02,266

232
00:18:02,266 --> 00:18:05,533
If you look at latitude and longitude, this is a good example.

233
00:18:05,533 --> 00:18:20,700
The the NC partner in this case is just an example, but those field units are in degrees, minutes and seconds and the standardized IDP latitude and longitude will change to decimal degrees as it's more intuitive for researchers typically.

234
00:18:20,700 --> 00:18:22,533

235
00:18:22,533 --> 00:18:32,966
So this chart helps get across kind of the work involved with the mapping of the source raw data file to the actual IDP itself.

236
00:18:32,966 --> 00:18:36,500

237
00:18:36,500 --> 00:18:42,633
This slide here just goes over how we provide access to analysts and analyst can obviously exist on either side.

238
00:18:42,633 --> 00:18:57,000
Within NASA, they're highly vetted and qualified before they can see the data, and then you've got also research partner analysts that would like to receive the IDP to share the IDP.

239
00:18:57,000 --> 00:19:09,433
NASA uses its cloud storage system box, which is heavily secured, encrypted uses state of the art authentication and authorization features.

240
00:19:09,433 --> 00:19:09,900

241
00:19:09,900 --> 00:19:18,000
Once the IDP is ready, what NASA does is upload it to the appropriate place in box, which again is strictly controlled.

242
00:19:18,000 --> 00:19:18,300

243
00:19:18,300 --> 00:19:27,966
And then it is available for other qualified users within NASA or the research partners themselves that are also qualified.

244
00:19:27,966 --> 00:19:29,266
Before that, they gain access.

245
00:19:29,266 --> 00:19:33,066

246
00:19:33,066 --> 00:19:38,000
Right now we dovetail into the the more technical aspect of the talk.

247
00:19:38,000 --> 00:19:38,233

248
00:19:38,233 --> 00:19:39,333
Hopefully you're still with me.

249
00:19:39,333 --> 00:19:44,233
Thank you for your patience and I'll hit on some of the salient points of this slide.

250
00:19:44,233 --> 00:19:50,733
Some of the things we've already spoken about, you already know that the IDP is a time series data set.

251
00:19:50,733 --> 00:19:51,833
It's synchronized to UTC.

252
00:19:51,833 --> 00:19:53,700

253
00:19:53,700 --> 00:20:08,633
The term IDP, although I think of it as this consolidated time synchronized data file, it really is more encompassing than that, includes quite a bit of complex and elaborate extraction transformation and loading software to make it all happen.

254
00:20:08,633 --> 00:20:08,700

255

00:20:08,700 --> 00:20:08,900
Then.

256
00:20:08,900 --> 00:20:10,866

257
00:20:10,866 --> 00:20:22,500
Each ISP is event based and by event we meet a specific, say series of flight tests for research partner that might extend over a couple of days to weeks.

258
00:20:22,500 --> 00:20:23,400

259
00:20:23,400 --> 00:20:37,933
But the event based nature of it helps us set configuration files and some of the settings that we need to have set prior to making that IDP that is tailored towards the event for the research partner.

260
00:20:37,933 --> 00:20:39,866

261
00:20:39,866 --> 00:20:41,966
This last major bullet on the left?

262
00:20:41,966 --> 00:20:42,166

263
00:20:42,166 --> 00:20:53,800
The IDP does maintain a concept of state and what we're doing there is essentially we can process the IDP asymmetrically.

264
00:20:53,800 --> 00:20:53,933

265
00:20:53,933 --> 00:21:12,366
You might have post flight raw data that is available in in real time or shortly after flight test, or you might have some raw files data files that are only available until a few days after a flight test because they have to go through their own processing systems.

266
00:21:12,366 --> 00:21:12,800

267
00:21:12,800 --> 00:21:21,166
So what we've done here with this concept of state is that we can create incremental versions of the IDP to support research faster.

268
00:21:21,166 --> 00:21:21,533

269
00:21:21,533 --> 00:21:35,800
Once the raw data files are available, then we process them and could continue to append to the IDP and deliver incrementally and iteratively just to support research more of a single stream rather than batch processing.

270
00:21:35,800 --> 00:21:38,200

271
00:21:38,200 --> 00:21:45,633
And then the top right, this last bullet on this slide is how we can extend the IDP to accommodate new events.

272
00:21:45,633 --> 00:21:46,066

273
00:21:46,066 --> 00:21:49,266
This might be more marketing language here because it says easily extend.

274
00:21:49,266 --> 00:21:57,333
I do believe that, but there is some work involved just to set up an event to get the IDP software ready.

275
00:21:57,333 --> 00:21:57,800

276
00:21:57,800 --> 00:22:05,333
Obviously, I mentioned that kind of collaboration that we have to have with a research partners, figuring out what data is going to be used, the files.

277
00:22:05,333 --> 00:22:05,533

278
00:22:05,533 --> 00:22:15,166
So there is work involved there, but what we've done is built the software in such a way that it can be a design pattern, can be followed to extend it.

279
00:22:15,166 --> 00:22:15,466

280
00:22:15,466 --> 00:22:17,500
So it's not as chaotic.

281
00:22:17,500 --> 00:22:21,300
It's more procedural and can be extended relatively easily.

282
00:22:21,300 --> 00:22:23,733

283
00:22:23,733 --> 00:22:25,966
Hey, Tim, you have a question in the chat, umm, is there the ability, is there the ability to integrate video data as part of the IDP?

284
00:22:25,966 --> 00:22:26,633
OK, great.

285
00:22:26,633 --> 00:22:32,100

286
00:22:32,100 --> 00:22:33,300
That's a great question.

287

00:22:33,300 --> 00:22:34,266

288
00:22:34,266 --> 00:22:39,600
Previously, when we've been asked to do that, I think we use some artificial intelligence.

289
00:22:39,600 --> 00:22:41,466

290
00:22:41,466 --> 00:22:49,000
Algorithms within Python to Python library braised actually look at the audio portion of video, but that was more of a one off.

291
00:22:49,000 --> 00:22:49,033

292
00:22:49,033 --> 00:23:06,866
We have not, in whole, actually incorporated video processing yet, but it's certainly the the team that the data services team that I helped represent is full of experts that we could talk about and see if that is a potential opportunity to include in future Idps.

293
00:23:06,866 --> 00:23:07,100

294
00:23:07,100 --> 00:23:12,033
So the answer short answer is not yet, but I do think that there are opportunities to do so in the future.

295
00:23:12,033 --> 00:23:14,533

296
00:23:14,533 --> 00:23:14,900
Great.

297
00:23:14,900 --> 00:23:14,933
Thank you.

298
00:23:14,933 --> 00:23:15,300
That.

299
00:23:15,300 --> 00:23:15,800

300
00:23:15,800 --> 00:23:16,766
Ohh yeah, my pleasure.

301
00:23:16,766 --> 00:23:17,900
Thanks for asking the question.

302
00:23:17,900 --> 00:23:18,066

303
00:23:18,066 --> 00:23:19,400
Thank you, Nicole, for interjecting.

304
00:23:19,400 --> 00:23:22,900

305
00:23:22,900 --> 00:23:24,033
Alright, let's see here.

306
00:23:24,033 --> 00:23:24,233
I.

307
00:23:24,233 --> 00:23:24,300

308
00:23:24,300 --> 00:23:24,733
OK.

309
00:23:24,733 --> 00:23:24,800

310
00:23:24,800 --> 00:23:26,100
So we're on the architecture side.

311
00:23:26,100 --> 00:23:32,633
Fortunately for everyone, I'm not going to go into the the mice print details on this slide.

312
00:23:32,633 --> 00:23:32,700

313
00:23:32,700 --> 00:23:39,600
There was a previous technical talk on the data management system, which we call AEROGRAPH.

314
00:23:39,600 --> 00:23:52,800
It was given by Jerry will wording and it goes into the detail of the architecture and how queuing and how we're using Docker to set up everything in a modular fashion.

315
00:23:52,800 --> 00:23:54,566

316
00:23:54,566 --> 00:24:06,266
I recommend if you are a systems engineering type of guy or an architecture type of gal, go ahead and look at that previous tech talk to understand this architecture in more detail.

317
00:24:06,266 --> 00:24:07,633

318
00:24:07,633 --> 00:24:18,100
What this particular slide is getting across though is where the IDP processing code lives in our larger data management system, there's two red circles.

319
00:24:18,100 --> 00:24:26,900
Here or ovals that point towards this Docker container, you'll see some source and utility files that I'll speak about in more detail in just a second.

320
00:24:26,900 --> 00:24:30,566

321
00:24:30,566 --> 00:24:34,000
This slot goes over the technology stack that we're using.

322
00:24:34,000 --> 00:24:34,400

323
00:24:34,400 --> 00:24:38,100
I think the Kenai would probably have already noticed that we're using Python.

324
00:24:38,100 --> 00:24:38,766

325
00:24:38,766 --> 00:24:43,733
We rely on it very heavily to produce the IDP for data manipulation.

326
00:24:43,733 --> 00:24:58,200
We use pandas and Numpy and then for geospatial data handling we use Geo π and π map 3D and those in particular have been really crucial for supporting some of the research that we've done for our research partners.

327
00:24:58,200 --> 00:24:59,266

328
00:24:59,266 --> 00:25:14,900
In particular, there was a a use case with a research partner where we had to figure out where the electromagnetic energy emitted from the airport surveillance radar was striking the body of an aircraft.

329
00:25:14,900 --> 00:25:14,966

330
00:25:14,966 --> 00:25:16,633
Kind of its radar cross section.

331
00:25:16,633 --> 00:25:17,066

332
00:25:17,066 --> 00:25:31,333
So we use that geospatial those packets those packages right there to figure that out, which requires some a fine transformations and things of that nature that they use and actually video game technology to figure out that RCS.

333
00:25:31,333 --> 00:25:31,366

334
00:25:31,366 --> 00:25:34,400
So those are great Python packages.

335
00:25:34,400 --> 00:25:34,700

336
00:25:34,700 --> 00:25:40,866
I highly encourage you to use them in your future research for data output.

337
00:25:40,866 --> 00:25:40,900

338
00:25:40,900 --> 00:25:41,133
Format.

339
00:25:41,133 --> 00:25:42,266

340
00:25:42,266 --> 00:25:45,200
The UDP is available in Parquet and CSV.

341
00:25:45,200 --> 00:25:45,800

342
00:25:45,800 --> 00:25:48,866
I think most people are familiar with CSV files like me.

343
00:25:48,866 --> 00:25:53,700
I kind of like excel to look at data tables and things of that nature, parquet.

344
00:25:53,700 --> 00:26:05,933
If you're not familiar with, it is an open source Apache format that really consolidates data into just kind of a very efficient data format.

345
00:26:05,933 --> 00:26:22,433
As I mentioned before, some of these flight test feature over 200 columns of data and a flight to us can extend for say 90 minutes and if you have an IDP with data that is reported at 60 Hertz, it's a lot of data.

346
00:26:22,433 --> 00:26:26,566
So working in Parquet really helps for that particular application.

347
00:26:26,566 --> 00:26:28,266

348
00:26:28,266 --> 00:26:29,666
And then lastly, we're then Python.

349
00:26:29,666 --> 00:26:34,833
We used something called stomp to interact with the messages on our message broker.

350
00:26:34,833 --> 00:26:41,133
That activemq and stomp kind of is the catalyst that kicks everything off in our IDP processing code.

351
00:26:41,133 --> 00:26:44,933

352
00:26:44,933 --> 00:26:46,133
Alright, so bear with me.

353
00:26:46,133 --> 00:26:46,166

354
00:26:46,166 --> 00:26:55,433
This slide goes over our data flow and the first thing you'll notice on this slide is the Big Blue arrow in the center of the slide that's pointing down.

355
00:26:55,433 --> 00:27:07,233
So temporarily we start at the top and go down on the left side of that arrow is the code that we're using and the right is the story of how data is processed.

356
00:27:07,233 --> 00:27:08,666

357
00:27:08,666 --> 00:27:16,400
So this particular example is using a DPS raw host flight data file DGPS.

358
00:27:16,400 --> 00:27:16,466

359
00:27:16,466 --> 00:27:25,733
It stands for differential GPS system and it's there are some instrument instruments down at the Archer Armstrong Flight Research Center.

360
00:27:25,733 --> 00:27:32,533
That really record down to the Nats eyebrow of where aircraft exist in the airspace.

361
00:27:32,533 --> 00:27:32,966

362
00:27:32,966 --> 00:27:34,933
The GPS is one of those systems.

363
00:27:34,933 --> 00:27:34,966

364
00:27:34,966 --> 00:27:36,500
It's really phenomenal.

365
00:27:36,500 --> 00:27:46,433
I suggest looking it up if you're not familiar with it, but it gets all that's kind of position, time, velocity information we need as well as the inertial and acceleration data.

366
00:27:46,433 --> 00:27:46,533

367
00:27:46,533 --> 00:28:02,466
That's really important for airspace and air vehicle performance research, so we have this DGPS file and it's just one post flight raw data file and what the team does is we receive that from whoever delivers it to us.

368
00:28:02,466 --> 00:28:02,500

369
00:28:02,500 --> 00:28:11,133
In this case, it would have been from an expert down at a FRC and we drop it in a

particular folder on our protected data management system.

370
00:28:11,133 --> 00:28:12,800

371
00:28:12,800 --> 00:28:14,566
When that happens, there is.

372
00:28:14,566 --> 00:28:15,466
It's a catalyst.

373
00:28:15,466 --> 00:28:23,300
This active MQ message broker notices that there's a new file and it kicks off this IDP messenger Python.

374
00:28:23,300 --> 00:28:25,433

375
00:28:25,433 --> 00:28:38,366
As opposed process that then calls the process underscore UDP, Python file or process there which then triggers the appropriate IDP processor.

376
00:28:38,366 --> 00:28:40,666
So in this example, we're talking about DPS.

377
00:28:40,666 --> 00:28:41,100

378
00:28:41,100 --> 00:28:55,100
If you just kind of have your eyes over those processors, it would the messaging system figure out that it's a DPS file that we're dealing with and then trigger the appropriate code on within the.

379
00:28:55,100 --> 00:28:55,133

380
00:28:55,133 --> 00:29:14,100
I suppose the data management system to properly ETL, extract, transform and load the data so the data the story on the right really is that that top block represents the post flight raw file which is time series only fixed intervals.

381
00:29:14,100 --> 00:29:37,433
It fulfills that contract that we've set up with the research partner or whoever is providing the data and then that that process that I mentioned on the left, the code pulls that file, extracts, transforms and loads it and it does this for each data file as it's dropped into kind of this header area of these folders that we protect.

382
00:29:37,433 --> 00:29:38,966

383
00:29:38,966 --> 00:29:51,800
You'll notice that there's a bullet on the right that is bolded, and the point that we're trying to get across there is that you can think that there's a number of different instruments that NASA's using.

384
00:29:51,800 --> 00:29:54,100

They don't all record at the same rate.

385
00:29:54,100 --> 00:29:54,500

386
00:29:54,500 --> 00:30:00,200
You might have something like a weather system that records the state of the world every one minute.

387
00:30:00,200 --> 00:30:00,233

388
00:30:00,233 --> 00:30:12,433
So when you merge onto that data onto an IDP that is printing out results every, say 160th of a second, you'll need a value for that weather.

389
00:30:12,433 --> 00:30:12,500

390
00:30:12,500 --> 00:30:22,700
And what we're doing here is we're using a forward fill as what we call it to print the last known and best state of the data at that particular time.

391
00:30:22,700 --> 00:30:24,800

392
00:30:24,800 --> 00:30:30,533
That's a lot of words, but that's the data flow and and how we produce the particular IDP.

393
00:30:30,533 --> 00:30:31,800

394
00:30:31,800 --> 00:30:45,633
Those two tables at the bottom of the data column on the right are indicative of, say, the the raw data file on the left, and then the more standardized IDP on the right, with a standardized names.

395
00:30:45,633 --> 00:30:48,433

396
00:30:48,433 --> 00:30:54,900
OK, so here we're gonna jump into the design pattern and look under the hood of how we do this within our data management software.

397
00:30:54,900 --> 00:30:55,800

398
00:30:55,800 --> 00:31:01,700
These six bullets here are really a mini agenda for the next couple of slides that we're gonna step through.

399
00:31:01,700 --> 00:31:02,366

400
00:31:02,366 --> 00:31:17,000

So we'll cover file naming convention configuration files Dot EPP processor which you've already seen that EBP utilities which you've seen a bit and I'll just talk about how there are some nuances between files that we have to accommodate.

401
00:31:17,000 --> 00:31:18,066

402
00:31:18,066 --> 00:31:20,333
There's a state tracker file.

403
00:31:20,333 --> 00:31:20,433

404
00:31:20,433 --> 00:31:32,166
I'll go over that and then there is an internal map of there's an interim IDP that we use for encapsulation and extension kind of internal state of the IDP.

405
00:31:32,166 --> 00:31:32,566

406
00:31:32,566 --> 00:31:38,966
We map that interim product to the forward facing customer IDP in a mapping file.

407
00:31:38,966 --> 00:31:42,200

408
00:31:42,200 --> 00:31:49,300
Alright, so you can think of these big blocks here as nearly a one to one representation of the bullets of the slide.

409
00:31:49,300 --> 00:31:52,566
I just presented this first one at the top.

410
00:31:52,566 --> 00:31:52,900

411
00:31:52,900 --> 00:31:57,300
Covers the file name convention and so this is part of the contract that we have.

412
00:31:57,300 --> 00:31:57,333

413
00:31:57,333 --> 00:32:10,033
So when a file raw file is delivered, we wanted to make sure that we knew what it was for where it came from, what sorted it was of a flight test and the day that that particular file was created.

414
00:32:10,033 --> 00:32:10,466

415
00:32:10,466 --> 00:32:20,266
So it's in this event source sorty underscore N being the number of that sorty, and then obviously the year, month date, the event config.

416
00:32:20,266 --> 00:32:31,966

If you study that block in the lower left there, those are some metadata about the event that help manage the IDP and set it up for success and processing.

417
00:32:31,966 --> 00:32:32,466

418
00:32:32,466 --> 00:32:35,233
So it includes the name of the event, the start and end time.

419
00:32:35,233 --> 00:32:44,433
You'll notice that the start and end time here extend for quite a few number of days because that's because flight tests sometimes gonna extend several weeks.

420
00:32:44,433 --> 00:32:45,400

421
00:32:45,400 --> 00:32:47,266
There's a frequency for the IDP.

422
00:32:47,266 --> 00:32:54,700
In this case, it's 10 Hertz, and then so on and so forth for different variables that are important for the IDP configuration.

423
00:32:54,700 --> 00:32:58,366

424
00:32:58,366 --> 00:33:00,733
This top block here goes over the state tracker.

425
00:33:00,733 --> 00:33:01,100

426
00:33:01,100 --> 00:33:17,133
As I mentioned previously, we want to turn around these Idps as fast as possible and so the way we did this is we have this concept of state where we can create an IDP incrementally and iteratively as the post flight data comes in.

427
00:33:17,133 --> 00:33:18,300

428
00:33:18,300 --> 00:33:25,666
So a state tracker helps us figure out for each day what we've processed, what was available, what's yet to be done.

429
00:33:25,666 --> 00:33:26,100

430
00:33:26,100 --> 00:33:32,133
And it's really turned out to be a good way to turn around the Idps to get them into the hands of the analysts faster.

431
00:33:32,133 --> 00:33:34,400

432
00:33:34,400 --> 00:33:47,000

The calm files here in the center, is it a simple text file and it's this master list of all the potential field names that are coming in to the IDP processing software.

433
00:33:47,000 --> 00:33:47,566

434
00:33:47,566 --> 00:33:49,800
It currently has over 1100 items.

435
00:33:49,800 --> 00:33:56,900
You can imagine it is a big file and it will expand as we continue to support advanced air mobility in the future.

436
00:33:56,900 --> 00:33:58,900

437
00:33:58,900 --> 00:34:05,600
The mapping file at the bottom is as I mentioned, there is an interim PDP that we've created.

438
00:34:05,600 --> 00:34:06,166

439
00:34:06,166 --> 00:34:10,066
That interim IDP needs to be mapped to the forward facing customer IDP.

440
00:34:10,066 --> 00:34:10,600

441
00:34:10,600 --> 00:34:18,266
This mapping is also a way to encapsulate part of the code to make it more adaptable and extensible.

442
00:34:18,266 --> 00:34:19,133

443
00:34:19,133 --> 00:34:22,033
Going into the the future, adding new events.

444
00:34:22,033 --> 00:34:25,200

445
00:34:25,200 --> 00:34:29,100
This block here go covers the IDP processor function.

446
00:34:29,100 --> 00:34:29,566

447
00:34:29,566 --> 00:34:35,466
We spoke a bit about this already, but really what's going on there is that's where the IDP is getting creative.

448
00:34:35,466 --> 00:34:35,733

449
00:34:35,733 --> 00:34:36,200
Excuse me?

450
00:34:36,200 --> 00:34:40,633
Created and it goes through depending on what data sources have been dropped into.

451
00:34:40,633 --> 00:34:47,133
Kind of that source catalyst folder iterates through there and creates this IDP incrementally.

452
00:34:47,133 --> 00:34:49,200

453
00:34:49,200 --> 00:34:58,700
The IDP UTILS or short for utility is a number of utilities that the processor function calls as necessary.

454
00:34:58,700 --> 00:35:02,233
Depending on the particular post flight data file.

455
00:35:02,233 --> 00:35:07,666
So, for example, some instruments record altitude in meters.

456
00:35:07,666 --> 00:35:08,966
This is a very simple example.

457
00:35:08,966 --> 00:35:09,333

458
00:35:09,333 --> 00:35:15,266
In our IDP, we standardized on altitude to be in feet, which is more common in the United States.

459
00:35:15,266 --> 00:35:15,700

460
00:35:15,700 --> 00:35:18,300
So that's just one example of the utility.

461
00:35:18,300 --> 00:35:30,100
There's other things too that we can do in there, like transformations and things of that nature that I mentioned earlier to figure out radar cross sections and where certain energy is hitting aircraft.

462
00:35:30,100 --> 00:35:30,566

463
00:35:30,566 --> 00:35:31,933
Those are two small examples.

464
00:35:31,933 --> 00:35:32,466

465
00:35:32,466 --> 00:35:39,333

The utilities function it's much larger than that because there are a lot of details that you have to worry about dealing with this data.

466
00:35:39,333 --> 00:35:42,233

467
00:35:42,233 --> 00:35:44,266
OK, so that was a look under the hood.

468
00:35:44,266 --> 00:35:48,833
Now I want to try to put this into context of how we use the IDP.

469
00:35:48,833 --> 00:35:50,300
So I have two examples here.

470
00:35:50,300 --> 00:35:50,333

471
00:35:50,333 --> 00:36:02,633
There's just two of many the charts that you'll see on this slide and the next are we're created to support research and analysis on previous flight tests.

472
00:36:02,633 --> 00:36:03,933

473
00:36:03,933 --> 00:36:10,800
This chart here was looking at how well an aircraft can conform to an approach path.

474
00:36:10,800 --> 00:36:12,000

475
00:36:12,000 --> 00:36:25,900
It featured a helicopter that was hand flown at the Armstrong Flight Research Center in California and the idea was to have a target glide that the aircraft had to start in a certain area.

476
00:36:25,900 --> 00:36:26,266

477
00:36:26,266 --> 00:36:31,233
And then glide down toward a helipad or verta pad, if you will.

478
00:36:31,233 --> 00:36:31,266

479
00:36:31,266 --> 00:36:34,400
Since we're looking at vertex pads and it advanced air mobility.

480
00:36:34,400 --> 00:36:36,400

481
00:36:36,400 --> 00:36:40,766
The way that you could look at this chart on the vertical axis is the height from the target feet.

482
00:36:40,766 --> 00:36:41,066

483
00:36:41,066 --> 00:36:44,600
Horizontal is the horizontal distance to the target feet.

484
00:36:44,600 --> 00:36:44,700

485
00:36:44,700 --> 00:36:52,000
In this case, the helicopter started in the top right and then went down towards the origin of this chart AT00.

486
00:36:52,000 --> 00:36:54,400

487
00:36:54,400 --> 00:37:05,066
The target glide for this particular test point and and a flight test can have many test points, but this is just a say 5 to 10 minute window test point.

488
00:37:05,066 --> 00:37:05,300

489
00:37:05,300 --> 00:37:07,366
The target glide was 9 degrees.

490
00:37:07,366 --> 00:37:09,000

491
00:37:09,000 --> 00:37:13,600
The yellow circles with the black outline coming from the IDP.

492
00:37:13,600 --> 00:37:20,066
All this data is the actual position of the helicopter as it made its approach.

493
00:37:20,066 --> 00:37:21,033

494
00:37:21,033 --> 00:37:24,500
The yellow line is the ordinary least squares.

495
00:37:24,500 --> 00:37:24,700

496
00:37:24,700 --> 00:37:32,033
It's a way to fit those circles to a particular line and figure out what the actual performance was.

497
00:37:32,033 --> 00:37:32,866

498
00:37:32,866 --> 00:37:40,633
So in this case the tart glide was 9 degrees and the performance was 10.23 degrees, which is fairly good.

499
00:37:40,633 --> 00:37:40,933

500
00:37:40,933 --> 00:37:44,100
It's better to be above than below in terms of safety.

501
00:37:44,100 --> 00:37:45,866

502
00:37:45,866 --> 00:38:02,400
Also, for the keen eye for the aerospace researcher, you'll notice that the the yellow circles are fairly consistently spaced at the top, but as the helicopter got closer to the target, you'll notice that the volume of circles increases and this was manually flown.

503
00:38:02,400 --> 00:38:02,833

504
00:38:02,833 --> 00:38:14,566
The complexity of landing a helicopter manually on a vertical pad really becomes challenging at the bottom as the pilot homes in on the vertical pad, so there's a lot of correction, higher mental workload.

505
00:38:14,566 --> 00:38:15,366

506
00:38:15,366 --> 00:38:16,500
This will be automated.

507
00:38:16,500 --> 00:38:21,200
This type of thing going in the future and advance air mobility emerging aircrafts.

508
00:38:21,200 --> 00:38:24,000

509
00:38:24,000 --> 00:38:26,100
Alright, I'm going to move on to the next slide.

510
00:38:26,100 --> 00:38:26,200

511
00:38:26,200 --> 00:38:29,933
This is a four dimensional trajectory performance chart.

512
00:38:29,933 --> 00:38:31,200

513
00:38:31,200 --> 00:38:36,500
This goes after how well an aircraft can conform to afford dimensional trajectory.

514
00:38:36,500 --> 00:38:42,366
So this is within kind of the realm of trajectory based operations management by trajectory.

515

00:38:42,366 --> 00:38:42,866

516
00:38:42,866 --> 00:39:00,766
It's very important for the future of the airspace, where aircraft have to be in a position that they're supposed to be at the right time and it's it has to do with the orchestration of many floods, especially at the tempos that some concepts are seeing.

517
00:39:00,766 --> 00:39:02,033

518
00:39:02,033 --> 00:39:14,633
So this chart in the chart, the Gray circles indicate the actual flight path of the aircraft and the green circles represent the commanded flight path.

519
00:39:14,633 --> 00:39:17,100

520
00:39:17,100 --> 00:39:29,000
I am in in this particular screen shot, I'm hovering over a green circle which includes the commanded time and then the target time, and you'll notice that the commanded time occurs roughly.

521
00:39:29,000 --> 00:39:31,466
Let's see about a minute before the target time.

522
00:39:31,466 --> 00:39:32,600

523
00:39:32,600 --> 00:39:42,366
So that's obviously gives the aircraft a target to reach in the future, which includes the three dimensional space of spot where the aircraft needs to be and the time.

524
00:39:42,366 --> 00:39:42,966

525
00:39:42,966 --> 00:39:52,833
This is a really good example of an aircraft meeting its target, its command, so it's done a really good job and it shows a lot of promise.

526
00:39:52,833 --> 00:39:54,433

527
00:39:54,433 --> 00:40:05,666
In the future, I think research will look at how advanced, how well it can do this type of conformance in kind of windier environments, more challenging environments.

528
00:40:05,666 --> 00:40:05,966

529
00:40:05,966 --> 00:40:11,500
But this is a particularly good example of conforming to a flight path and a commanded 40T.

530
00:40:11,500 --> 00:40:11,666

531
00:40:11,666 --> 00:40:12,100
Excuse me.

532
00:40:12,100 --> 00:40:15,900

533
00:40:15,900 --> 00:40:18,133
Alright, so if you're still with me, thank you.

534
00:40:18,133 --> 00:40:24,300
This is where the technical talk delves into a Trident home feature.

535
00:40:24,300 --> 00:40:24,333

536
00:40:24,333 --> 00:40:26,166
We're not gonna do this in real time.

537
00:40:26,166 --> 00:40:26,700

538
00:40:26,700 --> 00:40:31,166
This is for the aspiring data scientist or official intelligence researcher.

539
00:40:31,166 --> 00:40:32,100

540
00:40:32,100 --> 00:40:48,766
I was thinking it in a good faith effort that these technical talks not only can we talk about some of the technology that we're using, but maybe give colleagues at NASA something that they could use within their own research, and also citizens at Home, Oregon Research Partners.

541
00:40:48,766 --> 00:40:49,200

542
00:40:49,200 --> 00:40:50,900
So we'll go through this.

543
00:40:50,900 --> 00:40:54,100
I won't go through everything in my Sprint detail.

544
00:40:54,100 --> 00:40:54,500

545
00:40:54,500 --> 00:40:55,266
I'll set you up.

546
00:40:55,266 --> 00:41:00,666
I think with enough tools so you could see how we can create an IDP using Python.

547
00:41:00,666 --> 00:41:02,966

548
00:41:02,966 --> 00:41:10,366
So in this particular example, we're using three CSV files, and we'll create an interactive 2 dimensional chart.

549
00:41:10,366 --> 00:41:11,833

550
00:41:11,833 --> 00:41:18,366
In this example, we've got 2 aircraft and we've got a a wind machine that is recording wind information.

551
00:41:18,366 --> 00:41:20,033

552
00:41:20,033 --> 00:41:25,400
To run this example, you're going to need two Python packages, which includes pandas, and then plot the express.

553
00:41:25,400 --> 00:41:26,500

554
00:41:26,500 --> 00:41:28,333
I also like to use an IDE.

555
00:41:28,333 --> 00:41:28,366

556
00:41:28,366 --> 00:41:39,433
I use PyCharm, but there's a lot of good packages out there, a lot of good IDE S find one that you're comfortable with and go ahead and try to implement this particular example.

557
00:41:39,433 --> 00:41:41,200

558
00:41:41,200 --> 00:41:42,533
There are four functions.

559
00:41:42,533 --> 00:41:43,166

560
00:41:43,166 --> 00:41:44,666
There's the main entry point.

561
00:41:44,666 --> 00:41:45,366

562
00:41:45,366 --> 00:41:49,166
There's this create initial data frame or DF for short.

563
00:41:49,166 --> 00:41:50,433

564
00:41:50,433 --> 00:41:57,766
The third one is to create IDP and then lastly we'll plot the the IDP in this interactive

2D chart.

565
00:41:57,766 --> 00:42:01,133

566
00:42:01,133 --> 00:42:06,833
So here are just some notional files you'll have to create these on your own at home or at work.

567
00:42:06,833 --> 00:42:08,200

568
00:42:08,200 --> 00:42:19,000
The two aircraft files in my example included 30 minutes of data, 3 fields, so it's a relatively simple example and the data was recorded at 10 Hertz, so 10 times a second.

569
00:42:19,000 --> 00:42:20,900

570
00:42:20,900 --> 00:42:23,800
We've got a lot attitude, longitude and altitude.

571
00:42:23,800 --> 00:42:23,900

572
00:42:23,900 --> 00:42:27,866
I don't have units on there because that's not important for this particular example.

573
00:42:27,866 --> 00:42:28,366

574
00:42:28,366 --> 00:42:31,633
And then lastly, we have a win file.

575
00:42:31,633 --> 00:42:31,866

576
00:42:31,866 --> 00:42:43,533
You notice here we have also 30 minutes of data when we have two fields, but unlike those other examples, the wind data is recorded only once a minute or 160th of a Hertz.

577
00:42:43,533 --> 00:42:46,966

578
00:42:46,966 --> 00:42:48,200
So we might wanna buckle up.

579
00:42:48,200 --> 00:42:54,400
We'll go over a little bit of code here, and again I'll we'll go to too much detail here.

580
00:42:54,400 --> 00:43:01,866
I think if you follow this at home, you'll be able to kind of run fast and break things and figure it out.

581

00:43:01,866 --> 00:43:02,333

582
00:43:02,333 --> 00:43:04,600
This is your main or entry point.

583
00:43:04,600 --> 00:43:05,966

584
00:43:05,966 --> 00:43:13,700
We start off by defining and then specifying a few kind of metadata variables.

585
00:43:13,700 --> 00:43:17,366
So we have a start time and end time and there's it's 30 minutes.

586
00:43:17,366 --> 00:43:18,033

587
00:43:18,033 --> 00:43:22,200
We have the IDP time frequency, so that's the target frequency of the IDP.

588
00:43:22,200 --> 00:43:22,766

589
00:43:22,766 --> 00:43:28,866
I have 10 at home when you're experimenting, feel free to change that number for input files.

590
00:43:28,866 --> 00:43:37,466
Obviously we have the three input files I mentioned, but again John yourself at home expand that out to four or five or decrease to two if you want something simpler.

591
00:43:37,466 --> 00:43:39,666

592
00:43:39,666 --> 00:43:48,266
In this next line here, hopefully you can see my cursor recreate the IDP and this returns a data frame.

593
00:43:48,266 --> 00:43:48,733

594
00:43:48,733 --> 00:44:05,266
You'll notice that we're passing into this function some of these variables that we defined above start and end time, and the time frequency, and then our input files after the IDP has been created, we save it to a CSV so you could take a look at this and Microsoft Excel.

595
00:44:05,266 --> 00:44:05,333

596
00:44:05,333 --> 00:44:11,466
Excuse me excel for example and then lastly we plot the flight path and this interactive 2D chart.

597
00:44:11,466 --> 00:44:15,566

598
00:44:15,566 --> 00:44:34,066
This function here is creates an initial data frame and what this does really is it uses the specifications that we set up and creates an empty data frame or IDP if you will, with our UTC that will eventually become the time synchronized field.

599
00:44:34,066 --> 00:44:34,100

600
00:44:34,100 --> 00:44:38,300
So it's really just a data table with a single column of a time field.

601
00:44:38,300 --> 00:44:39,666

602
00:44:39,666 --> 00:44:49,066
The first thing it figures out is how many total seconds there are, and then the next thing, how many periods or this would be your rose and your data frame or IDP.

603
00:44:49,066 --> 00:44:50,566

604
00:44:50,566 --> 00:44:53,400
This frequency right here captures the frequency in milliseconds.

605
00:44:53,400 --> 00:44:55,133

606
00:44:55,133 --> 00:45:07,100
This line right here creates a dataframe, just an empty pandas data frame and then down here is where the magic happens, where we have this temporary data frame or IDP if you will, with just that UTC timestamp.

607
00:45:07,100 --> 00:45:10,000

608
00:45:10,000 --> 00:45:13,366
So this function's a bit out of order because the next one is actually going to call it.

609
00:45:13,366 --> 00:45:17,133
It so create IDP will reference the function we just saw.

610
00:45:17,133 --> 00:45:17,566

611
00:45:17,566 --> 00:45:22,900
You'll see a lot of the familiar variables that I just went over and start end time frequency and then the input files.

612
00:45:22,900 --> 00:45:24,000

613
00:45:24,000 --> 00:45:27,466
This very first line right here creates that initial data frame.

614
00:45:27,466 --> 00:45:37,300
That empty data frame that we just went over and then this for loop processes each of our input files like I'd mentioned previously one by one.

615
00:45:37,300 --> 00:45:37,366

616
00:45:37,366 --> 00:45:48,033
So the first thing it does is reads the CSV file, it then updates the timestamp in that CSV file to something that is consistent with our due time stamp.

617
00:45:48,033 --> 00:45:49,700

618
00:45:49,700 --> 00:45:53,466
This line right here, this temp underscore DF with this rename.

619
00:45:53,466 --> 00:45:53,833

620
00:45:53,833 --> 00:46:06,266
What we're doing is appending the file name to the the columns within each file, because otherwise aircraft one an aircraft two would be easy to mix.

621
00:46:06,266 --> 00:46:06,533

622
00:46:06,533 --> 00:46:11,500
So now you have some ideas of the provenance of where the data comes from and the final IDP.

623
00:46:11,500 --> 00:46:13,100

624
00:46:13,100 --> 00:46:15,633
This line here sort values in ascending.

625
00:46:15,633 --> 00:46:25,800
This is required before this next step here where we merge that raw data file which is in this data frame into our temporary data.

626
00:46:25,800 --> 00:46:26,433

627
00:46:26,433 --> 00:46:37,566
Excuse me into our temporary data file so it's appending and it's a growing as this particular for loop is processing this direction right here is backward.

628
00:46:37,566 --> 00:46:53,166
It's not intuitive in my mind, but it is what that concept that I mentioned earlier that basically Ford fills the last known data for a particular instrument until an update comes in and you'll see that in just a second how that works.

629
00:46:53,166 --> 00:46:56,400

630
00:46:56,400 --> 00:46:59,033
Here's the plot flight path procedure.

631
00:46:59,033 --> 00:46:59,633

632
00:46:59,633 --> 00:47:07,200
I won't go into all the details here, but essentially what we do is we create a figure using the scatter Mapbox within Plotly Express.

633
00:47:07,200 --> 00:47:07,700

634
00:47:07,700 --> 00:47:12,133
This first figure is for aircraft, one the second figure is for aircraft two.

635
00:47:12,133 --> 00:47:12,533

636
00:47:12,533 --> 00:47:20,366
We combine them and then we use this USGS map and place this data over that map.

637
00:47:20,366 --> 00:47:20,400

638
00:47:20,400 --> 00:47:21,500
As you'll see in just a second.

639
00:47:21,500 --> 00:47:24,900

640
00:47:24,900 --> 00:47:28,400
So this is an example of the produced IDP that comes out of it.

641
00:47:28,400 --> 00:47:47,933
I'm using some ellipses to just kind of condense what this IDP looks like, but this combines all the fields that we just wanna over in our sample files, you'll notice that the names have been appended to the field names at the top and the column and this is in essence the IDP that we create to support flight test research.

642
00:47:47,933 --> 00:47:50,233

643
00:47:50,233 --> 00:48:07,166
On the next chart is a chart, but this goes over that Plotly Express scatter Mount box chart that we do and I'm actually just briefly, I wanna go over to what I mean by interactive this is this will be created when you run this at home.

644
00:48:07,166 --> 00:48:12,766
This is in the Tucson area, which just notional data and what's nice about this is that you can.

645
00:48:12,766 --> 00:48:14,133

646
00:48:14,133 --> 00:48:23,000
Zoom, pan and you can also tilt just to get an idea of where your aircraft or whatever it is you're looking at, exists in the 3D environment.

647
00:48:23,000 --> 00:48:24,300

648
00:48:24,300 --> 00:48:33,333
It's also interactive in the the fact that you can hover over these different points in the chart to understand the state of the world at that particular time.

649
00:48:33,333 --> 00:48:33,600

650
00:48:33,600 --> 00:48:36,533
So it looks like I'm picking on aircraft one here.

651
00:48:36,533 --> 00:48:36,666

652
00:48:36,666 --> 00:48:42,166
You can figure out the latitude, longitude, altitude and then the wind and wind gust at that time.

653
00:48:42,166 --> 00:48:44,800

654
00:48:44,800 --> 00:48:46,900
OK, that's that.

655
00:48:46,900 --> 00:48:47,900

656
00:48:47,900 --> 00:48:48,700
I'm nearly done.

657
00:48:48,700 --> 00:48:50,333
I lied to you, I said 40 minutes.

658
00:48:50,333 --> 00:49:00,366
I've got 9 minutes over, but I'd be remiss if I didn't acknowledge the contributions that were made within data services within ATI within national campaign.

659
00:49:00,366 --> 00:49:00,733

660
00:49:00,733 --> 00:49:04,766
And I'm afraid I I'm I have a fear that I most likely miss someone.

661
00:49:04,766 --> 00:49:04,800

662

00:49:04,800 --> 00:49:11,200
So if I did, I apologize, but there's no way we could have done the IDP without the person's here.

663
00:49:11,200 --> 00:49:13,066
So I just wanted to acknowledge that and thank them.

664
00:49:13,066 --> 00:49:14,933

665
00:49:14,933 --> 00:49:18,266
OK, now I'm going to advance to the question mark slide.

666
00:49:18,266 --> 00:49:19,600
Thank you everyone for your patience.

667
00:49:19,600 --> 00:49:20,566
I know that that was a lot.

668
00:49:20,566 --> 00:49:22,600
These technical talks often are.

669
00:49:22,600 --> 00:49:23,566
It was a mouthful.

670
00:49:23,566 --> 00:49:24,000

671
00:49:24,000 --> 00:49:25,900
Hopefully there was some edification in there.

672
00:49:25,900 --> 00:49:26,033

673
00:49:26,033 --> 00:49:29,533
Thank you for your patience and I'll stop talking in case there are any questions.

674
00:49:29,533 --> 00:49:32,400

675
00:49:32,400 --> 00:49:35,866
Looks like there is OK, let's see here.

676
00:49:35,866 --> 00:49:37,066
Just a second, Billy.

677
00:49:37,066 --> 00:49:37,100

678
00:49:37,100 --> 00:49:41,866
I'm gonna open up the chat and then and I'm not sure.

679
00:49:41,866 --> 00:49:41,900

680
00:49:41,900 --> 00:49:42,766
Can someone confirm?

681
00:49:42,766 --> 00:49:42,800

682
00:49:42,800 --> 00:49:45,300
Can you see my chat?

683
00:49:45,300 --> 00:49:45,333

684
00:49:45,333 --> 00:49:46,966
I'm hopefully I'm sharing it.

685
00:49:46,966 --> 00:49:47,366

686
00:49:47,366 --> 00:49:49,566
What is the name of the visualization tool?

687
00:49:49,566 --> 00:49:50,666

688
00:49:50,666 --> 00:49:51,233
Alright.

689
00:49:51,233 --> 00:49:51,266

690
00:49:51,266 --> 00:49:52,900
And that was from Hemel.

691
00:49:52,900 --> 00:49:53,766

692
00:49:53,766 --> 00:49:57,100
Let me go back to the slides and just pull this up for you.

693
00:49:57,100 --> 00:50:00,066

694
00:50:00,066 --> 00:50:03,500
The visualization tool we're actually using is.

695
00:50:03,500 --> 00:50:04,800

696
00:50:04,800 --> 00:50:05,633
Let's see.

697
00:50:05,633 --> 00:50:06,100

698
00:50:06,100 --> 00:50:11,066
It's this particular partly express tool called Scatter underscore, Mapbox.

699
00:50:11,066 --> 00:50:12,133

700
00:50:12,133 --> 00:50:12,900
What this will do?

701
00:50:12,900 --> 00:50:15,966
This figure shows it's kind of hard to see at the bottom is.

702
00:50:15,966 --> 00:50:16,033

703
00:50:16,033 --> 00:50:20,166
Will open up that figure in your browser of choice.

704
00:50:20,166 --> 00:50:27,400
You'll notice that I had Microsoft Edge, but it can be whatever browser you want, so it creates an HTML file actively.

705
00:50:27,400 --> 00:50:28,733

706
00:50:28,733 --> 00:50:40,366
What I don't have here is that you can also save that particular file that that figure to it in HTML figure so that you can download it or save it to your hard disk and then share it with other researchers.

707
00:50:40,366 --> 00:50:41,933

708
00:50:41,933 --> 00:50:42,800
So thanks for the question.

709
00:50:42,800 --> 00:50:44,700
I answered what you were going after.

710
00:50:44,700 --> 00:50:47,066

711
00:50:47,066 --> 00:50:48,233
All right, let's see.

712
00:50:48,233 --> 00:50:53,966
I think there are some questions, perhaps let me see here, Billy.

713
00:50:53,966 --> 00:50:55,000
I don't know if you're on.

714
00:50:55,000 --> 00:50:55,033

715
00:50:55,033 --> 00:50:56,766
I don't wanna miss any questions here.

716
00:50:56,766 --> 00:50:57,966
Let's see, I think.

717
00:50:57,966 --> 00:50:58,766
Yeah, I'm here.

718
00:50:58,766 --> 00:51:00,566
There's one from Michael Abramson.

719
00:51:00,566 --> 00:51:00,600

720
00:51:00,600 --> 00:51:01,266
He has his hand up.

721
00:51:01,266 --> 00:51:01,733

722
00:51:01,733 --> 00:51:02,233
OK.

723
00:51:02,233 --> 00:51:02,300

724
00:51:02,300 --> 00:51:03,233
Yes, please go ahead, Michael.

725
00:51:03,233 --> 00:51:03,800

726
00:51:03,800 --> 00:51:08,300
Uh, yeah, it's regarding your visualization tool.

727
00:51:08,300 --> 00:51:10,800
Does IT support animation capabilities?

728
00:51:10,800 --> 00:51:15,833
So to solve where aircraft it is in real time, how it's moving.

729
00:51:15,833 --> 00:51:17,600

730
00:51:17,600 --> 00:51:19,366
Or it's only static trajectories?

731
00:51:19,366 --> 00:51:21,100

732

00:51:21,100 --> 00:51:21,933
I'm sorry, Michael.

733
00:51:21,933 --> 00:51:21,966

734
00:51:21,966 --> 00:51:23,266
I had a hard time understanding.

735
00:51:23,266 --> 00:51:24,733
Do you mind repeating again please?

736
00:51:24,733 --> 00:51:25,333

737
00:51:25,333 --> 00:51:30,100
Uh, does this visualization tool support animation?

738
00:51:30,100 --> 00:51:31,466

739
00:51:31,466 --> 00:51:31,733
Like uh, just playing the movie in position of aircraft.

740
00:51:31,733 --> 00:51:33,100
Does right?

741
00:51:33,100 --> 00:51:33,400
Does it?

742
00:51:33,400 --> 00:51:36,100

743
00:51:36,100 --> 00:51:37,700
Yes, that's a great question.

744
00:51:37,700 --> 00:51:38,166

745
00:51:38,166 --> 00:51:43,566
This one, the technical technical expert to answer that is not on right now.

746
00:51:43,566 --> 00:51:46,500
So that is a standard library.

747
00:51:46,500 --> 00:51:46,533

748
00:51:46,533 --> 00:51:47,900
The scatter mob that.

749
00:51:47,900 --> 00:51:47,933

750
00:51:47,933 --> 00:51:48,533
Excuse me.

751
00:51:48,533 --> 00:51:56,900
Scatter map box there are other visualization packages within Python that do do animation.

752
00:51:56,900 --> 00:51:57,000

753
00:51:57,000 --> 00:51:59,166
The one I showed here does not.

754
00:51:59,166 --> 00:51:59,200

755
00:51:59,200 --> 00:52:03,200
There might be extensions to this library that I'm unaware of.

756
00:52:03,200 --> 00:52:03,766

757
00:52:03,766 --> 00:52:19,000
What we have done and another example, Michael of other applications that we have done with the IDP is to write KML files which can be opened up in Google Earth and those do include animations.

758
00:52:19,000 --> 00:52:19,233

759
00:52:19,233 --> 00:52:20,100
So that's one way.

760
00:52:20,100 --> 00:52:22,233
I know that we have included animations.

761
00:52:22,233 --> 00:52:22,366

762
00:52:22,366 --> 00:52:25,600
What I've showed here today does not, but it doesn't.

763
00:52:25,600 --> 00:52:25,666

764
00:52:25,666 --> 00:52:27,833
That doesn't mean that Python doesn't support it.

765
00:52:27,833 --> 00:52:27,866

766
00:52:27,866 --> 00:52:29,700
It does, just not in the example here.

767

00:52:29,700 --> 00:52:30,900

768
00:52:30,900 --> 00:52:31,966
Umm, so thank you.

769
00:52:31,966 --> 00:52:32,866

770
00:52:32,866 --> 00:52:33,666
Thank you for the question.

771
00:52:33,666 --> 00:52:36,500

772
00:52:36,500 --> 00:52:39,700
And then I don't know that there might be another hand up and I can't quite see it, Billy.

773
00:52:39,700 --> 00:52:40,500
Yeah.

774
00:52:40,500 --> 00:52:40,600

775
00:52:40,600 --> 00:52:41,300
Yeah, there is.

776
00:52:41,300 --> 00:52:42,700
It's from Jay Jay woo.

777
00:52:42,700 --> 00:52:43,100

778
00:52:43,100 --> 00:52:43,700
There's a question.

779
00:52:43,700 --> 00:52:45,100
Yeah, yes.

780
00:52:45,100 --> 00:52:45,266

781
00:52:45,266 --> 00:52:48,033
The question I have is back in.

782
00:52:48,033 --> 00:52:48,066

783
00:52:48,066 --> 00:52:50,033
I think it's a slide 16.

784
00:52:50,033 --> 00:52:50,633

785
00:52:50,633 --> 00:52:59,233
You described a a method to address the different update rate.

786
00:52:59,233 --> 00:53:01,133

787
00:53:01,133 --> 00:53:05,033
Maybe it was a one before after something about yielding last value.

788
00:53:05,033 --> 00:53:07,300

789
00:53:07,300 --> 00:53:08,266
Yes, that's right.

790
00:53:08,266 --> 00:53:10,133
OK, let me find that this guy I think you made right here, right? Yes.

791
00:53:10,133 --> 00:53:10,700
Ah, here we go.

792
00:53:10,700 --> 00:53:12,033

793
00:53:12,033 --> 00:53:12,666
Right, right, right.

794
00:53:12,666 --> 00:53:13,833

795
00:53:13,833 --> 00:53:14,233
Have you?

796
00:53:14,233 --> 00:53:14,500
Have you?

797
00:53:14,500 --> 00:53:15,633

798
00:53:15,633 --> 00:53:29,400
I different ways and then I came to this was the best way to handle it or I mean you could all also like leave a unknown value at the time stamp is a zero or null space or.

799
00:53:29,400 --> 00:53:30,733

800
00:53:30,733 --> 00:53:36,333
You are hitting on a a great point and actually a lot of passionate debate occurred around that.

801
00:53:36,333 --> 00:53:36,866

802

00:53:36,866 --> 00:53:48,433
We settled in on Ford filling for the flight test that we did have, but the team talked passionately about whether or not other approaches were equally valid and what you suggested.

803
00:53:48,433 --> 00:53:48,466

804
00:53:48,466 --> 00:53:52,633
Say for instance keeping things Blank was also valid.

805
00:53:52,633 --> 00:53:52,666

806
00:53:52,666 --> 00:53:53,766
We consider doing that.

807
00:53:53,766 --> 00:53:54,000

808
00:53:54,000 --> 00:53:58,400
Fortunately, the software is written so that we can adapt it to the flight test.

809
00:53:58,400 --> 00:54:08,966
So if, for instance, a research partner in the future says, hey, let's actually look at splitting the difference between timestamps, we could get kind of the best of both worlds or leaving it blank.

810
00:54:08,966 --> 00:54:09,033

811
00:54:09,033 --> 00:54:13,266
Yet we certainly have the tools to accommodate that in the future, but that's a great question.

812
00:54:13,266 --> 00:54:14,700

813
00:54:14,700 --> 00:54:15,366
OK.

814
00:54:15,366 --> 00:54:15,933

815
00:54:15,933 --> 00:54:29,400
One thing I would add is there was an attempt to time stamp individual atom level data, but just the time stamping just got overblown in that sense.

816
00:54:29,400 --> 00:54:29,866

817
00:54:29,866 --> 00:54:34,800
So that way it doesn't matter whether there's a difference is in update rate or not.

818
00:54:34,800 --> 00:54:34,833

819
00:54:34,833 --> 00:54:41,700
But if we want to, if we wanted to see something in in one row, then it became challenged too.

820
00:54:41,700 --> 00:54:45,733
So yeah, there's a lot of issues, yes, but that different update rate.

821
00:54:45,733 --> 00:54:46,000

822
00:54:46,000 --> 00:54:47,766
Appreciate your feedback.

823
00:54:47,766 --> 00:54:49,766
Oh yeah, great question.

824
00:54:49,766 --> 00:54:52,633
And I'd love to talk about it more.

825
00:54:52,633 --> 00:54:57,100
So it's it's something certainly that we'll talk about in the future as we support more flight tests.

826
00:54:57,100 --> 00:54:57,200

827
00:54:57,200 --> 00:54:57,566
Thank you.

828
00:54:57,566 --> 00:55:00,466

829
00:55:00,466 --> 00:55:02,466
All right, it looks like there's a new message.

830
00:55:02,466 --> 00:55:02,766

831
00:55:02,766 --> 00:55:03,666
You have to bear with me.

832
00:55:03,666 --> 00:55:04,733

833
00:55:04,733 --> 00:55:05,200
OK.

834
00:55:05,200 --> 00:55:05,266

835
00:55:05,266 --> 00:55:05,700
Thank you.

836
00:55:05,700 --> 00:55:06,533
Not a question, but.

837
00:55:06,533 --> 00:55:07,300

838
00:55:07,300 --> 00:55:07,733
Oh yeah.

839
00:55:07,733 --> 00:55:08,266
Thank you, Douglas.

840
00:55:08,266 --> 00:55:10,166

841
00:55:10,166 --> 00:55:10,600
Or duck.

842
00:55:10,600 --> 00:55:14,400

843
00:55:14,400 --> 00:55:14,866
All right.

844
00:55:14,866 --> 00:55:16,266

845
00:55:16,266 --> 00:55:19,766
Are there any other questions have to answer them?

846
00:55:19,766 --> 00:55:19,800

847
00:55:19,800 --> 00:55:24,666
Of course you could email the team afterward, or or chat is on teams.

848
00:55:24,666 --> 00:55:25,233

849
00:55:25,233 --> 00:55:31,400
If anything comes to mind later, thank you very much for your attention, your patience.

850
00:55:31,400 --> 00:55:31,833

851
00:55:31,833 --> 00:55:32,933
Hope it was helpful for you.

852
00:55:32,933 --> 00:55:34,566
It was really my pleasure to give it to you.

853
00:55:34,566 --> 00:55:34,733

854
00:55:34,733 --> 00:55:35,500
So thank you.

855
00:55:35,500 --> 00:55:38,100

856
00:55:38,100 --> 00:55:46,466
So at this point, I guess, Nicole, we never talked about the conclusion, but I think it at this point we can conclude the meeting and go on our merry way.

857
00:55:46,466 --> 00:55:48,200
So thank you very much everyone.

858
00:55:48,200 --> 00:55:52,400

859
00:55:52,400 --> 00:55:53,400
Alright, take care.

860
00:55:53,400 --> 00:55:53,933

861
00:55:53,933 --> 00:55:54,633
Have a good weekend.

862
00:55:54,633 --> 00:55:56,733

863
00:55:56,733 --> 00:55:57,200
Thanks Tim.

864
00:55:57,200 --> 00:56:01,200