## Witness: Peter van Wyck Loomis

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### Direct Examination by Rick Distaso

DISTASO: Dr. Loomis, where do you work?

LOOMIS: I work at Trimble Navigation.

DISTASO: And what type of company is that?

LOOMIS: Our company makes, designs and produces GPS receivers. Satellite navigation receivers.

DISTASO: And when you say GPS, just for the record, what does that stand for?

LOOMIS: GPS is the Global Positioning System.

DISTASO: And can you tell the jury just briefly what your duties are at, actually let me stop. Let's just go back a little bit. I called you Dr. Loomis. Can you tell the jury briefly what your educational background is.

LOOMIS: Yes. I have a bachelor's degree in mathematics and a Ph.D in mathematics from UC Davis and a masters in mathematics from UC Berkeley.

DISTASO: And how long have you been working for Trimble Navigation?

LOOMIS: 20 years as of August.

DISTASO: And prior to that, did you work in some type of field regarding a guidance systems or navigational systems?

LOOMIS: Yes. I worked with inertial navigational systems at Lockheed.

DISTASO: And what's the difference between inertial navigation systems and GPS systems? Just briefly.

LOOMIS: Oh, well, the GPS system is identified as an anywhere, anytime positioning system. You turn it on anywhere, it will give you your position and your time. And your velocity. The inertial navigation systems track where you have gone. If you know where you start, it can track where you go after that point. So it's more of a tracking system from an initial, initial point.

DISTASO: And GPS systems, how long have you been working specifically with that type of navigational system?

LOOMIS: Oh, since 1985.

DISTASO: So about 19 years or so?

LOOMIS: Yes.

DISTASO: And Trimble builds, does Trimble build a whole number of different type of GPS receivers?

LOOMIS: We build a range of GPS receivers, from the least expensive high-volume mass-market GPS receivers, to very expensive survey instruments.

DISTASO: And the low, the lower cost units, what types of applications are those used for?

LOOMIS: The lowest cost units are put into hand-held devices, like PDAs. Cell phones is another market for that. The tracking devices for vehicles. Our biggest customer right now is GPS receivers going into the navigation systems in automobiles. And from my area of the company that's, that's our biggest customers.

DISTASO: Okay. So when you go and you buy a new car and it comes with a GPS unit in there, your company might be the one that supplied that receiver to the auto company?

LOOMIS: Yes.

DISTASO: How, well, at this time, your Honor, I'm just going to offer him as an expert. I, I don't think there's going to be any

JUDGE: Any questions on his expertise?

GERAGOS: No.

JUDGE: You're offering him as an expert in what, GPS?

DISTASO: GPS technology, your Honor.

JUDGE: All right. Let me ask you, how long, have you written any books on the subject, or any articles?

LOOMIS: I've written various articles, maybe 18 or 20 articles.

JUDGE: Okay. Where were they published?

LOOMIS: Most of them were published in conference proceedings. I did have a couple that were in refereed journals.

JUDGE: Did you have any on the job training, Dr. Loomis, with respect to GPS receivers?

LOOMIS: Oh, gosh, no, I've been in GPS for so long I helped in, circumvent parts of the field.

JUDGE: Based on achievement?

LOOMIS: Yes.

JUDGE: Have you ever qualified as an expert before in a court of law?

LOOMIS: No, not before this court.

JUDGE: Okay.

DISTASO: Just for the record, you did qualify, Dr. Loomis, in a prior proceeding in this case?

JUDGE: You qualified for me about six months ago.

LOOMIS: Yes.

JUDGE: Well, things haven't changed, so I'll accept he's an expert in GPS technology. Go ahead.

DISTASO: Dr. Loomis, let me show you just a couple slides that maybe we can just make clear how this stuff works. Can you describe for the jury what's going on when, when somebody turns their GPS unit on, what's happening.

LOOMIS: The GPS is actually two parts. It's a radio and it's a navigation computer. And the radio receives signals from satellites that are orbiting the earth. And there's roughly two dozen satellites up there right now, constantly changing, the orbits are such that they're constantly rising and setting, but there's always about eight satellites up there. And the satellites are sending out synchronized timed messages, and when the receiver gets them, it calculates how much time it took for that message to get from the satellite to the little hand-held receiver. And it converts that time with the speed of light into a distance, so it gets a distance to four satellites, and that sort of locks in the position right there.

DISTASO: Let me show, this is 234A, and it's just a little schematic of the world with the satellites going around. For the GPS unit to determine a location, how many satellites does it have to lock onto, or find?

LOOMIS: Well, a full location would require four satellites. One to set the time on the receiver, one for latitude, one for longitude, and one for altitude. But very often we sort of know our altitude, so we'll coast with a given altitude. So three is the recognized industry minimum for satellites.

DISTASO: Okay. So if the receiver find three satellites, it can give you a pretty good idea where you are?

LOOMIS: Yes.

DISTASO: Okay. And here's another little view. And does, what, what would this show us?

LOOMIS: Well, this shows that typically we'll have eight or nine satellites up there. They would be spread all over the sky. Some of them are going to be low on the horizon, some of them are going to be vertical. And by reading as many as we can, we get the best answer we can.

DISTASO: And by best answer, you mean the best location?

LOOMIS: The best location. But, really, once you get four, your location will not improve that much when you get a fifth or a sixth.

DISTASO: How does the receiver pick up the signal from the satellite?

LOOMIS: Oh, it can take a little bit of time for the receiver to pick up the signal. I'd actually have to search for the signal at a certain frequency, and it actually searches for the time message. So typically, the newest receivers can actually pick them up in a couple seconds, the ones that are going into cell phones right now, but the older receivers, and this, this is of a previous generation that we're speaking of here, can take 40 to 60 seconds to actually acquire all the satellites and get all the data that it needs to get a position. So it does take a little bit of start-up time.

DISTASO: To find out where it's at?

LOOMIS: To find out where it's at.

DISTASO: And would an analogy be of how it's picking up the signal similar to how you turn the radio on in a car and you get a signal?

GERAGOS: No.

DISTASO: No?

LOOMIS: No. Actually it would be more like trying to scan for a channel and locking on channels. So it takes time for the GPS to lock on a channel.

DISTASO: And the signal that's send down, is that a standard radio frequency? Or what type of frequency is it?

LOOMIS: It's what's called spren, excuse me, spread spectrum. It's very much like the PCS or Seaview made telephones that are being, that are common right now. Sprint-type telephones. Same technology.

DISTASO: Okay. How, in what time zone is GPS data recorded?

LOOMIS: Well, the GPS works with the worldwide time zone. Call it GMT for Greenwich Mean Time, and I believe the military calls it Zulu Time. So it's a worldwide time standard which, which at, at midnight is midnight in London, basically, at zero degrees longitude. And so, by using this one time standard, there's no confusion about what the time stamps on the positions are.

DISTASO: So if we have a time stamp that is 8:00 p.m. GMT, that would be 8:00 p.m. London time, for example?

LOOMIS: Yes.

DISTASO: Okay. Now, if we're on the Pacific coast, do you have to add or subtract some particular time to get a local Pacific time?

LOOMIS: Right. It has to be converted to local time here on the Pacific coast. We subtract eight hours. So an 8:00 p.m. GMT would be noon here in, on the Pacific coast. And that would be a standard time. Of course you have to do a daylight time, change by an hour and only subtract seven hours during the summer.

DISTASO: And to your knowledge are all GPS units, are the times initially recorded in this GMT, or Greenwich Mean Time?

LOOMIS: Yes.

DISTASO: Certainly all the ones from your company are?

LOOMIS: Yes. And the satellites themselves broadcast time in GMT.

DISTASO: Okay. Now, were you asked to look at some data that was collected in this particular case regarding some tracks of the defendant to the Berkeley Marina?

LOOMIS: Yes.

DISTASO: Or the Berkeley Marina area?

LOOMIS: Yes.

DISTASO: Let me show you the first track. This is 234C. I'm going to mark this next board, your Honor. It has two. We'll mark them A and B.

JUDGE: All right. 235 A and B.

DISTASO: Do you want to see this?

GERAGOS: I assume it's the same one.

DISTASO: It's the same one you saw over there.

GERAGOS: What's the B?

DISTASO: It's the other side.

GERAGOS: The other side. Got it.

JUDGE: Dr. Loomis, there's a pointer there.

DISTASO: This, this was a track from January 9th of 2003 that was done. And let me show you, that, what is that. 235A is on a picture, and here it is on a, this is 234 B, it's kind of a little more rudimentary map. Did you look at the data that was associated with these particular, with this particular track?

LOOMIS: Yes, I did.

DISTASO: And what was your opinion as to the quality of the data for the track here in the Berkeley Marina?

LOOMIS: I thought the data was very good quality. It was equivalent to any, any good quality data that our car navigations produce. For GPS.

DISTASO: And what, and what is the accuracy, I, I don't know if that's the right word. You correct me if it's not. But how, how accurate are these particular units, the ones that were used in this case that were used in the automobile?

LOOMIS: In, in a clear-view situation, where they have a good view of the sky, the accuracy will be about 30 feet. And that would, that would be my, maybe an 80% number. So sometimes it would be a little bit worse, but almost all the time they would be within about 30 feet.

DISTASO: So when we're seeing these little yellow dots that are the, as the unit's taking the plot, we can say with fairly good assurity that the car is within 30 feet on either side of one of those dots?

LOOMIS: I would say yes. On this particular data set.

DISTASO: Okay. Now, did you, were you asked to look at the tracks for the entire day of this particular day, just to review some issues that were seen in other parts of the data?

LOOMIS: Yes.

DISTASO: Okay. Let me show you this particular map.

JUDGE: What number is that?

DISTASO: This one is 234C. And specifically let me, let me start with, let me just ask you, did you notice, did you notice any anomalies or issues with the data as it related to the track to the Berkeley Marina?

LOOMIS: No. No.

DISTASO: Did you notice some anomaly or issue in other portions of the tracks for other different times of the day?

LOOMIS: Yeah. There were two issues.

DISTASO: Okay.

LOOMIS: Um...

DISTASO: Let me stop you. Let's go to the very first issue that you found. There's, do you see where my pen is pointing? It looks like there's two dots that kind of jump away from the, a location. Do you see that?

LOOMIS: Yes.

DISTASO: Okay. Did you look and see what that particular issue was, what was happening with that particular issue?

LOOMIS: Yes. I examined that issue quite a bit, and it showed up not only here but in, I think, two other places in the data files. And there was some interesting little phenomenon happening here. And we talked to the, the manufacturer of, of the tracking device. Now, here, we only build the GPS receivers, which is the little, as I said, the little radio computer, and this has been put into a tracking device that combines our GPS receiver with a cell telephone for communications, and a data recording system also. And it turned out that there was, that there was a problem in our GPS receiver in reporting certain data, and this caused a data recording problem on the, on the side of the, Orion, who was the manufacturer.

DISTASO: Let me show you a binder with that particular issue. This is 234 E. Let me just show you a portion of that. There's a track in there kind of, if you look, it starts at 7:59 and then goes to 7:74. It looks from the data set that all of a sudden the automobile is going 38 thousand miles per hour, and clearly in your opinion that wasn't the case.

LOOMIS: That's right. It did, it did have a rather large jump in that one second.

DISTASO: Right. And how long of a discrepancy does that show for?

LOOMIS: This particular one, it looks like it was about a hundred seconds or so.

DISTASO: Okay. And so for a couple minutes, in your opinion, would that GPS data be reliable?

LOOMIS: The recorded data I would say was not reliable.

DISTASO: Did you determine what the problem was for that hundred seconds there?

LOOMIS: Yes. After talking to the manufacturer, and we discovered that he was reacting badly to a small problem that we had.

DISTASO: Uh-huh.

LOOMIS: In recording our data

DISTASO: And can you give us, I know this is complicated.

LOOMIS: Yeah.

DISTASO: Can you give the jury some analogy as to how the hundred second problem showed itself?

LOOMIS: I can try. When we get very near a longitude line, in this case it was a longitude line of a hundred and twenty-one. That, about three feet to the east of that longitude line, we begin to change the way we report things. And maybe the best way of making an analogy is if somebody asked how tall my son was, I would say Well, he's five eleven. Five eleven point one, point three, five eleven point nine nine, five eleven twelve. And right before he gets to six feet I would say five eleven twelve, and that's, that's not normal. Now, the data is still there. If a person were hearing this, they would under what five eleven twelve is. It means six feet. If you feed this into a computer, though, the computer gets confused. And that's what happened here. Orion had a computer and we fed them a longitude of a hundred and twenty degrees and 60 minutes rather than a hundred and twenty-one degrees, and that caused a confusion on Orion's part.

DISTASO: Okay. And what did that confusion cause the computer to do?

LOOMIS: According to Orion, it caused to it jump actually a whole degree. So instead of turning a hundred and twenty degrees 60 minutes into a hundred and twenty-one degrees, it turned it into a hundred and twenty-two degrees.

DISTASO: And have you, so for that 100, 100 seconds or so where it was reading this wrong, it, it showed a position that was inaccurate?

LOOMIS: Yes.

DISTASO: Okay. Now, have you, have you, did you take this data and actually put it back one degree?

LOOMIS: Yes, I did.

DISTASO: And if you do that, does it line up correctly with the other data?

LOOMIS: It's very consistent with the other data in all the cases.

DISTASO: And also on that particular day, well, again, let me just ask you. This issue that you're talking about didn't have anything to do with this track here at the Berkeley Marina?

LOOMIS: No. No.

DISTASO: And also later in the day, did you review another issue or problem with some data down in Fresno?

LOOMIS: Yes. There is a

DISTASO: Let me, let me point that out if I can

LOOMIS: Please.

DISTASO: for the jury. Is that, is that reflected by this little kind of dip that we see down there?

LOOMIS: Yes. And that's a genuine problem with the GPS positioning. The GPS did go awry at that point.

DISTASO: Okay. How long was the GPS data going, having a problem during that period of time?

LOOMIS: It started out pretty definitely, and it, because we have filters in our system it takes a little bit of time to flush the error out of our system, so it was about 300 seconds. Five minutes.

DISTASO: So about five minutes there was another problem where you don't believe the data was reliable?

LOOMIS: For five minutes, yes, exactly. And, in fact, the GPS data was wrong and couldn't be reconstructed.

DISTASO: Okay. And did that problem have anything to do with the data in the Berkeley Marina?

LOOMIS: No, it did not.

DISTASO: Okay. Do you, were you able to determine why the GPS didn't operate correctly for that five minutes?

LOOMIS: No. No, I was not.

DISTASO: Is that, is this problem something, have you ever seen this type of problem before?

LOOMIS: You know, I saw it in the early 1990s. Something similar. And I believe it was because of airplane over-flights and having a radar, a flight radar aimed directly at our antennas and it was jamming our antennas. But I can't say for sure that's exactly what was happening then, and I don't know for sure what happened this time.

DISTASO: Other than, on January 9th, other than these problems that we've talked about, did you notice any other, you know, discrepancies or problems with the data as you saw it?

LOOMIS: Nothing serious, nothing abnormal. There was a track through downtown San Francisco, and we always have a very, very hard time tracking through the Market Street area of San Francisco. And, you know, there were, there were some rare cases where it was off by maybe fifty to a hundred yards. I think two or three in many, many hours of traveling, but all of those, within the data before and after, seemed to be reasonable.

DISTASO: And in your opinion as you sit here today, what is your opinion as to the data as it relates to the track here at the Berkeley Marina?

LOOMIS: This particular data is very, very good.

DISTASO: Myco-counsel just pointed out a good question for you. I should probably have you explain to the jury, just briefly, when we're talking about data, what does that mean?

LOOMIS: That's a good question. The data that I look at is basically time, latitude and longitude. That's all that I have available to me from the data sets. There's also a, a velocity that's listed in the data sets, but I don't put too much reliance on that. It's informational only.

DISTASO: Do you know how Orion, the company that puts your receiver together with the software, do you know how they calculate their velocity?

LOOMIS: The velocity appears to be calculated from differencing two positions. So, in other words, if I have a position at one time and a position at another time, they'll actually calculate the difference between those two positions and divide it by the time. Which is why, for instance, if their reporting system accidentally slipped by one degree, all of a sudden we can have a very, very high speed.

DISTASO: That's how you can get the 38,000 miles per hour?

LOOMIS: Yes.

DISTASO: Dr. Loomis, let me ask you about another track. This one was on January 26th. And again, did I ask you to, or, or did somebody from the Modesto Police Department ask you to look at a track from the Berkeley Marina on January 26th?

LOOMIS: Yes.

DISTASO: Okay. I think it's on the back here, 235 B. Yeah. Here's the track on a map. And then 235 B there is the track on a photograph. Did you also look at the date set,

JUDGE: Mr. Distaso, what's this number that you're showing him now?

DISTASO: Yeah. This is 234 G.

JUDGE: G. Okay.

DISTASO: And did you also look at the data set, these data sets here in 235B and 234G?

LOOMIS: Yes.

DISTASO: Okay. And do you have an opinion as to the validity of the particular data here to the Berkeley Marina on January 26?

LOOMIS: Yeah. This data is, again, good data. Very good data

DISTASO: Okay. And on that particular track, let me show you, this is 234F.

JUDGE: F?

DISTASO: F. Frank. This is the track of the entire day. Does that particular, did you notice any, any of the similar, or anomalies that we talked about in prior data for that track?

LOOMIS: I can't remember on this one. There was one other track similar to this that had, but I don't see, I don't see any anomalies on this track at all. It looks very solid data

DISTASO: Okay. All right. Let me show you, I think the one you're thinking of is the next one I'm going to show you, so

LOOMIS: Okay.

DISTASO: This is the last track. This track on January 27th. Let me show you this one. This, let me, your Honor, I didn't have this one marked.

JUDGE: All right.

DISTASO: I'll have this one marked next in order.

JUDGE: All right. That's 236. This is the January 27th track?

DISTASO: It is. While we're getting that, Dr. Loomis, this is 234I. And there's a, one single dot that looks like it kind of jumps, you know; if you look at the, the screen, Dr. Loomis.

LOOMIS: Oh, excuse me.

DISTASO: There's one single dot that kind of jumps way out there, and if I show you the data sets for that, maybe you can explain that to the jury.

LOOMIS: Yeah, this is a similar situation where, again, the vehicle was dwelling, and it produced a position that was within a few feet of a longitude line. And because of this, the reporting, again, skipped a degree. And you can see that on the map here basically there's just a few points directly west. It's in the hills above Danville, I think, or in the Pleasanton area, where there's just a few points. After a while the recording system recovers and it again starts tracking Modesto. There seems to be one, one particular area that is just on a longitude line that a lot of these vehicles dwelled.

DISTASO: Okay. That's where you saw this jumping one degree?

LOOMIS: Yes.

DISTASO: And how long did this particular problem last?

LOOMIS: This particular one lasted about five minutes, according to this track here.

DISTASO: So for five minutes of this particular track?

LOOMIS: Oh, excuse me. Just a minute. It was, it dwelled in that area for about five minutes. Of that time, about 90 seconds, it had jumped to the, so, in other words, it was, it was there for a couple minutes at this location, then all of a sudden it jumped for a minute and a half to this odd point in Pleasanton, and then it jumped back for the rest of the five minute period.

DISTASO: All right. So for the 90 seconds or so, that obviously was incorrect data, when it jumped the one

LOOMIS: Yes.

DISTASO: Did you take that data, and I think you got, I don't know what the mileage was, but it was something, it's probably there in front of you.

DISTASO: The, the time?

LOOMIS: Yeah, the incorrect mileage.

DISTASO: The speed you mean?

LOOMIS: Uh-huh. Yes.

DISTASO: What is it?

LOOMIS: Oh, it's 19,000 miles an hour. It's half of what it was before because the Delta times, in other words the times between readings, was twice long in this particular data set.

DISTASO: Okay. So the, when you went back and, did you go back and take that data and put it back one degree?

LOOMIS: Yes.

DISTASO: And did it line up correctly?

LOOMIS: Yes, it lined up with the rest of the data

DISTASO: Okay. So for this ninety second, period, though in your opinion that data would obviously be incorrect?

LOOMIS: Yes.

DISTASO: Going to the data now at the Berkeley Marina, do you have an opinion as to the data set there, I called it the Berkeley Marina but it's actually kind of the frontage road up towards the race track. Do you have an opinion as to the validity of that particular data as represented on People's 236?

LOOMIS: This, again, is very good data

DISTASO: Okay. And let me show you 234I. It's, it's a copy of the track for the entire day. This was what was just on the screen.

LOOMIS: Oh, thank you.

DISTASO: When you look at that and you see kind of a solid line of GPS plots all the way through, is that something you look for?

LOOMIS: I, I look for a consistency in the data. The GPS, a single GPS point alone won't be able to tell me exactly where somebody is within a hundred yards, but looking at the data before, looking at it after, looking at the consistency with which it lies on the streets, these are all signs that I'm looking for. In this particular case, a map of the size that you showed on the screen here doesn't tell me too much. And so I really have to analyze it on a smaller scale like this.

DISTASO: The, there was, let me go back kind of to the beginning. And can you explain for us exactly what the latitude and longitude line is?

LOOMIS: Oh.

DISTASO: Or how would you describe it in kind of simple terms.

LOOMIS: Well, it's a way of identifying a point on the earth. Gosh, you know, I, a latitude and longitude is a coordinate system that's, that's used to identify positions on the earth. It's, it's a global system, so that it's, you know, it doesn't change from place to place.

DISTASO: Is it

LOOMIS: It's a mathematical concept.

DISTASO: Okay. Let me just ask you this, Is it a standard way of recording position data on the earth?

LOOMIS: Yes, it is.

DISTASO: So where I'm standing right here in court would have a definitive latitude and longitude line?

LOOMIS: Yes.

DISTASO: You seem to hesitate.

LOOMIS: The reason I'm hesitant is because, and this is, actually, it's a major point to people that are in mapping, like myself, because there's different ways of defining maps. And they're called datums. There's a worldwide datum which GPS uses, and so that this datum is very well defined over the whole world. But back a hundred years ago there was no satellite system to define a worldwide datum, so the datums could typically be defined nation by nation. So American has one datum, Japan has another, and even Hawaii has its own datum. And it wasn't until the past few decades that we could actually link these datums up and determine how the datums relate to each other. That's why I'm a little bit

DISTASO: Okay.

LOOMIS: So, for instance, if somebody gives me a latitude and longitude in North America datum of 27, 1927, which was the commonly used one to make road maps back 20 years ago, 30 years ago, and even some maps now, unfortunately, that can be off by a hundred yards in some places.

DISTASO: Okay. So some of the older maps that didn't use the GPS system are not as accurate as maps that are based on GPS coordinates?

LOOMIS: You know, as long as you say that, what the datum is, you can call it accurate, but you can't necessarily relate it to, to GPS without a conversion.

DISTASO: Let me just ask you a just couple final questions. The applications that GPS is used for, is it used just for, you know, tracking automobiles around?

LOOMIS: No. No, it's not. GPS is actually used to make maps and determine the position of things worldwide. It's a very, very efficient way of doing so. The GPS is used to time cell phone systems to within a very tight frequency and timing standard. It's used to navigate aircraft. The military uses it very heavily.

DISTASO: So it's used in, is it fair, is it a fair kind of summary for me to say that it's used in many applications where position data is necessary?

LOOMIS: Yes.

DISTASO: Okay. There was one final issue with converting some of this data to put it on the photographs. And I don't know if you feel comfortable talking about it, or, or you'd rather have the Orion representative talk about it. It was something with the date download time. Is that something you feel comfortable –

LOOMIS: No, I don't think that has anything to do with the GPS data directly.

DISTASO: Okay. So that issue that I'm talking about is an Orion issue that they need to discuss?

LOOMIS: Yes.

DISTASO: Okay. That, that aside, the opinions that you've given about the accuracy or the quality of the data as you saw it as it relates to these trips to the Berkeley Marina, does, would any of that change your opinion?

LOOMIS: No.

DISTASO: Thank you, your Honor. I don't have anything further.

JUDGE: Just before you leave this witness, so we're on the same page, did you identify 234 D, H, J and K? Or did I get lost here?

DISTASO: Let me see, your Honor.

JUDGE: 234 D, H, J and K.

DISTASO: Let me take a look. 234 D I did.

JUDGE: All right. What was that?

DISTASO: That was a map of the Berkeley Marina.

JUDGE: All right.

DISTASO: And then I can just do it quickly here. 234E, Dr. Loomis, is this the data you reviewed for some of these, that, what you've been discussing here, the one degree offset?

JUDGE: Yeah, I have that down as the tracking data.

DISTASO: Okay.

JUDGE: What about H, J, and K?

DISTASO: Let me go through and make sure. H, is that the data from one of the tracks of the Berkeley Marina that you reviewed?

LOOMIS: Yes.

JUDGE: What date is that track?

DISTASO: And that is the one on the 26th, your Honor.

JUDGE: Okay. J and K.

GERAGOS: I just want to see what J and K are.

DISTASO: J, your Honor, is just a map that's basically represented by the photograph on 236.

JUDGE: A duplicate?

DISTASO: A duplicate. I'll just, just for the record, Dr. Loomis, is that, does this map represent what's on 236?

LOOMIS: Yes.

DISTASO: Okay.

JUDGE: All right. So J is the same map as 236?

DISTASO: Yes.

JUDGE: All right. And K.

DISTASO: Oh, and K is that the data set for the trip to the Berkeley Marina or the area on January 27th?

LOOMIS: Was this the Golden Gate Fields?

DISTASO: Yeah.

LOOMIS: K was the data for the trip to Golden Gate Fields.

DISTASO: Right. That's what I mean. I think I've been saying Berkeley Marina, but what, we're really talking about an area north of Berkeley Marina, correct?

LOOMIS: Yes.

DISTASO: Okay. I think that covers them all, your Honor.

JUDGE: All right. Mr. Geragos.

DISTASO: Actually, I just have a couple more questions.

JUDGE: Okay. I thought you were done. All right. Go ahead.

DISTASO: The, Dr. Loomis, let me have you look at, we'll just use this one. January 27th, those map, or the photo represented by 236, and the little boxes with numbers, do those correspond to the, to the data set here if you look at, like, starting at 1341 and, and then going to 1364, is that what those little boxes correspond to?

LOOMIS: You know, it's very difficult for me to tell because here on the page I have latitudes and longitudes.

DISTASO: Okay.

LOOMIS: And what I can do is I can say yes, he was going north at a certain speed and that would correspond roughly to the, but I would have to actually look at these myself to see if it

DISTASO: Okay.

LOOMIS: corresponds to this.

DISTASO: No problem. And finally, did you, did you actually take some of the data, or take this data yourself and plot it on your own maps that you have in your office just to confirm that it was accurate?

LOOMIS: Yes, I did.

DISTASO: And did it line up the way that we presented it here today?

LOOMIS: Yes, it did.

DISTASO: Okay. Now I don't have anything further, your Honor.

**Cross Examination by Mark Geragos**

JUDGE: Okay. Mr. Geragos.

GERAGOS: Thank you, your Honor. Good morning. Dr. Loomis, the maps, the data sets that are produced by the GPS give you points; is that correct?

LOOMIS: That’s correct.

GERAGOS: And these points obviously are, show you one, just marked.

JUDGE: You want the 9th?

GERAGOS: For instance, right here, which is

JUDGE: Can you identify it, Mr. Geragos.

GERAGOS: 234C.

JUDGE: 234 C. Okay. That's the map. One nine.

GERAGOS: Now, what we've got here, maybe it's easier with a pointer. And I'll take you up there

LOOMIS: Sure.

GERAGOS: if you want. The, it just looks like there's a series, I guess from this distance it's kind of hard to tell, but it looks, there's a series of points that are plotted onto the map; is that correct?

LOOMIS: That’s correct.

GERAGOS: Okay. And so as you look here, from a distance, at least, on January 9th, we're looking either from Bakersfield, and then up here in the Bay Area, you see what looks like just a general line of where a, a traveling of wherever the unit is, correct?

LOOMIS: Yes.

GERAGOS: Okay. Now, the GPS actually plots every how many seconds do you get a reading?

LOOMIS: The GPS in this device gets a reading every one second. If it, if it doesn't get enough signal, it just will not put out a position at all. It won't try and propagate and guess where it is.

GERAGOS: Now, and specifically here you come down and see, I guess you say it's good data. Notwithstanding when there's a spike or a glitch in the data, you can generally see where the person was, correct?

LOOMIS: Yes.

GERAGOS: Okay. And then specifically here you see that it looks like there's a body of water there? And then I'm going to show you another exhibit that's already been marked. And this was marked as D5Z.

JUDGE: D5Z?

GERAGOS: D5Z. I believe that what this will show is it's a close-up of this area right here. And it looks like you can get a better picture that what actually is happening is somebody is traveling along, gets off, goes over to this reservoir in here, gets back on; is that correct?

LOOMIS: Yes.

GERAGOS: Okay. Are you able to distinguish or tell kind of the direction that someone is going, based upon the GPS?

LOOMIS: Yes, by actually, yes, exactly.

GERAGOS: Okay. So you can get, by plotting the points on here, you can tell what the direction is that they're heading, correct?

LOOMIS: Yes.

GERAGOS: And then, sequentially, as they, as they get plotted on, even if they turn around and go onto the reservoir here, take a look around here and come back, you can determine that also through GPS?

LOOMIS: Yes. And actually how long they dwell at one point.

GERAGOS: All right. You've got the ability to just time their travel, correct?

LOOMIS: Yes.

GERAGOS: And the direction that they're headed?

LOOMIS: Yes.

GERAGOS: Okay. And this is, I assume that looks to be, to you, good data there?

LOOMIS: I, I examined this. This is excellent data here. I wish all my data was this good.

GERAGOS: Okay. And this shows specifically who is going into here, whoever has got the unit, the GPS unit?

LOOMIS: Yes.

GERAGOS: Is going to another reservoir and taking a look over there, and that shows it. That isn't any one of these kind of glitches or anything else?

LOOMIS: Oh, no. This data was extremely consistent, and I examined it in detail even closer than this. It's very good.

GERAGOS: Okay. And when you say "closer than this," on some of these maps here that are enlarged, it looks like 36 is not quite as, I don't think has –

LOOMIS: May I help you?

GERAGOS: Behind this. Yeah. 235A, this was done pretty good in terms of being able to chart out exactly where somebody was on the map, wasn't it?

LOOMIS: Yes.

GERAGOS: Okay. So, for instance, and this is also on January 9th, similar to what we have up there at a reservoir down south, here you've got some, are the yellow and the red dots, by the way, so that the jury understands, is the yellow prior to the red? Is the red prior to the yellow?

LOOMIS: On this particular chart the red are not actually GPS positions. They're just arrows that lead you from one position to another.

GERAGOS: Okay.

LOOMIS: Is that correct? I think they're all triangles.

GERAGOS: Yes, they are. Can you show the jury what the course of travel was on the 9th? We've got a lot of dots here. Are you able to do that?

LOOMIS: Not from this map alone, no.

GERAGOS: Okay. Do you have, does it appear, at least, that whoever is driving this vehicle that's got the GPS on it is driving along here, and at some point is going down, is circling in here, circling around, coming back out, coming over here, circling around the parking lot, coming out to this little point here, and then exiting back out once again?

LOOMIS: Yeah. Let me just correct myself. With the red arrows you can actually tell the direction of travel.

GERAGOS: Yeah. I assume they're pointing in different directions.

LOOMIS: Let me check. So first this GPS receiver did come in this direction. And then circled in this area. And then after that it traveled to the upper end of the map.

GERAGOS: Okay. So, for instance, if somebody is looking for two witnesses who might have seen them there two weeks before

DISTASO: Objection, your Honor, it's argumentative.

GERAGOS: circle the entire parking lot.

JUDGE: Sustained. The jury can disregard.

GERAGOS: If somebody comes into the parking lot and they're looking or they're driving around, this is going to show exactly where they were and what they're looking for? Or where they're driving, at least, correct?

LOOMIS: It will show the position of the car at that time and what time they're there.

GERAGOS: Okay. And then I assume what happens is this map, or this aerial photo, is that a satellite image?

LOOMIS: I, I don't know whether this was a satellite or an airplane image. I assume it was a satellite image. They're commercially available.

GERAGOS: Okay. And then the points that are on there, the yellow dots are the, the data that's in this kind of a run; just so that we understand what we're dealing with here, you get a run that looks like this? And this is B, correct?

LOOMIS: That's what I get. And the columns that I pay attention to are the date and time.

GERAGOS: Right.

LOOMIS: And then the latitudes, which are the numbers that start with 37.

GERAGOS: Right.

LOOMIS: The longitudes, which start with minus 120.

GERAGOS: Okay. You get a date and time here, you get the longitude and latitude there. That produces the little yellow dots that are here?

LOOMIS: Yeah. The satellite image is actually related to latitude and longitude coordinates, so we can plot those points.

GERAGOS: Okay. And then looks to you like, as I indicated, this portion of D5Z appears to be excellent data as you've said, correct?

LOOMIS: Yes.

GERAGOS: Okay. And we've got also, I've got two others, Judge. Just one second.

JUDGE: Got the January 27th data, January 26th?

GERAGOS: No, I marked two others. Marilyn’s got them.

JUDGE: You marked them earlier?

GERAGOS: Yes.

JUDGE: Okay.

GERAGOS: The next two in order that I'm going to mark are D6G and D6H.

JUDGE: All right. D6G and D6H.

GERAGOS: These are, these are maps of GPS data taken on January the 20th.

JUDGE: Both of them, Mr. Geragos?

GERAGOS: Yes. It appears, and Dr. Loomis can correct me if I'm wrong, one is of the entire day, which is D6H. D6G is a close-up of one portion of that day?

LOOMIS: Um, it's, yes, there's a lot of data on one, so I assume it's many hours of driving.

GERAGOS: Right.

LOOMIS: In fact, I know it's many hours of driving, and then there's a close-up there.

GERAGOS: Okay. I'm going to show you D6H, and this is a January 20th, that's the GPS for January 20th? And I'm going to ask you, if you need to step down, you can, does that appear to be good data?

LOOMIS: Again, when I talk about good data, I'm talking about data that's within, you know, things that are a hundred yards off or 200 yards off trigger my, my, my data quality flags. And I really can't tell on this size of map. There's no huge problems with the GPS data here.

GERAGOS: We don't see anything where it's spiking out?

LOOMIS: No.

GERAGOS: Like you talked about down by Fresno where there was a jump here and that. Now, specifically it looks like this area right here, that's that same area that we talked about? That reservoir on the 9th? Do you remember that?

LOOMIS: Yes.

GERAGOS: That was on D5Z. I've got a close-up of that as well I'm going to show you. That's been marked as D6G. Does that appear to at least indicate that the travel is right along here, comes back over to this portion of this reservoir, and then along the outside of the aqueduct itself?

LOOMIS: You know, I can't tell, I can't tell which direction of the travel is just from the map.

GERAGOS: It could be either one direction, but that does appear to plot out and appear to be good data?

LOOMIS: Yes.

GERAGOS: Okay. And specifically you don't see any of these spikes or these areas where the, you hit the longitudinal line?

LOOMIS: No.

GERAGOS: Okay. And specifically the, if I understand correctly, you've looked through or how much of the data in actuality was produced on this system that you have actually looked at?

LOOMIS: Oh, you know, I don't have a count of the number of hours. There were some very long drives over large parts of California. I, I would be guessing between 20 and 40 hours, maybe. But it could be higher. I don't think it's lower than 20.

GERAGOS: Okay. And were you specifically just asked to deal with the data that had to do with these particular dates, the 9th, the 26th and the 27th?

LOOMIS: I looked at all the data that was, I asked for all the data that was given, that was taken from our devices so that I could examine, you know, the quality of the data

GERAGOS: Okay. And in doing that, Mr. Distaso went through those two areas

LOOMIS: Yes.

GERAGOS: where there were these glitches where the cars indicated they go 39,000 miles an hour or 19,000 miles an hour.

LOOMIS: Yes.

GERAGOS: If you throw that out, does that appear, at least to you, if the GPS, even though this is what you call one of the older generation models, did it appear that at least it was functioning

largely intact and correctly?

LOOMIS: Oh, I think it was working quite well.

GERAGOS: Okay. The, specifically, if you wanted, could you plot out on a daily basis exactly what we've done here on the 9th, on the 20th, showing the various areas where the person who had this device in their car was actually going?

LOOMIS: I –

GERAGOS: We've done it here for the, as you've seen the exhibits, we've done it for the 9th, the 20th, the 26th and 27th. Could we do it for everyday that we have this information?

LOOMIS: Oh, yes. That can be put on the maps.

GERAGOS: Okay. And you could find out, as long as you weren't near Fresno in that one area, or by the, the location that we saw on the 9th where there was the little blip as well, we could pretty much plot out and we would know where, where this person was, as long as that vehicle was moving, correct?

LOOMIS: Even when it was stationary.

GERAGOS: Right. When it's stationary, there's also another component to this. That's a motion sensor detector; is that correct?

LOOMIS: Yes. That's not my, that's not my province, so I really can't talk too much about that. I know they're tricky devices.

GERAGOS: Okay. That, that device is at least put in or is combined with your device? I know I'll ask Mr. Roddis that, the specifics of it, but do you understand at least that that is put together with your technology?

LOOMIS: I understand it's bundled, so there's a GPS receiver in this device, there's a motion sensor in this device, there's a cell phone in this device. But they all operate sort of separately.

GERAGOS: And so is it a fair statement that, based upon the data that you've seen, that at any one point, whoever has access to this, which is law enforcement, that they can download, they can find out where the person is, with some exceptions, basically, or where the vehicle is?

LOOMIS: You know, I'm not sure exactly how they use this. Sometimes they're downloaded in real time. You actually track them in real time. Sometimes you wait until the car is stopped and go and just download the files from the car. And I'm not sure how this was used in all cases. I know that in some cases there definitely was real time tracking, so that they did know from minute to minute where the car was, and...

GERAGOS: When you say, if I can break that down. When you say there's real time tracking, you've got a cell phone device?

LOOMIS: Yes.

GERAGOS: The cell phone device is the way that the GPS is able to communicate the data?

LOOMIS: Yes.

GERAGOS: So if somebody says at 4:00 o'clock on January 10th We want to know where it is, they can, from whatever the home or base unit is, they can basically call this unit, correct?

LOOMIS: On some systems you can. I don't, I don't know exactly how the Orion system works.

GERAGOS: Okay. In any case, whether you do it real time or whether you download it later on, you still would get the same information, correct?

LOOMIS: Yes.

GERAGOS: I mean –

LOOMIS: Yes.

GERAGOS: arguably or theoretically or ideally you're going to have that same information?

LOOMIS: That's right.

GERAGOS: Okay. And whether that, and I assume that this information is saved on some kind of, by some kind of method internally, correct?

LOOMIS: It leaves our GPS receiver every second. We don't, we don't keep anything in memory. So if it's saved, it will be saved on the tracking device by Orion.

GERAGOS: Okay. And the tracking device is not in your bailiwick; that's Orion's?

LOOMIS: That’s correct.

GERAGOS: Okay. Now, originally there was a problem, or when this problem showed up about the, these 39 thousand miles per hour, these glitches, Orion came up with one analysis, correct, first, correct?

LOOMIS: I believe that's true, yes.

GERAGOS: Okay. That didn't jive with the analysis that you had; isn't that correct?

LOOMIS: No. And what I did was I actually took the three cases that I had where this occurred and found it occurred in a very, very specific, it was triggered by a very specific instance that was known to be a strange behavior in our receivers, and I communicated to Orion could it be this problem, and that, and they decided to change their analysis.

GERAGOS: Okay.

LOOMIS: I believe.

GERAGOS: Do you remember what their first analysis was of what the problem was?

LOOMIS: No, I, I don't.

GERAGOS: Okay. You do know that after you took a look at it, you realized that what they were attributing the error to was not, in fact, correct? Isn't that a fair statement?

LOOMIS: I, yes, I would say that is. In other words, I would definitely not attribute it to what they were talking originally.

GERAGOS: Okay. As you sit here today you don't remember what it was?

LOOMIS: You know –

GERAGOS: At a certain point there was some letters exchanged, you took a look at them, it didn't make much sense what they were saying out of Orion, you suggest, you wanted to look at the data yourself; is that correct?

LOOMIS: Yes.

GERAGOS: Once you took a look at the data yourself, you realized that what Orion was attributing it to was not an accurate understanding of what was going on with the unit; is that a fair statement?

LOOMIS: Yes.

GERAGOS: Okay. And later on Orion deferred to your analysis; is that right?

LOOMIS: They added to my analysis, as a matter of fact. Saying that this, that this five foot twelve problem that I described could actually trigger this in their system and it was a known problem.

GERAGOS: Okay. The, specific mapping portion of this that we've seen today, is that something that you're involved in? Or is that –

LOOMIS: No.

GERAGOS: That has nothing to do with your unit?

LOOMIS: No.

GERAGOS: Your unit basically is just a GPS device that you sell to people like Orion or to automobile manufacturers?

LOOMIS: Yes, that's correct.

GERAGOS: Okay. As far as using it for the mapping or anything else, that's not where your, where your area of expertise is?

LOOMIS: No.

GERAGOS: Okay. Yours is in analyzing the data, making sure that when you see, when we see these points, that the points are, accurately reflect this little laundry list of latitude and longitudinal points?

LOOMIS: That’s correct.

GERAGOS: Okay. Thank you. I have no further questions.

**Redirect Examination by Rick Distaso**

DISTASO: A couple questions.

JUDGE: Redirect?

DISTASO: Just a few. Dr. Loomis, did you, did you determine the location in Modesto that was causing these, these jumps?

LOOMIS: It was, it was right on a longitude line, and all of these jumps started on that longitude line.

DISTASO: Do you remember what the exact location was? Or did you know that?

LOOMIS: I, I've been told what the location was, yes, but I,

DISTASO: What was that?

LOOMIS: I've been told that it was,

GERAGOS: There's an objection,

JUDGE: Hearsay. Sustained.

GERAGOS: as to what he was told, unless,

DISTASO: Well, he can rely on hearsay, Judge. He's an expert.

JUDGE: Well, if he relied on it in forming his opinion.

DISTASO: Well, that's true.

JUDGE: In coming to his opinion.

DISTASO: Did, did, did that impact your, does it matter where it was,

LOOMIS: No, it does not.

DISTASO: Okay. That it would do it.

JUDGE: All right. Any re-cross, Mr. Geragos?

GERAGOS: No.

JUDGE: Okay. Dr. Loomis, thank you very much.