IN THE COMPETITION Case No. 1280/3/3/17

APPEAL TRIBUNAL 28 June 2018

Victoria House,

Bloomsbury Place,

London WC1A 2EB

Before:

THE HON. MR. JUSTICE MANN

(President)

DR CLIVE ELPHICK

ANNA WALKER CB

(Sitting as a Tribunal in England and Wales)

BETWEEN:

VIASAT UK LTD AND VIASAT, INC Appellants

- and -

OFFICE OF COMMUNICATIONS Respondent

-supported by-

INMARSAT VENTURES LIMITED Intervener

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HEARING

A P P E A R AN C E S

Michael Bowsher QC, Fiona Banks and Khatija Hafesji (all of Monkton Chambers) appeared on behalf of the Appellant .

Josh Homes QC, Julianne Kerr Morrison appeared on behalf of the Respondent.

Tim Ward QC and Anneli Howard (both of Monkton Chambers) appeared on behalf of the Intervener

Thursday, 28 June 2018

(10.00 am)

Housekeeping

THE CHAIRMAN: Mr. Holmes, two bits of housekeeping. Since we have started earlier and are going on for longer, we will have a slightly longer break halfway through the morning, I think about 11.30 would be appropriate.

Secondly, just so that -- and because time is limited for cross-examination and so that we can keep an eye on the relevance and purpose and direction of cross-examination, I am going to ask you and each of your brethren before each witness now, and at this point with this witness, to indicate the areas in which you are going to be cross-examining.

MR. HOLMES: Yes, sir.

THE CHAIRMAN: So we know, just to make sure that they are going to be fruitful areas for us so we can keep the thing within bounds.

If any of you would like that to be done in the absence of the witness in question, because you might be concerned you would be flagging up something you do not want to have flagged up before the witness, then I am content for that to be done in the absence of the witness in question. I doubt if that is this sort of case, but if any of you want that, I am certainly

prepared to accede to an application that the witness leave the room for the one minute while we are being told about the areas.

MR. HOLMES: For my part I am very happy to discuss my road map with Dr. Webb and it may even assist in the course of cross-examination. There are two main topics.

THE CHAIRMAN: Just give me a moment. (Pause).

Yes.

MR. HOLMES: The first topic is the contribution to coverage that the satellite component of Inmarsat's European Aviation Network can deliver.

THE CHAIRMAN: Yes.

MR. HOLMES: And the second is the capacity that the Inmarsat aviation network will need to provide and is capable of providing.

That is it. Those are the two topics. As I touched upon yesterday, I was not proposing to rehearse the purpose of the legislation or the meaning of it, those being matters for the tribunal.

THE CHAIRMAN: Yes. Good, thank you. That is helpful.

Where is Dr. Webb?

Would you come forward, please.

MR. HOLMES: Is your intention to go along the line, sir, in terms of areas of cross-examination?

THE CHAIRMAN: No, I will ask everybody before they

cross-examine.

MR. HOLMES: Understood, sir. Yes.

DR. WILLIAM WEBB (Continued)

Cross-examination by MR. HOLMES (Continued)

MR. HOLMES: Good morning, welcome back.

THE CHAIRMAN: Dr. Webb, you have taken some paperwork into the witness box with you; what is that?

A. It is just some short notes to remind myself of the names of the key players here and some numbers in case I am asked about particular calculations.

THE CHAIRMAN: Would you rather the witness did not have those, Mr. Holmes?

MR. HOLMES: I think it will be fine. I do not want to hamper him.

You may be able to find the figures in your reports in any event and it would probably be sensible at the outset if Dr. Webb were given bundle D, containing his two reports.

THE CHAIRMAN: I think it will be obvious when Dr. Webb is referring to his piece of paper and if you have concerns about it, it can be dealt with.

MR. HOLMES: Indeed, sir, yes.

So you begin your first report with a helpful general introduction to some of the issues involved in designing any wireless network, and I would like to

start briefly there. You say that:

"The key challenge for all wireless systems is to ensure that the radio transmissions can be received sufficiently well to meet the usage requirements of the end user for the particular application at issue."

That is at paragraph 7 of your first report.

A. Yes.

Q. Do you recall that?

A. Yes.

Q. And that is your view. One aspect of this challenge is ensuring that the system has the coverage required to reach the end user at their location; would you agree?

A. Yes.

Q. And that is a question of how wide, among other matters, the signal propagates?

A. Yes.

Q. And you refer to this as the coverage requirements of the network?

A. Yes.

Q. And you explain that satellites can achieve particularly broad coverage and that a geostationary satellite, like Inmarsat's, can cover up to a third of the world's surface.

A. Yes.

Q. Another aspect of the challenge is ensuring that enough

data is available to the end user for the service they are seeking to use, in other words, the system has sufficient capacity; is that right?

A. Yes, that is right.

Q. And you explain that capacity can be measured in terms of the data rate which identifies the volume of data that can be carried over a given period of time; is that right?

A. I think I would add a bit more detail to that. It is the combination of the data rate and the amount of data consumed that adds to the capacity.

Q. Absolutely. Just to -- there are a few ways in which that can be measured, a few different measures, but if only for my benefit, because I have a tremendous capacity to get confused about this, they all measure the number of bits, or bytes, per a given unit of time?

A. Yes.

Q. One bit is one binary unit of data, a 1 or a 0?

A. That is correct.

Q. And 1 Kbit/s means 1,000 bits per second?

A. Yes.

Q. 1 Mbit/s is a million bits per second?

A. Yes.

Q. And 1 Gbit/s is a billion bits per second, or a 1,000 Mbits/s?

A. Yes.
Q. Very helpful. Thank you. Now in meeting the capacity and coverage requirements of the system you would agree that there are various design choices to be made by the engineering team, would you?
A. Yes.
Q. So, for example, in configuring a mobile network you need to decide how big the cell is by adjusting the power and the height of the antennae on the mast, for example?
A. That is correct, yes.
Q. And that will affect how much capacity is available within the cell and also how wide the cell extends?
A. Yes, in principle. The key design criteria is actually the number of cells. Each cell has a specific capacity, so by making a cell smaller, you enable more cells to be deployed and therefore add more to the capacity.
Q. Yes, very helpful. There will also be commercial choices about what is the best value way of getting end users what they want?
A. Yes.
Q. Now in paragraph 7 of your first report you observe that usage requirements change over time and as they do so the requirements of the system will also change. That is a fair summary?

A. Yes.
Q. And just turning to paragraph 7, you observe in the second sentence as an example that:
"... before the widespread adoption of the smartphone, wireless mobile phone networks were primarily optimised and designed to ensure users could place telephone calls with certain quality (ie, without too much interference or too many dropped calls)."
In terms of the taxonomy that you provided yesterday --
A. Yes.
Q. -- is this referring to the engineering meaning of quality that you posited, namely signal-to-noise ratio or signal distortion, or are you talking about the quality of service, or is it both of those things?
A. I think in this case it corresponds to the technical quality, and so the bracketed paragraph talks about interference and dropped calls, and interference is one example of the measure I talked about yesterday, the signal-to-noise ratio which looks at the quality of the signal compared to the overall noise or interference level.
A dropped call will typically occur if the temporal quality of the radio channel became too low for the apparatus, the phone, the handset, to maintain a call of

that particular quality.

Q. And you go on to explain that:

"Since the advent of smartphones, mobile networks must now be designed not only to optimise call quality but also to service additional end user requirements, such as the desire to stream music and videos."

Is that right?

A. Yes.

Q. And that:

"... a wireless network will therefore likely have a minimum data rate and a minimum capacity that is required to enable users to undertake desired activities, such as placing a video call."

A. Yes.

Q. And would you regard these new qualitative indicators based on capacity as engineering measures or as quality of service measures?

A. I think they are both in that you need to engineer the network to deliver the extra capacity needed for these particular services. But also there is always an issue of quality of service. The end user experiences a certain quality of service and that always needs to be sufficiently high for the service in mind and for the end user's applications.

Q. And the quality of service depends partly on the

capacity that is available at the end user's location?

A. Yes.

Q. Thank you.

Turning, then, to Inmarsat's system. Can I first check that we agree on the general architecture of the system? I think that we do, but I want to make sure. The network obviously uses two methods of transmission to communicate with the aircraft: first, the wireless connection with the geostationary satellite, and second, the wireless connection with ground stations; that is right, is it not?

A. Yes, that is right.

Q. And based on your understanding of the system architecture, it is correct to say that the connection to a given aircraft can be switched between these two wireless elements during the course of a flight?

A. Yes, that is what I understand.

Q. And your understanding is also that the choice of which wireless connection to use is centrally controlled by a routing engine on the ground?

A. Yes, that is correct.

Q. Thank you. So turning to the coverage of the EAN and how the EAN achieves its coverage, you discussed this in more depth in your second report, beginning at paragraph 37. Could we quickly turn to that?

A. Yes.
Q. You say at paragraph 38 that:
"It is true that there may be some occasions when planes move out of terrestrial coverage ..."
Now pausing there, terrestrial coverage means the coverage of the ground stations.
A. Correct.
Q. "... but remained within the coverage region of a satellite, and so by utilising a satellite can remain connected."
A. Yes.
Q. Now, you do accept, do you not, that there will be some occasions when planes move out of terrestrial coverage but remain within the coverage regions of the satellite?
A. Yes, I do accept that.
Q. And that is illustrated by the quantitative evidence that you rely upon in the second report?
A. Yes. And that sets out an estimate of the percentage of time that that might occur. I think it was in the region of 6 to 8 per cent, depending on particular assumptions.
Q. Yes. If we may, I would like to look at it. It was originally exhibited to the witness statement of Mr. Brice Dorman of Viasat, but it is now to be found in bundle E3 at tab 114.

You obviously rely on the quantitative analysis so it would be fair to say you are well familiar with it?

A. I would say I am reasonably familiar with it; I did not carry it out myself.

Q. No, no, you did not carry it out yourself. Did you discuss the methodology with Mr. Dorman before the analysis was conducted?

A. Yes, I did.

Q. If we turn to the second page, in the lower half of page 2 there is a map and the green area shows the total satellite coverage, or footprint, as it is often referred to; is that right?

A. Yes, that is right.

Q. And over the following two pages, Mr. Dorman shows three further versions of the same map, now zoomed in on Europe, and he has superimposed the European Aviation Network ground station coverage, shown in brown; is that right?

A. Yes, that is right.

Q. And the maps apply differing so-called buffer zones around the land areas of 50 kilometres, 100 kilometres and 150 kilometres respectively; is that correct?

A. Yes, that's correct.

Q. And that explains why the maps progressively cover larger areas of coastal space around the countries in

mainland Europe?

A. Yes, that is correct.

Q. And that is to model the fact that ground stations situated near the coast will achieve some coverage extending out to sea, but it is not clear exactly how much; is that right?

A. That is right. It was not clear to us exactly how far that might extend. The documentation that we had from Inmarsat suggested that a maximum range of 150 kilometres could be achieved, but we were not sure that that maximum range would be applied in all cases so we modelled a range of scenarios.

Q. Yes, and the 150 kilometres is the range from the ground station?

A. Yes.

Q. So in determining the extent to which the coastal area at sea will be covered, one needs to know how close or how far the terminal is from the coast?

A. The ground station from the coast, yes.

Q. It would need to be right on the coast to achieve the full 150 kilometres of coverage that is possible?

A. That is correct, yes.

Q. And we do not know exactly what the power of each ground station would be in any event?

A. No.

Q. Therefore we do not know if it would cover the full 150K?

A. Correct.

Q. Therefore very reasonably you have considered various scenarios with differing extents.

Looking at the widest possible ground station coverage shown in 4, you accept, do you not, that the satellite coverage will be needed for flights because the spaces between countries show a number of green areas which are only within the coverage of the satellite but not within the coverage of the terrestrial ground stations?

A. Yes, so I certainly accept that at that point the aircraft would be out of the coverage of the ground stations. Whether the satellite component is needed depends on the service that is being offered to the end users and whether that service is sold as being continuous or not, but at that point in time certainly the only way for the plane to be connected would be to the satellite.

Q. That is helpful, and I will come back to continuity of service, so do not worry, that point is on my critical path, as they say.

Taking the widest coverage, then, and looking at that map, aircraft travelling from mainland Europe or the

UK to the Scandinavian states may cover the North Sea, as may flights from the UK to the Netherlands, and they may be out of scope of the ground stations there?

A. Yes.

Q. In the Baltic, similarly, planes travelling across the Baltic. Across the Balkans, in the Bay of Biscay, which has been mentioned a few times?

A. Mm-hm.

Q. In large swathes of the Mediterranean, the Bay of Naples, the Balearic Sea, the Ionian Sea to the east of Sicily, the seas around Cyprus and Crete and when travelling from mainland Europe to the Canaries; is that a fair summary?

A. Yes, that is a fair summary.

Q. So whichever of the buffer zones is assumed, there will still be a number of areas which are within the coverage of the satellite but outside the coverage of the ground stations?

A. Yes, that is correct.

Q. And in all those areas you have no reason to dispute the proposition that planes will be outside terrestrial coverage, as we have agreed?

A. Yes, that is correct, yes.

Q. Yes. The quantitative analysis you rely on is then compiled, in very crude summary, tell me if I get this

wrong or it is too high level, by looking at flight data concerning flights within the EEA and flights across the Mediterranean basin, from the EEA to North Africa, and the analysis works out what percentage of aircraft, taking all those routes into account, fly over the satellite-only area for some of the flight, and how much flying time is spent over the satellite-only area; is that broadly right?

A. Yes, that is correct.

Q. And there is an EEA and a UK-only variant --

A. Yes.

Q. -- which either looks at flights in which one of the airports is a UK airport or all of the flights across the EEA, regardless of the point of departure or arrival?

A. Yes, that is correct.

Q. And the aim is to see how big a contribution the satellite could, in principle, make to the coverage of the EAN system; is that fair?

A. Yes, I think it was to understand in more detail the point that was made by other experts that there will be times when the planes are outside of the coverage of the ground component and to understand the extent to which that would happen.

Q. To quantify it.

A. To quantify it, yes.
Q. To quantify the contribution to coverage?
A. Yes.
Q. Could we consider the results of the analysis, which are shown on pages 10 and 11 of the report. Starting with the table on page 10, this shows that on the largest possible 150-kilometre buffer assumption, just under a third of all flights analysed, that is to say 30.7 per cent, would utilise the satellite-only region for some portion of the flight; is that correct?
A. Yes, that is correct.
Q. And 30.7 per cent of all flights, assuming all subscribe to Inmarsat's network, would be dependent on coverage from the satellite alone for some portion of their journey?
A. Yes.
Q. And for that third of flights, the portion of flight time when they would be dependent on the satellite amounts on average to 20.6 per cent, or a fifth of the time in the air?
A. Yes.
Q. And that is presumably during a period at or near cruising altitude, given the distance from the coast, when customers are relaxing and looking for something to do in the cabin?

A. I would guess so, yes.
Q. Yes. The aggregate time spent in the satellite-only region, averaged across all flights, including those that do not touch the satellite-only regions at all, is 8.9 per cent of all flight time?
A. Yes.
Q. So all of the minutes spent in the air by all of the flights, 9 per cent of them will be in the satellite area?
A. Yes.
Q. That is, as we have said, on the most extreme assumption. If ground stations were a little bit further from the coast, or the transmission power level was lower than 150 kilometres, or the reach of the ground station was affected by climatic conditions, for example, one need to moderate that assumption of 150 kilometres downwards?
A. Correct.
Q. And the 100-kilometre assumption, you see that nearly half of all flights use the S-band-only region, the satellite-only region for a portion of the flight; that is right, is it not?
A. Yes.
Q. 12.3 per cent of total flight time, all of the flight minutes on all of the flights in Europe would be spent

in the satellite-only region?

A. Yes, that is correct.

THE CHAIRMAN: Mr. Holmes, can I lay down some groundwork for you and your brethren in cross-examination. I tend to ask questions when they occur to me rather than saving them until the end. I do not interrupt gratuitously, but I am going to ask a question now. If at any time I ask a question or any of my colleagues ask a question which is going to tread on your cross-examination toes, you may ask us politely to wait for the question and we will. If we can reach that understanding, it helps things to go smoothly.

MR. HOLMES: I am grateful.

THE CHAIRMAN: I just want to ask the witness this question, I do not think I am going to tread on your toes, but you can tell me if I am right.

Dr. Webb, why is the word "touch" used in the heading of the third column of that table as an alternative. Were you coming to that?

MR. HOLMES: No, it is a helpful question, sir, because it is not clear to me. I think we have agreed in evidence that what is meant is "use", but the "touch" I was curious about as well, and it is not clear to me.

Do you know?

A. I do not know, sorry.

THE CHAIRMAN: It suggests something less than "utilise", I mean, just go round the edge and hardly bother with. It almost seems to qualify "utilise", but is it your understanding we should really put a line through that and "utilise" means "utilise".

A. That is my understanding, sir.

THE CHAIRMAN: That is how we should view this table?

A. Yes.

THE CHAIRMAN: I will put a line through it then.

MR. HOLMES: That is very helpful, sir.

Now, just to pick up a small point, and this is really just by way of -- correction is the wrong word, but just in view of a subsequent development, whether you have any reason not to adjust your evidence on a particular point, at paragraph 41 of your second report, turning over the page, I think we are in the second report at the moment, so just turn to page 14.

A. Yes.

Q. You say that flights to the Canary Islands cannot be covered in their entirety by the European air network satellite based on an indicative figure in Mr. Sharkey's first statement; is that right?

A. Yes.

Q. You have seen that in Mr. Sharkey's second statement he explains that Inmarsat has successfully tested satellite

connectivity in-flight via the satellite as far as the Canary Islands, and you have no reason to dispute that factual statement or to accept that in light of it the point you make in that paragraph does not apply?

A. Correct, I have no reason to dispute that.

Q. Could we look at paragraph 42 of your second report, this is coming to the continuous point I think you touched on a moment ago.

A. Okay.

Q. You say there that:

"The fact that contiguous coverage across all flight paths is not considered important by airlines can be seen from the approach taken by some airlines as set out in the confidential text in paragraph 42."

That is right, is it not?

A. Yes, that is right.

Q. Just to clarify, contiguous is not a term that -- I must admit I was reaching for the dictionary, by "contiguous" coverage, you mean coverage and therefore the possibility of an uninterrupted service throughout the course of the flight; is that right?

A. Yes, I think I use the word in the same way as "continuous" or "uninterrupted".

THE CHAIRMAN: So we could use "continuous" and be less confused?

A. I could. Sorry, sir.

MR. HOLMES: Now, beginning with the preferences of the airlines, you have not yourself made any study to establish their degree of interest in a continuous coverage service; is that correct?

A. That is correct.

Q. And you have seen no evidence to suggest that all airlines would want a product without full coverage; is that right?

A. That is correct.

Q. And you have seen from the evidence of fact, and heard it -- I know -- sorry, you have been in court throughout the proceedings, have you not, Dr. Webb?

A. I have.

Q. You have heard that Inmarsat is not offering a product which is confined to the terrestrial network, and you have heard also that Ofcom would not allow it to do so?

A. Yes, I have heard that.

THE CHAIRMAN: I do not think we have heard the latter. We have heard that they might take steps. We do not know what they would be, if the satellite terminals were not installed. Has it gone further than that?

MR. HOLMES: I believe it has, sir, but I am happy to traverse that territory in submission. It is probably more appropriate. I can show you the reference.

Turning for a moment to the views of end users, would you accept that some end users will value consistency of service throughout the flight?

A. I would accept that, yes.

Q. Yes. And so for someone sending a time-sensitive e-mail or message, a continuous connection would enhance the quality of the product.

A. Yes.

Q. You exhibit and rely upon a report from LSE called Sky High Economics?

A. Yes.

Q. And we can find that in bundle E3 at tab 96. Looking at the first page you see from the cover that this is chapter 1, which is about:

"Quantifying the commercial opportunities of passenger connectivity for the global airline industry."

And it is by a Dr. Alexander Grous in the department of media and communications, and it is published in association with the intervener, Inmarsat, but that has not put you off relying on it. I just note that for fairness, that Inmarsat was obviously involved in the production of it, as, no doubt, you did as well.

A. Yes.

Q. If you turn to page 11 -- I am afraid the text is in teeny-tiny writing, so I hope your eyesight is a lot

better than mine.

A. It is adequate, thank you.

Q. You see beneath the figure in the left-hand column the statement that:

"Quality appears to be the most significant enabler, with passengers indicating a preference for a number of related attributes."

The first being:

"A service with seamless connectivity across large areas."

Now, pausing there, that I understand to be a reference to continuity of service. Does that sound right to you?

A. Yes, that sounds correct to me.

Q. And the third is:

"A lack of persistent drop-outs of connectivity."

Do you see that?

A. I see that, yes.

Q. So taking those points together, does that not suggest that for many end users, continuous service is an important characteristic?

A. Yes, I think that is correct.

Q. Thank you.

Now, as well as the satellite-only areas, you do accept, I think, that the satellite could be used to

provide a connection to planes travelling over mainland Europe if a ground station were offline because it failed?

A. Yes, subject to the satellite having sufficient capacity to do that.

Q. Yes. Indeed, and I fully accept that we need to debate capacity. I am taking coverage first, but we will come to capacity and we will see how the two marry up.

Your point, I think, about the risk of failure is that there are back-ups which could be provided on the ground, depending on the design choices made by -- in implementing the ground-based stations; is that right?

A. That is right, yes, so there are a number of things that could fail, they could be duplicated or protected in various ways to reduce the probability of that failure occurring.

Q. That would reduce the risk of failure but not entirely eliminate it?

A. Correct.

Q. Subject to providing sufficient capacity, can we agree that Inmarsat's satellite can make a useful contribution in terms of the coverage which it is able to provide?

A. Yes, I agree that the satellite can enhance the coverage of the ground network.

Q. So turning, then, to capacity.

THE CHAIRMAN: Can we be clear, the question was not whether it can enhance the coverage, but it can enhance the coverage in the event of a failure of a ground station. That is the essence of the question.

MR. HOLMES: Sir, I fear that I was not sufficiently clear. My intention was in view of -- to conclude that line of questioning, to say that the satellite -- to put it to the witness that the satellite could usefully contribute to the coverage achieved by the EAN, the European Aviation Network, both in the event of a failure of a particular ground station, but also in all of the areas that we saw on the map in which flights would be passing over satellite-only space.

THE CHAIRMAN: That was your question was it.

MR. HOLMES: I took it too quickly. I am grateful to you.

THE CHAIRMAN: You may not have done; I may have misheard your question, Mr. Holmes.

A. That was what I understood by your question.

THE CHAIRMAN: Right, well you have obviously understood each other perfectly.

MR. HOLMES: It is very helpful to have it clear on the transcript.

Now, your analysis of capacity, it is fair to say that is really the meat of your analysis. We are coming now to the meat, are we not, with the capacity analysis?

A. Yes.
Q. If you turn to page 37 of your first report, that is where your analysis starts.
A. Yes.
Q. And you have done two -- there are two broad limbs to your analysis, the relative capacity analysis in section D -- part 5, section D -- and then the required capacity analysis in part 5, section E; have I rightly understood?
A. Yes, that is correct.
Q. Beginning with the first of these, the relative -- this considers the relative contribution, the proportionate ratio, made by the satellite on the one hand, and the terrestrial elements on the other to the overall capacity of the European Aviation Network; is that right?
A. That is right, yes.
Q. And what you have done is to estimate the maximum data rate that can be achieved by the satellite and the ground stations?
A. So not data rate; data volume.
Q. Data volume. I apologise. That is a helpful clarification. Yes, indeed, data volume. Data volume measured across time?
A. Correct.

Q. Yes. That is on the assumption that the ground -- just to be absolutely clear, that the ground stations and the satellite are all being used simultaneously at their highest possible capacity, firing on full cylinders, so to speak?

A. The capacity itself is just an absolute number. It is the maximum capacity delivered by the system.

Q. Capable of being delivered by the system?

A. Yes.

Q. It is not the capacity that would actually be delivered by the system at a given moment in time, depending upon the needs of users?

A. Correct. As users' needs change and as the number of flights grows and decreases the capacity demanded from the system will of course rise and fall.

Q. There is agreement between you and Ofcom's technical witness, Dr. Harrison, that the satellite is capable of yielding somewhere in the region of 42.1 Mbits/s; is that right?

A. That is right, yes.

Q. And that figure is shown in the top of the third column of table 4 on page 37 of your report, where you report the results of the relative capacity analysis?

A. Yes.

Q. And that is 42.1 million bits/s?

A. Correct.
Q. Yes. Your estimation of the ground station's combined throughput, if you added together their maximum notional capacity, is 34,268 Mbits/s, that is 34 billion bits/s or around 34,000 Gbits/s?
A. Yes.
Q. If you turn to page 47 of your first report -- I am so sorry, that is a wrong reference. If you turn to paragraph 47, I beg your pardon, of your first report, the relative capacity analysis we have just considered is the basis for your statement at the end of that paragraph that the ground stations provide around 99.9 per cent of the overall network capacity; is that correct?
A. That is correct.
Q. And that is the metric which you cite there in support of the conclusion that the satellite segment of the network serves essentially no function whatsoever; is that correct?
A. Yes, that is correct.
Q. Just to be clear, that is not to detract from the useful contribution which a satellite could make to coverage, as we have established?
A. Correct.
Q. We have established that your relative capacity

calculation is based on the notional maximum throughput, but could I ask you to turn to Mr. Sharkey's first statement, which is at bundle D/4 --

A. Yes.

Q. -- and review paragraph 71 of the statement, in particular the final sentence.

A. Yes.

Q. So you accept that in practice, ground stations will not all be used simultaneously at full capacity, do you?

A. I think that is probable, but equally I would say not necessarily all the satellite either.

Q. Instead they will often be used at lower capacity or will be on stand-by waiting to be deployed when needed as aircraft travel above them?

A. That is difficult for me to determine with any precision. If I were designing such a ground network I would try and match the deployment of the ground resources to the demand. The demand in this case is well understood, it is the flight pattern and therefore could predict it in the future, and therefore I would have designed the network such that the ground stations were predominantly used for most of the time and those sort of situations were rare.

Q. But Mr. Sharkey in his second statement explains the difficulty which arises with that suggestion, which you

make at paragraph 35 of your second report. So if you could turn to Mr. Sharkey's second statement at tab 7 of the bundle and look at paragraphs 30 to 31. Your point is the one, I think, in the final sentence of paragraph 30, is it not?

A. Yes.

Q. He says that:

"This misunderstands how the network operates and how demand changes during the day. Traffic hot spots change diurnally during the day and Inmarsat obviously does not intend to relocate the CGC base stations during the day as the flight patterns change since the base stations are fixed. Air traffic patterns also change with the weather. Hot spots on one day may be different to the next. This dictates that at any instance, a large number of base stations will be lightly loaded and thus any estimate of achievable capacity based on maximum equal loading is misleading. Capacity demand is also to a certain extent unpredictable since user preferences and aggregate demand volumes may evolve depending on factors that are outside Inmarsat's reasonable control."

Now, I do not expect you to comment on the factual assumptions underlying what Mr. Sharkey says there, but would you agree from your experience and knowledge of

designing networks that a problem might arise as a result of unpredictability of demand, as a result of which one would need to have more base stations to ensure that all of the usage requirements of the system were met, to use your phrase?

A. I would agree such problems can occur, but they are unusual. If you look at, for example, the standard cellular system, the usage patterns are generally very well understood and predictable. It is only if some particularly unusual event occurs, such as an atrocity or a particular sporting event, that unexpected peaks in demand can happen.

Q. But Mr. Sharkey is here positing as a factual question that the considerations applicable to an aeronautical system are different because demand is lumpier and less predictable?

A. I would have thought demand was more predictable, frankly, given that the times of planes are known well in advance, in fact, many months in advance.

Q. But his point is that the routes of planes are not known in advance. You do not have any reason -- I mean, I am debating the facts with you --

A. Yes.

Q. -- you do not have any reason to dissent from that?

A. I am not an expert in air traffic patterns.

Q. No. Thank you.

Your other capacity analysis begins at section E of your first report. If we could return to that. It is on page 37.

A. Yes.

Q. Now, I will need to debate the detail of it with you but can I first just consider the results of it at paragraph 114 in the accompanying table 5.

A. Yes.

Q. Can we just look at the per region Mbits/s requirement which you estimate for the EU-28 at the bottom of the far-right column?

A. Yes.

Q. So this is the overall required capacity that you think a system serving all aircraft across Europe would need; is that right?

A. That is right, yes.

Q. You have two estimates: a low usage scenario and a high usage scenario?

A. Yes.

Q. And on the upper band estimate, the higher usage scenario, the EAN would only be using 17.3 Mbits/s, or 17.3 Gbits/s in total?

A. Yes, I think you actually misstated that, 17,000 Mbits/s or 17 Gbits/s.

Q. Yes. Thank you. That is around half of the notional maximum capacity of the EAN which you used to derive the 99.9 per cent figure; that is right, is it not?

A. That is right, yes.

Q. So to pick up a point that was raised by the Chairman yesterday, I think you agreed with him that the 0.1 per cent statistic given in paragraph 115 derived from your relative capacity and not your required capacity analysis, the one we have been considering, the total capacity analysis; is that right?

A. Correct.

Q. So there is a slight glitch in the text there, which I think the Chairman may have apprehended:

"Given the actual data usage expected in the European aviation market currently it can be seen that the satellite segment of the EAN is nearly useless, providing around 0.01 per cent of the high-load scenario."

It is not, in fact, the high-load scenario, is it? It would still be a very low figure, I accept, on your high-load scenario but the 0.1 per cent actually derives from your total capacity analysis; is that right?

A. That is correct. So it would actually be about 0.2 per cent in this case.

Q. Indeed. Thank you.

1 And on the low-load scenario the data use is
2 1.2 Gbits/s, which is a very small share, around
3 3.5 per cent of your maximum capacity analysis?
4 A. Yes.
5 Q. Let us turn, then, to consider the required capacity
6 analysis. So this is a calculation of what a system
7 will actually need by way of capacity; is that a fair
8 summary?
9 A. Yes.
10 Q. And you fairly recognise at the outset of this analysis
11 that while we can estimate the number of passengers in
12 the air with some precision at any one time --
13 A. Yes.
14 Q. -- the data requirements per passenger are far less
15 certain. That is at paragraph 111 of your first report;
16 that is right, is it not?
17 A. That is right, yes.
18 Q. That is why you have an upper band and a lower band
19 estimate, presumably --
20 A. Yes.
21 Q. -- to take account of those uncertainties.
22 A. Yes.
23 Q. Just to consider the uncertainties for a moment, you
24 accept that the demand will depend on whether the
25 service is offered for no additional charge to

passengers or whether, instead, they are required to pay for the service?

A. Yes.

Q. There might also be differences depending on how they are charged, whether it is a flat rate or whether it depends on the amount of data which they consume?

A. Yes.

Q. If it is the latter they might be rather more careful about the activities that they indulge in?

A. Indeed.

Q. Service providers can also manage usage in other ways as you point out by limiting the services that can be accessed or cutting the available bandwidth to each device, which you refer to as "throttling back" the maximum speed?

A. Yes.

Q. The services being accessed can also manage their capacity to be within that available, would you agree, so that, for example, a video service may have a variable bit rate facility so that if there is lots of capacity it will broadcast at a high definition, and if there is less data available, there is a slower connection available, less capacity available, it will reduce the definition of the video being transmitted?

A. Yes. Possibly. There is certainly the capability for

a number of different video services to adapt the video quality according to the data rate experienced by the device. That would depend on the particular service, for example, whether it was Netflix or others, and it would depend exactly how it interacted with the in-flight system, but yes, in principle that is possible.

Q. Thank you. Looking at this from the perspective of the passenger, the factual evidence which you have considered also suggests that their desire to use their devices may depend on the length of the flight?

A. Yes.

Q. They may be prepared to do without their devices for an hour or two between take-off and landing on short haul flights, which are the norm in Europe?

A. That I do not have evidence of. I think it is just dependent on the length of flight, but whether they are prepared to do without altogether I am unsure.

Q. The use they make of the service will also depend on the quality of the service at any given time. If the data rate is lower, they will use messaging apps or make video calls rather than streaming video. Make voice calls, I meant, I am sorry.

A. In that case I would tend to use the words "data rate" rather than "quality".

Q. Thank you. In this connection it is fair to say that European consumers still have relatively limited experience of being able to use their devices at 36,000 feet. I can say I have never been on a flight where internet connectivity is available within Europe. I am giving evidence from the Bar here, but is that ...?

A. I am afraid I do not fly enough to be able to make a comment on it.

THE CHAIRMAN: Do you want us to take judicial notice of this?

MR. HOLMES: The tribunal will, of course, have its own experience of these matters. I withdraw the question, sir. On reflection it was probably not the right question.

Airlines can also manage expectations by focusing on messaging and browsing rather than video streaming. We saw some factual materials, some advertising materials, during the course of Inmarsat's opening which shows that that is what it does with its L-band service; do you accept that as well?

A. I have seen that material, yes.

Q. Another consideration is what alternative ways are available for bored customers to stream videos, would you say that? Or to watch videos, watch video content?

A. Yes, there are alternatives.

Q. Yes. So, again, the quantitative data, which we will come to, shows that having a seatback display reduces the propensity of customers to take an internet -- to buy an internet connection, or to use an internet connection?
A. Yes.
Q. Because they have enough entertainment on-tap?
A. Yes, that does appear to be the evidence.
Q. You have seen that Inmarsat's system proposes to incorporate video content which is stored on board, or cached locally, to use the jargon?
A. Well, there have been some references which I have been unable to fully able to understand which hint perhaps to that direction but I have very little understanding of exactly what is proposed there.
Q. That could provide an in-flight entertainment service without the need for a seatback through streaming locally-stored content to users' devices. That is technically possible?
A. It is technically possible but it would result in a much, much reduced range of choice, to essentially the movies or the content that was pre-stored on the aircraft as opposed to being able to choose anything that they wished to watch.
Q. So rather like a seatback, they are confined to, say,

a library of 1,000 films, rather than the full panoply of content available on YouTube?

A. They are certainly confined to whatever is on the aeroplane. I do not recall thousands of films on the aeroplanes I travel on. Maybe I travel on the wrong airlines.

Q. With those caveats in place, can we consider your usage estimates in more detail and the conclusions are given at paragraph 114 of your first report. Now, as set out in the table you have used two scenarios, one low and one high, and working back from the end column, the end column is the total Mbits/s requirement for the EU-28 and the UK respectively?

A. Yes.

Q. And you have derived those regional figures by multiplying your per plane estimate in the previous column by the average number of flights which are in the air at any one time; is that right?

A. Yes.

Q. And the UK figure is for the average number of flights above the UK, which you have estimated at 110.

A. Yes.

Q. And the EU figure is for the number of flights above the EEA, which you have estimated at 550 flights at any one time?

A. Yes.
Q. So by simple arithmetic, if you multiply the per plane estimate by those figures you get the per region figures?
A. Yes.
Q. So your total required capacity estimate, which you have measured the EAN system against, models the data capacity that might be needed to serve the entirety of the average air traffic across Europe?
A. Yes.
Q. You are assuming a world in which the short haul fleet of every European carrier is upgraded so that every plane offers internet connectivity via the EAN system?
A. Yes.
Q. You would accept that only a fraction of planes currently subscribe to any internet service? Or you do not have knowledge of that?
A. I do not have knowledge of that.
Q. You are assuming that a single system would meet the entirety of this demand, the EAN system, that all of the planes will not only have installed internet connectivity, but they will all be using Inmarsat as their service provider from the get-go?
A. That is effectively what this assumes, yes.
Q. If only half of aircraft were fitted for on board wi-fi,

your overall average capacity estimates, both high and low load, would need to be reduced by 50 per cent, that is correct, is it not?

A. That is correct.

Q. If some airlines chose to use some of the different service providers to which Mr. Baldridge refers -- he tells us there are lots of alternatives -- the average capacity requirements for the European Aviation Network would be lower still?

A. Sorry, I do not quite follow that.

Q. If some airlines chose not to install the EAN system --

A. Yes.

Q. -- but some other system, the capacity requirements of the EAN system would be lower?

A. My assumption would be, although I do not have broad knowledge of this, that if, say, only half of the planes chose the EAN system, the other half would chose a different system.

Q. That is already assuming that all of the planes are choosing to have internet connectivity at all?

A. Yes.

Q. If half of planes were equipped with connectivity and Inmarsat won half of that business, you would need to divide these figures down to 25 per cent; that is right, is it not?

A. Numerically that is correct, yes. I have no understanding of whether that is commercially right, yes.

Q. That is a commercial matter rather than a technical matter. It is outside your expertise. I am simply highlighting or making sure that I have understood the assumptions underlying your analysis and, as I understand you rightly, you are assuming that every aircraft in Europe is fitted with the EAN system as their chosen connectivity and that they have all opted to have such connectivity for their passengers.

A. Yes.

Q. Now if we could turn to the per plane estimate in the penultimate column, you get to that estimate by multiplying your per passenger estimate in the middle column by the average number of passengers on each plane; that is right, is it not?

A. That is right.

Q. To work out the average number of passengers you have assumed that 80 per cent of seats are sold and that planes have an average of 136 seats, giving you 110 passengers per flight. So again it is a simple matter of arithmetic to scale up from the estimate in the per passenger column to the per plane estimate; you just multiply by 110?

A. Correct, yes.
Q. So really it is the per passenger estimate we need to drill down into, because that is the driver.
A. Indeed, yes.
Q. Now, at this point, sir, I would like to consider with the witness some information confidential to Viasat which was provided about their per passenger usage based on experience in the United States where they have established services available.

Now, I would therefore ask, with the tribunal's permission, that we might go into closed session for a period. It is very difficult to consider that evidence in the detail and with the granularity needed. The Viasat -- the appellant's people can, of course, stay if they are privy to Viasat confidential material. Otherwise the Inmarsat people may need to leave insofar as they are outside the confidentiality ring.

THE CHAIRMAN: And the Ofcom people?
MR. HOLMES: The Ofcom people are all entitled to see the confidential material.
THE CHAIRMAN: They are all in the ring. So you want to exclude everybody from those two parties who is not in the ring.
MR. HOLMES: I want to exclude the Inmarsat people who are not in the ring.

THE CHAIRMAN: Yes. I think we will have to do that. We will keep this as brief as possible. When I see what the information is we will, if necessary, consider the extent to which the confidentiality in the information should be preserved. I have already indicated that is not -- that cannot be assumed.

MR. HOLMES: No. I am grateful, sir.

(10.57 am)

Hearing in private (redacted)

(12.04 pm)

Hearing in public

THE CHAIRMAN: You need not wait for them, Mr. Holmes.

MR. HOLMES: No. In relation to the forward-looking point, at paragraph 25 of your second report --

A. Yes.

Q. -- you refer to the LSE report, and you point to the likelihood for growth in demand as assessed in that report --

A. Yes.

Q. -- which predicts very substantial growth in revenues for airlines --

A. Yes.

Q. -- resulting from in-flight data services; is that correct?

A. Yes. That is correct.

Q. In that figure, we can go to the report if necessary, but would you agree that we can exclude the red and the pink which refer respectively to low-cost carriers international, and flagship carriers international, and focus on the domestic, that is to say the EEA flights, which are shown as LCC-DOM and FSC-DOM in grey. Do you recall that?

A. I do not recall that.

Q. Let us go to the report, then. It is at ... sorry, I have to go back and find my reference. Tab 96. I am grateful. The figure appears, it is chart 5, page 21.

A. Yes, I see that. I note on page 20 --

Q. Sorry, what do you see, just so we know we are discussing the same thing?

A. So I am looking at page 20 of this report.

Q. Yes.

A. Where I had spotted a paragraph on the right-hand side, two-thirds of the way down, that starts with the words "Revenue has been defined", and then it discusses in that paragraph that they have attempted to classify flights in ways -- they note in some cases this will result in a skewing of flights to be classified as international such as within Europe and between Europe and neighbouring countries, so I think there is some debate about exactly how relevant these two categories

are for Europe. I do not know what they have done as a result of that data.

THE CHAIRMAN: Yes, Mr. Holmes, you are looking at chart 5 on page 21.

MR. HOLMES: Indeed.

THE CHAIRMAN: That is not the corresponding chart which is produced in the report. It is chart 15 on page 33, I think.

MR. HOLMES: I am grateful, thank you, sir.

THE CHAIRMAN: Sorry, page 34. Chart 15 on page 34.

MR. HOLMES: 34, yes, Europe.

THE CHAIRMAN: That is, I think, the actual chart which is reproduced.

MR. HOLMES: Indeed. Yes, and that was why I could not find what I was saying, so international FSCs and LCCs show the highest broadband enabled ancillary revenue potential with FSCs in particular accounting for ... around one-third is accounted by international LCCs.

So do you see from that the domestic, it means intra-European, I think. Does that sound right to you?

A. It sounds generally right, although I take from the earlier paragraph that there is some difficulty in classifying some flights.

Q. There is a little -- there is some difficulty, as there always is, yes.

THE CHAIRMAN: Mr. Holmes, I am sure it is my fault, and I may be the only person who is in this position but I am simply not following what you and the witness seem to be debating.

MR. HOLMES: Sir, you see that there are four different coloured bars shown in each of the stages of the chart.

THE CHAIRMAN: Yes.

MR. HOLMES: What I was debating with the witness was which of the colours are relevant when considering the revenue growth which is anticipated in this report over the next ten years in Europe.

THE CHAIRMAN: Right.

MR. HOLMES: The question was, what LCC-DOM and FSC-DOM mean by comparison with LCC-INT and FSC-INT, which are the four different colour-coded categories on the chart.

A. Yes.

Q. So LCC means low cost carrier, in the lingo of the airline trade. FSC is flagship carrier. So insofar as the distinction remains, it is Ryanair by comparison with British Airways.

The question is what is meant by "Dom", domestic, and the understanding is that it means short-haul intra-European flights. That is what we are debating.

THE CHAIRMAN: Well, that is your interpretation of what "domestic" means.

Dr. Webb, are you accepting that you believe that is how one interprets this chart which you adopted?

A. I am not absolutely sure, given the text I just spotted earlier in the report that seems to suggest there is some difficulty, but I think by and large that is what they are trying to achieve.

MR. HOLMES: Yes, I am grateful, that is very helpful. Looking at that it does indeed show a substantial growth?

A. Yes.

Q. From about 100 million, looking at the two grey parts of the bar.

A. Yes.

Q. Up to about $1 billion in revenue by 2028.

A. Yes.

THE CHAIRMAN: Sorry, I want to make sure I am understanding this, or not misunderstanding it.

MR. HOLMES: No, of course.

THE CHAIRMAN: You are suggesting that one excludes, are you, the red, because they are FSC international, or because it is international?

MR. HOLMES: And pink, sir, because in general, all of these calculations have been done for usage on the basis of short-haul intra-European flights.

THE CHAIRMAN: Well, why is this -- if this chart includes

international, that is to say outside Europe flights, why does it appear under a heading of "Europe"?

MR. HOLMES: Because it is covering European air traffic generally, including services to locations outside the EEA, long-haul flights.

THE CHAIRMAN: I see.

MR. HOLMES: It is not entirely clear, sir, and it is a point of marginal importance. I should, perhaps, not have laboured it as much as I have.

So I think where I have got to with the witness is that his point in evidence is that on any view there is substantial growth, and his and my understanding of this table, which he has included in his report, appear to be the same, which is that the two grey bars represent the short-haul revenue growth which is anticipated from a base of around $100 million to around just in excess of $1 billion by 2028. Is that a fair summary of your evidence, as I have understood it?

A. Yes, what I believe you are saying is that if you take that data, it would indicate about a 10-fold growth.

Q. Yes.

A. Whereas I have indicated a 15-fold growth. These are all forward-looking and speculative. I think they both indicate very substantial growth.

Q. That is very fair and very helpful.

But your modelling of the data required already assumes, as we have discussed, that every passenger across Europe has access to a service provider and that between 30 and 50 per cent of passengers are actually using the service, does it not? We have discussed that.

A. Yes.

Q. On either of your two scenarios, low or high demand, you are therefore already assuming a total transformation from the present position where very few passengers have access to in-flight wi-fi on short-haul European flights; is that fair?

A. That is fair and that is my understanding of what Inmarsat are marketing this as, a transformation of the in-flight service to one which delivers the equivalent of a home broadband which is not available at present on an aeroplane.

Q. So insofar as you are suggesting that your estimates may be conservative, my point to you is they already bake in optimistic assumptions about the growth in use to be expected, and they are really at the end of the curve, if you like, when every plane is equipped and very, very large numbers of passengers in the skies above Europe are using the service?

A. I disagree with that. I think they do predict a substantial growth from the current situation but I do

not think that they are unreasonable given what we have seen in terms of home and other mobile broadband use and given the growth that we see in the mobile industry of more than 50 per cent a year of usage. I think they seem reasonable to me.

Q. Let us turn to consider home broadband usage, and you say that it is around -- you make this point at paragraph 30. You say that it is around -- I shall get my gigabytes right now. You say it is around 190 gigabytes a month per home and growing fast?

A. Yes.

Q. This equates to 4 Mbits/s over the four evening hours when most use is concentrated?

A. Yes.

Q. That figure is for the data consumed by households --

A. Yes.

Q. -- with multiple members --

A. Yes.

Q. -- rather than by individual devices, is it not?

A. Yes.

Q. There may be four, five or six devices used by different people, including televisions, all connecting at once to a home broadband hub?

A. There may be. I think at most there would be, as we have said, by far the highest usage of data is video

streaming, therefore it would seem unlikely that one person is watching multiple video streams, therefore most usage I think would be related to the number of people in the house assuming that they were all video streaming simultaneously.

Q. Yes, but many households have more than one television screen and many have devices on which they view video content other than the television?

A. Yes.

Q. The usage made in the home will include devices like HD and 4K televisions and fixed console gaming stations or PCs being used for Photoshop applications which require high capacity usage of data; would you agree with that?

A. I think the main usage would be driven by video consumption, and that depends on, as we talked about already, whether that is standard definition or high definition or 4K video.

Q. Just to make the point clear so that it is put, that simply will not occur on a flight where an individual user will have a smartphone or a tablet?

A. I think we have covered this to some degree already. It may be that those users still stream the video at that sort of quality.

Q. Home broadband contracts also frequently allow for unconstrained capacity usage which cannot be assumed on

an aircraft, can it?

A. It is not clear to me what the policy will be other than Inmarsat's suggestion that it will be equivalent to home broadband.

Q. Now, can I now turn to consider, we have covered coverage --

A. Yes.

Q. -- and we have considered capacity.

A. Yes.

Q. Can I now turn to consider whether Inmarsat's satellite has sufficient capacity to ensure continuous coverage by providing a service to the planes that fly outside the range of ground stations?

A. Yes.

Q. You have addressed this point at paragraph 46 of your second statement.

A. Yes.

Q. You say that if 8 per cent, working on the basis of the data we have looked at if 8 per cent of flights are out of coverage of the terrestrial network at any one time --

A. Yes.

Q. -- that would give you, assuming that the number of planes you have modelled is the correct one for the EAN network, a number of about 44 planes.

A. Yes.
Q. But to go back to what we have considered earlier, supposing only half of those planes were equipped with broadband capacity?
A. Yes.
Q. How many planes could then be served?
A. Then there would be 22 planes outside that area.
Q. Yes. Supposing that Inmarsat did not supply a service to all of the broadband-enabled planes, supposing that a new product launched, took half of the market; how many planes would then require to be served?
A. Half of that number again.
Q. Which is how many?
A. Which is 11.
Q. 11 planes. You accept, do you not, Dr. Webb, that Inmarsat's satellite has the capacity to provide a service to 20 planes on the basis of your low usage scenario?
A. Yes.
Q. For those 20 planes, Inmarsat's satellite would be providing a service?
A. Yes.
Q. So I put it to you, Dr. Webb, that the satellite is not almost useless. It provides coverage across Europe and enough capacity to meet levels of demand which, based on

the current usage figures in the United States, a far more developed market than the European Union, are reasonable and realistic?

A. My understanding is that this is a service that is offered -- to be experienced at much higher than my low usage levels back to the point that Inmarsat are proposing something with the equivalence of home broadband and therefore those users who are on the plane whilst it is within the coverage of the ground network will be experiencing a much fuller service, therefore when they transfer out of that, if those planes fall back to the low scenario, then they will notice a severe degradation in their service.

Q. There would be a difference in service. One that users on the ground are familiar with --

A. Yes.

Q. -- as their mobile phone moves from a 4G spot to a 3G spot to a -- forgive my language -- GPRS, whatever the next level down is?

A. Yes.

Q. Or into and out of wi-fi. They are well familiar with situations in which available capacity varies in different coverage areas, are they not? That is a familiar experience of consumers in the UK, based on your knowledge of networks?

A. I would not want to ...
Q. You would not want to comment on that.
Within those areas where the satellite is serving the 8 per cent of flights of however many planes --
A. Yes.
Q. -- you cannot be certain, might end up being installed with the Inmarsat network equipment, they would on the low usage scenario be capable of being provided with a service that you accept in your first report is within a range of realistic usage scenarios?
A. Yes.
MR. HOLMES: I am grateful. No further questions.

Cross-examination by MR. WARD

MR. WARD: Sir, I am going to be a lot briefer than Mr. Holmes. I have three topics to cover. I want to make some limited additional points in regard to aspects of coverage of the satellite. My second point will be about the contribution of the ground stations relative to the contribution of the satellite, and then I have, really, very short points to put about different communications standards between the satellite and the ground stations, and what I am essentially putting to Dr. Webb are various aspects of Mr. Sharkey's evidence.
Dr. Webb, we have been talking this morning about the ways in which the satellite can provide coverage

over a wide area.

A. Yes.

Q. I want to ask you about certain other ways in which the satellite can assist even within the footprint of the ground stations. The first one is about mountains.

A. Yes.

Q. I am sure as a good start to this project we can agree there are quite a lot of mountains in Europe?

A. Yes.

Q. In the Alps, in the Pyrenees and that aeroplanes have to fly over them sometimes.

A. Yes.

Q. You deal with this issue in your second report, if I may ask you to turn to tab 9 of bundle B.

A. Yes.

Q. You have two diagrams. It is page 18, I am sorry, I did not say.

A. Yes.

Q. What we see in the top diagram is one ground station, and then the diagonal line draws the distinction between planes that would be in coverage which are above the line and planes which would be out of coverage, which are below the line.

A. Yes.

Q. So you have a clear reception region above and the

non-reception region below. What we can see immediately, just at a glance, we will look at the detail in a moment, from both of these diagrams, in fact, is that the question of whether the plane is in coverage or out of coverage will depend on the height of the plane, the height of the mountain, and the distance between the mountain, the plane, and the transmitter.

A. Yes.

THE CHAIRMAN: Well, the angle, really.

MR. WARD: The angle.

THE CHAIRMAN: It is not the distance.

MR. WARD: Sir, you are quite right.

THE CHAIRMAN: The angle is subtended by the transmitter.

MR. WARD: Yes, thank you.

At the previous page you explain what has gone into these diagrams, which is assumptions about each of those things?

A. Yes.

Q. In fact you have chosen Mont Blanc, the highest mountain in Europe, and in the third line you have an assumption about the height of the aircraft, namely 11,000 metres. Then you say -- you imagine the situation where a terrestrial component is 50 kilometres away from Mont Blanc, and then you say with the aircraft in the worst possible position, and then you make the point

about angle the Chairman made and then you say:

"If the aircraft is less than 110 kilometres from the terrestrial component it will take a greater angle resulting in clear reception."

Then indeed in the second diagram you show essentially with two different transmitters you can provide an even better area of coverage?

A. Yes.

Q. Now, just examining those assumptions in turn, firstly, you have posited an aircraft at 11,000 metres. If the aircraft is lower, there is a greater risk of being in the non-reception region; would you accept?

A. Yes.

Q. Of course, if an aircraft is starting to descend towards an airport, it may be lower than 11,000 metres; would you accept?

A. I do not have insight on whether aircraft descend towards airports whilst still over mountains.

Q. Well, there are airports in mountains too, are there not, like, say, Innsbruck, or Grenoble, for example, so it is at least possible, is it not, that some aircraft over mountains will be starting their descent?

A. Yes.

Q. Here you have shown just one mountain, obviously the crown jewel of the Alps, but of course the Alps is

a range and in the real world there will be a lot of other mountains as well; agreed?

A. Yes.

Q. That could also affect, if you like, the angle of coverage achieved from a particular base station?

A. Yes, although those mountains will by definition be lower and therefore will make less (inaudible).

Q. Lower, but possibly closer?

A. That depends on the geometry of the situation.

Q. It depends on the geometry, and what I put to you is it depends on really the precise geometry as between the transmitters and the mountains in question?

A. Yes.

Q. Would you accept? So would you accept, therefore, that in a network of 300 ground stations, which is what we have, it is quite possible that there could be a shielding effect from some peaks?

A. I have not seen that in any modelling I have done. I accept that if you placed your base stations very close to mountains and did not take note of them when you planned the coverage, then you could have a bad network, but that would seem to me a poor thing to do.

Q. But if you had enough towers you could overcome that problem?

A. Yes.

Q. Would that be right? But would you agree with me that there is a judgment to be made about whether it is economically efficient to add so many towers, particularly if you have a satellite which can pick up those holes in the coverage?

A. Yes, I agree that there is an economic judgment to be made in deploying a new network.

Q. Let's talk about the failure of towers, which Mr. Holmes touched upon, and you have already accepted that you can reduce but not entirely eliminate the possibility of individual towers failing.

A. Yes.

Q. I just want to go into a little bit more of the detail of what you said in your witness statement about this, and this is now paragraph 57.

If I just read the handful of lines that deal with the point, starting on the second line:

"Cellular base stations can fail, for example because power is interrupted, the backhaul communications link to the network is broken, or due to failure in the electronic equipment."

The backhaul link is -- sorry if I am being crude -- but it is the cable that links that base station to the main trunk network of the system; is that ...?

A. That is correct, although in some cases that is a radio

link rather than a cable, but yes.

Q. It could be radio, it could be cable.

What you say is you:

"... would not expect the terrestrial components to be located in remote areas where such redundancy was difficult to arrange."

By "redundancy" you mean, in a sense, a double provision?

A. Yes, in most cases, although in the case of power that might be a local power supply, such as a back-up generator.

Q. So you might have in, just using an example, rural Greece, there may be for example, an area-wide power cut of some kind, and your suggestion is there would be a mobile generator?

A. There could be one, if that were a choice made by yourselves of --

Q. But we do not know?

A. No.

Q. In terms of the backhaul link, I think what you are saying is that you might have two because, just to give a stylised but simple example, if someone digging a road on the cable path cuts the cable --

A. Yes.

Q. -- you would need an alternative route?

A. Yes.
Q. And you have not investigated what levels of redundancy are actually built into this particular system?
A. I do not have that information available to me.
Q. But would you agree that the more redundancy you build in, the higher the costs are?
A. Yes.
Q. Because there is going to be essentially a double provision.
THE CHAIRMAN: Is there much -- if we take the mobile phone system in this country, for example, is there much redundancy in the backhaul cable for your average transmitter which litters the country or is there just one digger-vulnerable cable in most cases?
A. It typically depends on how important the mobile perceives that particular site as. So if that is a site with a lot of capacity built into it and it is the only site that serves an area, they may well build redundancy in, whereas if it is a --
THE CHAIRMAN: This is the theory. They may well -- do you know if it is done as a matter of practice?
A. I know it is certainly done in some cases. I do not know what percentage of cases, sir, that would be.
MR. WARD: Mr. Sharkey can be asked about what there is in this particular system, but the point, Dr. Webb, I think

we are coming to, hopefully with agreement, is the more redundancy you build in, the more cost is involved?

A. Yes.

Q. It is a form of double connection.

A. Yes.

Q. Now, I think you would accept, based on what you said to Mr. Holmes, that even with all that redundancy you could still have failure. So take, for example, there is weather damage to the station, is a good example?

A. Yes, I would accept it is never possible to completely remove any chance of failure, but it can be reduced to a very low level.

Q. Now, you say at the end in paragraph 57, in the last four lines:

"... many planes will be able to 'see' more than one terrestrial component at any time."

So it could switch?

A. Yes.

Q. In other words, it might be within sight of more than one tower, and that would be another form of redundancy built in?

A. Yes.

Q. Might I ask you please to turn to your first report, under tab 8, at page 36. This is a diagram which you took -- so sorry. Page 36 of your first report, which

is under tab 8.

A. Yes.

Q. And it is figure 12. The footnote tells us that you took this diagram from some Inmarsat slide deck which was no doubt available on the web, I assume. This is -- what it is really showing is a path of a particular flight across Europe and showing the base stations that will be triggered; would you agree with that?

A. Yes.

Q. Would you also agree that what it shows is that there is some area of overlap between the coverage of individual base stations, but nothing like a kind of comprehensive duplication.

A. Yes.

Q. So what I would suggest to you is that, again, one is left with the question of how much money is one going to spend on building in redundancy -- I think you are agreeing with me?

A. Yes.

Q. Yes, so far. What I suggest, again, is that it might be more efficient to allow the satellite to provide the base coverage to fill those gaps when it arises?

A. Potentially, yes. I do not have access to the data to make that calculation.

Q. Thank you. Just turning on to a different way in which

the satellite is potentially relevant, it is about the targeting of capacity, and for this I would just like to show you what Mr. Sharkey said, and this is under tab 7 at paragraph 33.3, which is the penultimate page of his report. I am afraid we omitted page numbering on Mr. Sharkey's second report, it is the last but one page, paragraph 33.3; do you have that, Dr. Webb?

A. Yes.

Q. This is all about the ability of the satellite to target its capacity, and what Mr. Sharkey says is:

"... the S-band satellite has a digital processing payload where we can indeed switch capacity dynamically between beams to allow 'tidal' dynamic allocation of different quantities of capacity at different times of the day or based on instantaneous demand changes, triggered automatically if we so wish."

Have you any reason to doubt that Mr. Sharkey's technical explanation is correct?

A. No.

Q. The question is whether this might be a valuable attribute of the satellite. I am not going to reopen any of the issues you have discussed with Mr. Holmes about exactly how many aeroplanes are in the sky that may be relevant, but what I would suggest to you is that what this shows is if, to take an example, it is

a Saturday morning in July and there are a lot of aeroplanes, for example, en route to Spain, there may be some value in being able to switch capacity into that area; would you accept that is at least a possibility?

A. I would suggest that is very limited value given the total capacity of the satellite is so small, the amount of capacity that you are switching from one place to another is not going to make a material difference.

Q. I will not reopen that question which you have already debated with Mr. Holmes.

Another way in which the satellite might be of assistance is in respect of different types of data, and you will have seen that Mr. Sharkey gives the example that the satellite can provide uninterrupted coverage for, for example, point of sale data.

A. Yes.

Q. In other words, the flight attendant is moving down the aisle with the hand-held terminal taking card payments, perhaps for some low-value item like a cup of coffee or perhaps for a higher value item like perfume, yes? We have all seen this.

THE CHAIRMAN: I do not think cups of coffee on those flights are low value any more.

MR. WARD: At least compared to the perfume prices.

THE CHAIRMAN: You certainly need a credit card.

MR. WARD: Yes, well we all know what we are talking about.
A. Yes.
Q. If the airline, if the aeroplane at the time is -- I am so sorry, let me start my question from a slightly different place.
A. Yes.
Q. Would you agree that there is value for the airline in enabling the payment to be verified at the moment the transaction takes place?
A. I can accept that, yes.
Q. There may be also value for the passenger because they may be allowed to take the goods immediately rather than having to wait until the verification takes place.
A. Yes.
Q. If we posit a world where we have ground stations but no satellite, and the passenger wants to buy the coffee or the perfume over the sea or over Serbia, that would not be possible, would it? We would just have the ground stations?
A. It would be possible if you made use of other satellite capabilities such as the other satellite systems that you or your competitors offer.
Q. We are going to come to that, but we are going to talk just now about the EAN, which is the principal topic for today. You would agree that on the EAN that would not

be possible?

A. Yes.

Q. And you make a point in your witness statement that these types of transactions are very quick, they only take a few seconds, but you would, I am sure, accept that that is not much use if you are, in fact, over the sea at the time?

A. Yes, under the situation you describe, which I do not accept is a very likely one.

Q. You do not accept it is very likely that the passenger would buy coffee over the Bay of Biscay?

A. That I accept is likely, but given that aeroplanes already have satellite connectivity I would imagine that they would be making use of something like the existing satellite system to enable that sort of thing to take place.

Q. You have not suggested in your evidence that this can be done by other satellite systems, have you?

A. I do not recall.

THE CHAIRMAN: Sorry, so we are not at cross-purposes. Mr. Ward, you are imagining the EAN system installed and working in an aircraft?

MR. WARD: Yes.

THE CHAIRMAN: You are out of reach of a ground station, and what you are suggesting in those circumstances, it would

be irritating for everybody concerned not to be able to complete the point of sale cup of coffee; that is what you are suggesting?

MR. WARD: I am, I am going at least a centimetre further than that and saying it is actually value added for the airlines to be able to say: we have hand-held terminals, we can check the transaction now, we do not have to either bother the passenger later or worry about even the card being declined or anything of that kind. That sort. It is a utility to the airlines that the satellite element of the EAN will provide, that is the point I am putting.

A. Yes.

Q. And I think that is accepted?

A. Yes.

Q. Then there is another point which you will have seen Mr. Sharkey makes which is plainly a bit more speculative, which is about using the satellite to broadcast?

A. Yes.

Q. You give a helpful example, indeed a topical one, of the Champions League football final as an example that you might want to make a single transmission to a lot of aircraft flying in a particular area, and a particular transmission of that kind will use up, forgive me, I am

going to be very crude, a certain amount of capacity, and we do not need to worry about bits or bytes for the purpose of this argument, and Mr. Sharkey made the simple point that if you do that over the satellite, that is more efficient than using up some of the capacity of all the 300 base stations of all the three -- or at least all the ones that are currently being triggered. That is just the point I want to put to you, that it is in that sense a more effective use of the satellite, of the available capacity?

A. I am not entirely in agreement with that. I think you can transmit that from the ground stations or from the satellite. They are both using the same spectrum. Exactly how you balance a load within your network I think is up to you.

THE CHAIRMAN: Can I just understand what goes on in that scenario?

A. Yes.

THE CHAIRMAN: Imagine two scenarios, please. One passenger in an aircraft, let's confine ourselves to one beam of the aircraft for the moment --

A. Mm-hm.

THE CHAIRMAN: -- who is watching, whatever it is, the Champions League final, or World Cup match now, and they are taking a certain amount of bandwidth from the

satellite, and what is envisaged here is a broadcast, in which it is a broadcast available to everybody. Does that require the same capacity of the satellite, that is to say one person demanding it on the one hand, and it being generally made available to everybody else in the same beam, does that require the same capacity from the satellite?

A. Yes, sir, in the same beam.

THE CHAIRMAN: If they are in the same beam?

A. Yes.

THE CHAIRMAN: Of course, three beams, it would be three times as much capacity or perhaps a subtle adjustment of that?

A. Yes.

THE CHAIRMAN: Thank you. So there is no premium in capacity attached to the fact that you are broadcasting it and making it available to lots of people as opposed to just having it made available to one on demand?

A. That is correct, sir.

THE CHAIRMAN: Thank you.

MR. WARD: I wanted to just now go to what you did say about the possibility of using other satellite systems on the aircraft. This is in your second statement, which is under tab 9, page 14, paragraph 43. You say, referring again to Inmarsat publication:

"... aircraft may be fitted with many different satellite terminals, such as the Alphasat-L and GX terminals, whose associated satellites offer greater coverage and capacity."

So where there is no terrestrial component, other Inmarsat coverage is available.

Now, what you are saying there is an airline might install more than one of Inmarsat's products; yes?

A. Yes, or it may install one of those different products.

Q. One of those different products. But you would accept, would you not, that the EAN system is being marketed as a single standalone product?

A. I am not clear exactly on how it is marketed. I think that is a matter for someone else to address.

Q. That is fine. If you brought several systems there would be more cost and there would be, of course, a weight penalty on the aircraft; would you agree with that?

A. I do not have the commercial information available to me to understand how the costs would vary across multiple services.

Q. If you buy two pieces of kit instead of one it costs more money; would you agree with that?

A. I do not know your pricing, sir.

Q. Okay, fine, I am happy to leave that there.

Let me turn to my second topic which was about the relationship between ground stations and satellite capacity. Could I ask you, please, to turn to page 9 of your second statement, page 11 -- sorry, I meant tab 9, page 11, forgive me.

A. Yes.

Q. Sorry, that is clearly a wrong reference, even though I have given it twice. Give me a moment, please, and I will show you what I actually want to talk about. (Pause).

It is tab 9, it is your second statement, but it is page 4 and it is paragraph 12, I am so sorry. You say in the first sentence:

"... it is not correct that the terrestrial component will inevitably provide more capacity."

A. Yes.

Q. Then you go on and talk about higher capacity satellites, which I am going to come to as a separate topic very shortly.

A. Okay.

Q. But look at that first sentence and then move on to paragraph 13, where I think you give an explanation of your thinking, you say:

"If terrestrial elements were only installed where there was no available satellite coverage there would be

very few, if any, of them since the satellite coverage is widespread."

A. Yes.

Q. Yes. So in other words, if, in fact, you only used the terrestrial elements to plug a gap in coverage, you would not have any -- or many, sorry.

A. Yes.

Q. Indeed in the case of an aeronautical system like this, possibly none.

A. Possibly none.

Q. Yes. But one of the points of your analysis you have been debating with Mr. Holmes this morning is that ground stations can greatly increase the capacity.

A. Yes.

Q. Agreed?

A. Yes.

Q. Whether or not it is logically inevitable, it certainly can be done?

A. Yes.

Q. Turning on, then, to paragraph -- could I ask you to look at paragraph 31 of your statement, which is on page 10?

A. Yes.

Q. You say in the opening four lines there:

"Inmarsat's desire to provide a service equivalent

to home broadband to multiple passengers on multiple planes is laudable but can clearly only be achieved in the relatively narrow frequency bands it was awarded by the EC with a terrestrial network."

A. Yes.

Q. Yes, and the relatively narrow frequency bands, you heard me explain it in, I hope, tolerably accurate but short form to the tribunal: different frequency bands have different capabilities?

A. Yes.

Q. But what I think you are accepting here is that if Inmarsat had this ambition, this laudable ambition, given this allocation of frequency, it was going to need ground stations?

A. Yes.

Q. Now, putting aside any of the questions of the legal framework for a minute, and exactly what is and is not permitted, would you accept that if it was going to try and achieve that objective, it needed to make a series of commercial and engineering judgments about how best to do it?

A. Yes.

Q. That sort of judgment might involve financial calculation as well as questions of what is technically attainable?

A. Yes.
Q. Putting up a satellite is, of course, an expensive business; yes?
A. It depends what you compare it with.
Q. Well, several hundred millions, I would say, is an expensive business; would you agree?
A. Compared to building a stretchable(?) network for a cellular system, no; compared to my home budget, yes.
Q. Well, compared to mine too.

Would you agree that once it is up in the air, it can be quite difficult to fix if it goes wrong?

A. I would imagine impossible, nearly.
Q. So if it was your money, you might want to take a rather risk-averse approach to this; would you accept?
A. I think that is a hypothetical that I would rather not.
Q. Okay, that is fine. I accept that.

In terms of the commercial choices that are being made here, would you accept that different options will inevitably carry different costs?

A. Yes.
Q. And that if you want your product to be not just innovative but also competitive, you need to keep control of those costs; would you accept that?
A. Yes.
Q. There is no point in creating an innovative product if

it is too expensive for people to buy it; would you agree?

A. Yes.

Q. You have explained in your opening remarks and questioning from Mr. Holmes that you had experience at Ofcom in looking at new products in, I think it was the research and development team?

A. Yes.

Q. Have you ever personally been involved in the design and launch of a satellite?

A. No.

Q. What I want to do now is look at the evidence you have given about three different alternative satellites that might have been contemplated by Inmarsat as compared to the one that was actually launched, the one that is above us as we speak, and the easiest way to see that is in your first report, which is in bundle D/8 at page 32, and just to help everyone with the direction of travel, there are three satellites we are going to discuss. There is 9-beam, there is EchoStar (180-beam), then there is Ligado (500 beam). Those are the three.

Your case is essentially that all of those would have had much more capacity than the satellite that Inmarsat actually launched?

A. Yes.

Q. For the purpose of this part of the discussion, I want to be clear, I am going to take all your capacity analysis as read, even though, in fact, we associate ourselves with the points that Mr. Holmes has already made about it, there is no reason for us to re-debate those points now.

Let me start with the 9-beam, which you talk about in paragraph 94 of your report, and as you rightly say -- you say:

"Inmarsat [had] originally proposed to deploy a satellite for its mobile satellite system that would have deployed 9 beams ..."

We went over that yesterday while you were in court, that is not in dispute. As you say, that would have provided more capacity by a factor of 3.

A. Yes.

Q. Then just in terms of simple arithmetic, with that we would go from 99.9 per cent of the capacity being provided by the ground stations to 99.65 or something?

A. Something like that.

Q. Something like that, yes. So if the aim was to achieve the kind of service that Inmarsat aspires to, there would still have been a very great imbalance in favour of the ground network in terms of capacity?

A. Yes.

Q. Then if we look at the next one you talk about, it is the EchoStar satellite. Here it became clear from the exchange you had with Mr. Bowsher yesterday that there is a reasonable, if not perfect, degree of agreement between you and Mr. Sharkey where I think, I may be able to just save some time and if you do not agree we will unpick it and go much more slowly, but I think that the end result of this is that, at least very roughly, you would agree that if the EchoStar satellite had been employed, the ground network would still have made up in excess of 96 per cent of total capacity?

A. Yes, but I think it is worth perhaps dwelling on a point made by Mr. Holmes. If you were assuming the low scenario, then actually that EchoStar satellite would have sufficient capacity for that low scenario for all the aeroplanes.

Q. Let me talk about design issues, because in broad terms in the S-band, the more beams you have the larger the antenna has to be, does it not?

A. Yes.

Q. And the antenna is -- to somebody like me, it is what I would call "the dish", the big round thing. We know that the satellite that Inmarsat put up -- sorry, I said "we know" and then I realised I was not absolutely sure. (Pause).

I will have to come back to that. What we do know is the EchoStar with its nine beams --

A. EchoStar has 180 beams.

Q. I am so sorry, 180 beams. Thank you. It is 18 metres wide, is it not?

A. I believe that is correct.

Q. That is what Mr. Sharkey says.

A. Yes.

Q. What I would like to do is show you what Mr. Sharkey says about why Inmarsat would be resistant to that course, and this is under tab 4 in Mr. Sharkey's first witness statement at paragraph 63, and that is page 18.

A. Yes.

Q. He says at the bottom of paragraph 63:

"The EchoStar antenna ... is 18m in radius ..."

Then he says at 64:

"... the EchoStar antenna with the 18m radius could ... be deemed ... too large. This is because, at this size, the risk of engineering failure due to an antenna deployment malfunction is very high and could ... put at risk the associated investment."

Let me at least pause there. Do you accept that is possibly a reasonable concern?

A. EchoStar appeared to come to a different judgment on that one so I guess there is a case for doubt.

Q. There is a case for doubt. We will see --
THE CHAIRMAN: But do you accept it is a cause for concern?
A. I accept that any satellite launch is risky so there is concern --
THE CHAIRMAN: Would you accept there is a greater risk and a greater cause for concern if you have a bigger antenna because of the risk of the greater risk to deployment; that is the question?
A. Yes. I believe that is true.
MR. WARD: Thank you, sir. Indeed, it might be helpful to see, even with smaller beam antennas, there is still risk, is there not; you would accept?
A. I accept there is risk with any size antenna, yes.
Q. So it may be just helpful to see in bundle E1 under tab 19 we have a story from a publication that I for one am becoming increasingly familiar with, called SpaceNews, and this is actually not about this satellite, I want to make that absolutely clear, this is about a different satellite that EchoStar also bought from --
A. I am sorry, I may have the wrong bundle? Which bundle?
Q. I am sorry, I did not give you a tab. It is E1/19.
A. Yes, I have it now.
Q. So this is about "EchoStar buys struggling Solaris S-band satellite", and just to remind everybody who does

not have this at their fingertips, Solaris was the other original winner of the EU selection process and, as you know, EchoStar bought them out. This is not an article about the 180-beam satellite, but I am really just giving this to you as an example:

"EchoStar which has already purchased from bankruptcy the S-band mobile satellite assets of two companies ... on Jan. 6 said it has purchased a European S-band spacecraft payload from its two fed-up [operators]."

Then if we look at the third paragraph:

"Solaris has a licence to operate a mobile S-band satellite service in Europe but has struggled to find a market. Its large S-band antenna was launched on a Eutelsat telecommunications satellite in mid-2009 but a defect was discovered during its unfurling that limited its coverage and power.

"Since then, owners SES and Eutelsat have kept Solaris on life support but not much more as they determined what to do with an asset into which they had invested ... 130 million euros ..."

I put this, really, just as an example: there can be problems in this area. If we go back to what Mr. Sharkey said, I was taking you to paragraph 64 on page 18 under tab 4.

A. Yes.

Q. He says, now I am picking it up about five lines down:

"We consider [the size we have, 11 metres] ... [an] optimum size for the opportunity based on Inmarsat's needs, its costs and the associated risk of ... failure ... I note in passing that EchoStar's satellite was not designed for use for the European market. EchoStar acquired it 'second-hand' on the bankruptcy of ... TerreStar ..."

So that one they got from another source, it is not the one we have just been looking at:

"... following its commercial collapse."

Then he says:

"It is, of course, not Inmarsat's role to judge EchoStar's technical or commercial choices. However, one thing is certain: there were, and there still are, very sound technical and good engineering reasons that explain why Inmarsat has elected not to mimic the size of EchoStar's beams, in the interest of quality of service and protection against the risk of technical failures."

Do you accept that for Inmarsat those are relevant commercial and engineering considerations?

A. Certainly I accept that, yes.

Q. If we can just -- we are going to -- if we can now move

on to the third satellite that you posited, which is the Ligado satellite, and we can pick this up in your second witness statement at tab D/9, page 4, paragraph 12.

A. Yes.

MR. WARD: Sir, I can see the time but I think if I was given about another five minutes I could probably finish this point, if that would be convenient?

THE CHAIRMAN: Then how much more of your cross-examination?

MR. WARD: Then I have really very little.

THE CHAIRMAN: Put a number on it.

MR. WARD: Maximum 15 minutes.

THE CHAIRMAN: Oh, as long as that.

MR. WARD: Well, I hear what you say and I will do my best over lunch to turn 15 into 5 in that case.

THE CHAIRMAN: It was described as a "very, very short point on different communication standards", that is how it was described to us.

MR. WARD: That is the very last point.

THE CHAIRMAN: I see, that is not the point you are just describing.

MR. WARD: Sir, if it is convenient, if we rise now I can talk about the Ligado satellite with Dr. Webb whenever it is convenient to resume after the short --

THE CHAIRMAN: Take the Ligado point now and we have already agreed amongst ourselves that we will, in the interests

of this case finishing today, we will take a shorter lunch break.

MR. WARD: Sir, thank you. Let me do my best to deal with this quickly as I hope I can.

You say in paragraph 12, never mind the EchoStar satellite with its 150 -- you say 160 but I think it is 180 beams, is it not?

A. Yes, I think there has been some different numbers in the press on that but 180 I think is the more generally used number.

Q. Luckily enough nothing turns on it. And in the middle of the paragraph you say:

"For example, Ligado operates a satellite with a 22m antenna that forms around 500 beams ..."

Now, on that satellite you exhibited some material which has found its way into bundle E3, if I could ask you to take that up.

Under tab 118, please, is some marketing material from Ligado and we can see on the second page, which is under the -- if we go past the glossy photograph of the north-eastern United States, it says, and just for the tribunal, SkyTerra 1 is the name of the satellite, so Ligado and SkyTerra 1 are interchangeable for the purpose of this case.

On the second page it says, in the big type:

"SkyTerra 1, the high-powered L-band satellite enables transmissions to small low-cost devices and narrow spot beams by using a 22m reflector based antenna, the largest satellite reflector to be put into service on a commercial satellite."

Is that consistent with your understanding?

A. Yes.

Q. Are you aware that there were serious technical problems with this satellite when it was launched?

A. I have not been following that, no.

Q. Could I show you, again, the mighty SpaceNews, and this time under bundle E1 -- oh dear, I have the wrong reference. I am sorry. It is at E1 -- no, it is E1/13 and it is SpaceNews again. Here we can see --

A. Sorry, which tab?

MR. WARD: So sorry, E1/13A, that is what confused me.

Here is the SpaceNews reporting on the launch of SkyTerra 1, and it says SkyTerra 1 --

THE CHAIRMAN: Sorry, E1/13?

MR. WARD: 13A. A, which was omitted.

THE CHAIRMAN: I see, right.

MR. WARD: It was, in fact, an exhibit to Mr. Sharkey's witness statement but it just fell out of the bundling:

"The SkyTerra 1 mobile communication satellite launched on November 14 for start-up wireless broadband

provider LightSquared has been unable to deploy its large reflector antenna which is the key enabler for the company's planned US broadband network."

Then if we just pick it up, four paragraphs down there is a quotation:

"The situation does not look good but it is too early to say whether it is a major issue or something that will be forgotten in a few months. It is understandable the satellite control team need to take its time."

I am simply putting the point that there were serious difficulties with this.

THE CHAIRMAN: Did they fix it?

MR. WARD: I actually do not know, sir. I can try and find out over lunch if you are curious.

But the point that Mr. Sharkey makes about this I want to show you now in bundle D, tab 7, we might need to go back to that if you do not mind, I am sorry, I should have made it clear. Mr. Sharkey talks about this in paragraph 13 of his witness statement where he says -- do you have that, Dr. Webb?

A. Yes, I do.

Q. Thank you:

"It remains my view that achieving high levels of S-band frequency reuse through a large satellite antenna

or large number of beams is disproportionately costly, risky and complex for diminishing returns compared either to achieving high spectral efficiency ..."

Then he talks about the Ka-band, we do not need to worry about:

"... or through a CGC network. It was also unnecessary for the EAN project. As such ..."

I will stop there and we will talk about capacity in a minute.

A. Mm-hm.

Q. Do you accept that this was a legitimate judgment to be made in terms of balancing of risk for Inmarsat in the design of its network.

A. I do not have all the data to understand whether that was legitimate judgment but I do understand that you would make judgments of that sort.

Q. Okay, thank you. Then the final point I want to make about Ligado -- sorry, before we come on to capacity, is the kind of use this satellite was actually designed for, and I should have asked everyone to keep bundle E3 open and I did not, for which I apologise, but we can see this again from your document that you exhibited. If we look under tab 118, this now is the next page, so the second page of text?

A. Yes.

Q. It explains, if you look at that last paragraph under "versatility to enable new services", I think I am right in thinking that the proposition was essentially to provide a sort of satellite service to mobile phones; is that right?

A. I do not know the detail of this one.

Q. You are not sure. What it says though, if we look five lines down in that next paragraph:

"The spot beams enable use of small, low-cost equipment, including hand-held devices and hand-portable equipment."

The point is a lot of beams that it be targeted on rather weak hand-held terminals, would you accept that that is a rather different project than trying to deliver throughout to high performance terminals on aircraft?

A. There are some differences, I do not think it is a very large difference, but I can imagine that there are some differences in the link budget between those two.

Q. You might not specify the same type of satellite for both purposes?

A. You might not.

MR. WARD: I will leave that there with you, but what I hope can be done very quickly, and if it is complicated, it will have to be after the short adjournment, you have

seen Mr. Sharkey's evidence that in practice this Ligado satellite would not have added much capacity to that of the EchoStar satellite in this particular context; do you agree with that?

A. I defer to his expertise in that situation.

MR. WARD: In that case we save a lot of time and in that case I can say with confidence that my final point is very short and it cannot take more than 10 minutes.

THE CHAIRMAN: Right. Do you have re-examination?

MR. BOWSHER: I do have re-examination.

THE CHAIRMAN: For how long?

MR. BOWSHER: I would think about 20, 25 minutes, given the matters that have arisen. How late do you -- I mean, I have got, as I said, at least a couple of hours of cross-examination, and --

THE CHAIRMAN: Well, you were positing three hours yesterday, but we will see.

MR. BOWSHER: Yes, as I say, I am trying ...

THE CHAIRMAN: Mr. Holmes has had his hour and a half, which I think he foresaw yesterday. Mr. Ward has had more than his half hour, but he will not have much more than his half hour. You may have the time, at least the time which you predicated yesterday, well, most of it anyway, I think you said three hours, you have now come down to two, but you will not be any more disadvantaged by the

time made available to you than your brethren have been. That is all I think we can say. We will rise now and we will sit at 1.50. Can I ask if our shorthand writers are all right, because you are having long, harder days.

We will sit at 1.50 with a break in the afternoon.

Did you want to say anything else, Mr. Bowsher?

MR. BOWSHER: No, my timing was my only concern. That is all.

(1.10 pm)

(The Luncheon Adjournment)

(1.50 pm)

MR. HOLMES: Sir, before Dr. Webb resumes his evidence, there is one point of factual correction which I should make in relation to a proposition of fact on which one of my questions this morning was premised. The tribunal will recall that I took Dr. Webb to a slide in the Brice Dorman exhibit which set out various city pair flight times, including San Diego-San Francisco, Los Angeles-San Francisco and Las Vegas-San Francisco. Reviewing my script during the short adjournment I realised that I had slightly misstated the range of flight times. I think I said 1 hour 20 to 1 hour 45 minutes on my feet. The correct figure is an hour to an hour and a half.

I raised this with my learned friend Mr. Bowsher and

we agreed that I should correct it in this way, given the difficulty of dealing with that straightforwardly by way of re-examination, and in case it affects the questions that Mr. Bowsher might want to put.

THE CHAIRMAN: Right, but it does not render unfair or inaccurate the substance of what Dr. Webb has said or what you put to him. You put it to him on the basis that they were typical short-term flights of an hour and a half.

MR. HOLMES: Yes, sir, but I thought in fairness and to avoid any risk, I should make sure the factual position was clear.

THE CHAIRMAN: You are entirely proper to raise the point, I am just concerned that Dr. Webb's evidence -- he should have a chance -- do you understand the point?

A. I do understand the point, sir, and I do not think it makes any material difference.

THE CHAIRMAN: It does not make any difference to anything you said this morning?

A. No.

MR. HOLMES: I am grateful, sir. Thank you.

MR. WARD: With that, I was going to move to my very final topic and, with a bit of luck, it is a very brief one, and that is the topic of different communication standards for the satellite element and the

ground-facing element of the system.

You will recall, Dr. Webb, well, it is common ground between the parties, that the terrestrial element uses LTE --

A. Yes.

Q. -- which is essentially a mobile phone standard?

A. Yes.

Q. And the satellite element uses DVBS, which is a satellite standard for the transmission of data?

A. Yes.

Q. The short point that it may be we can reach immediate agreement on is that whilst LTE is suitable for mobile phones it is not at all suitable for satellite transmissions and where DVBS is suitable for satellite transmissions, it is not suitable for the same uses as LTE; would you accept that?

A. I would not accept that they are not at all suitable. I can accept that they have been optimised for different purposes, but they could be used in other purposes.

Q. Let me just expand on that slightly, so I suspect any area of disagreement between us will be very slight.

A. Yes.

Q. If we go to Mr. Sharkey's second statement under tab 7, you will see on page -- well, it is under tab 7 and it is paragraph 7 as well, which is the second page of the

statement. You will see he says:

"I believe it is legitimate and technically justified to have chosen the most appropriate and efficient wave form and protocol technology for the two very different links."

Would you at least agree that those two standards are the most appropriate and efficient for those two tasks?

A. I have not analysed it sufficiently to understand that.

Q. Then just to pick up at the end of that paragraph, the last five lines, he explains a core difference:

"A terrestrial technology such as LTE is well adapted for the round-trip time and channel model of a link reaching tens of kilometres between a CGC and an aircraft, but not for a 36,000-kilometre geostationary path to the satellite ..."

Pausing there, would you agree with that?

A. I would agree that LTE was designed for the shorter range links.

Q. Then he says:

"... and equally a satellite transmission standard is poorly adapted for a CGC link over tens of kilometres but well adapted for a 36,000-kilometre geostationary transmission path."

A. I think that depends on the satellite standards, but

there are satellite standards that are adapted for both, or DVB standards that are adapted for both satellite and hand-held communications --

Q. Okay, well let us look at what lies behind that and see if you agree with these differences on the next page, which is paragraph 8, 8.1?

A. Yes.

Q. He makes the point:

"A satellite transmission standard will include measures to conserve satellite power, whereas a CGC tower will be mains powered and can use more power-hungry amplifiers."

Do you agree with that?

A. Yes.

Q. Then the next consideration he talks about is error correction, and he says:

"Another consideration is a satellite system, we must modify the error correction mechanism to deal with a long round-trip time of perhaps half a second rather than a much shorter round-trip time of 1/20th of a second."

Do you agree with that?

A. I am not sure it is necessary that they are modified.

Q. Then thirdly he says:

"The far lower round-trip time of the CGC

transmission path allows us to be more aggressive in our frequency reuse because we can constantly measure feedback and adapt transmissions for each aircraft individual by within a few milliseconds, but the round-trip time over satellite is half a second, we cannot make similar instantaneous measurements and corrections."

Do you agree with that?

A. Yes, I agree with that, but I do not think that necessarily implies different standards.

MR. WARD: Okay. I have put the case I need to put and obviously that can be put to Mr. Sharkey.

Thank you. Those are all the questions I have for Dr. Webb.

DR. ELPHICK: Could I just ask one follow-up question to the questions from Mr. Ward.

Let me try to be clear, Dr. Webb, are you saying that the use of -- is it technically optimal to have the same language for communication with the ground, or communication with the satellite, or is that technically suboptimal?

A. It may be technically suboptimal. I think the point that we got to here was that there was a question as to whether it was possible to use the same standard in both, and the answer, I believe, to that is yes.

DR. ELPHICK: But if you were designing a system, would you expect to use different languages rather than the same?

A. I would anticipate probably different languages.

DR. ELPHICK: Probably different languages.

A. Yes.

DR. ELPHICK: But of course you criticise Inmarsat quite strongly for using the same language. You criticise them in effect for having the technically optimal solution.

A. I am sorry, I missed that slightly.

DR. ELPHICK: You are sort of critical of Inmarsat for using different languages, but you would use, in fact, different languages?

A. I am not trying to be critical. I think the point was just made that they said it was impossible, or not possible to use the same language, which I think hinges on one of the points of law that is being considered, and I think the response I would get is it is possible to do so.

DR. ELPHICK: But suboptimal.

A. But suboptimal.

Re-examination by MR. BOWSHER

MR. BOWSHER: Dr. Webb, I have only a few questions for you. Just picking up that last topic, what is the language that you are referring to that you can use in both

directions?

A. Yes, there is a standard called DVB-SH where the S stands for satellite and the H stands for hand-held which is actually specifically to cope with a mix of both satellite and terrestrial links.

Q. Is that an inherently suboptimal language?

A. No, I do not believe so.

Q. Does it address the technical challenges that you would expect to meet if you were having to communicate in both directions to a ground station and a satellite?

A. I have not looked at it in any detail, but I would expect that it would have been designed with that in mind.

Q. Can I ask you a couple of questions then about the low-load analysis that you were being asked about, the low-load and the high-load analysis you were being asked about. When we come to some of the yellow pages, I will indicate that we want to -- thank you for pointing that out.

You have set out in your report, going back to where we have already been, the table at page 114 sets out those two scenarios, does it not?

A. Yes.

Q. That is what we have been talking about. A number of different variables, reasons to change these scenarios

were being suggested to you. Taking those in the round, what is your view as to where you end up on the low-load scenario?

A. I believe the low-load scenario still to be a valid one for current usage in typical situations.

Q. Have you considered how the -- you were also asked a couple of questions about the performance of the originally planned Inmarsat EuropaSat satellite, what I would like to do is ask you to consider how the performance of that relates to that low-load scenario. You were asked about performance and perhaps if you could take a document that sets the material out, it is E1/7.

We saw this in opening. This is the Thales press release about the originally planned EuropaSat satellite. What are the technical features that we get from this document which are relevant to the capacity of this -- sorry, the ability of this satellite to meet the load demand that is going to be put on it?

A. Yes, I believe the key parameters here are the number of beams and the overall power of the satellite system.

Q. Could you just identify the beams, therefore, that is carrying a payload.

A. So the beams are identified in the second paragraph on the first page, where it says a payload at 2 GHz

generating 9 S-band user spot beams in two polarisations, from which I am somewhat unclear as to whether that equates to 18 beams or whether that is 9 beams but with different polarisations.

Q. What is the significance of your doubt, if I can put it that way, about the polarisations?

A. If each of those beams is transmitted in a different polarisation then they are effectively separate beams and there would essentially therefore be 18 beams in total.

THE CHAIRMAN: Polarisation meaning the switch through 90 degrees, effectively?

A. Exactly right, sir, yes.

MR. BOWSHER: The power information we see over the page?

A. Yes, so the power is detailed in the very top line of the second page where it says 8.5 kilowatts of payload power. The significance of that is that the more power you are able to transmit, the stronger the signal that you are able to receive, and the stronger the receive signal, the more data you can encode upon that signal in just the same way that as you move closer to your wi-fi router, the data rate increases, therefore by using more power you are able to deliver a higher data rate within those beams.

Q. Tell me if you cannot do it -- I am trying to take this

quickly, and tell me if it is not fair -- are you able to indicate how that performance corresponds to your low-load scenario?

A. Yes. So I do not have enough detail to be absolutely certain about this, but my understanding is that the effective power of the payload that Inmarsat have on their shared satellite is about 2 kilowatts. In which case this satellite would have about four times the power which would indicate roughly four times the data rate would be available.

If we assume that the 9 beams have three times the capacity of the 3-beam satellite that is now in orbit, we factor in this factor of 4 from the power, then that is a factor of 12, and then that might be a factor of 24 if the polarisations are related to both beams. So that would be a capacity increase of somewhere between, let's say, 10 and 20 on the current satellite.

MR. WARD: Sir, I do not object to this line, even though it is quite extravagant as re-examination. What I do want to make clear though is this is essentially new material about power of the satellites which has not been flagged up at all. This will need to be put to Mr. Sharkey.

THE CHAIRMAN: Well, I think the power of the satellite features as a feature in Dr. Webb's original report, does it not?

MR. WARD: We are hearing something new here. I am not objecting to the line of questioning but I do say this needs to be put to Mr. Sharkey so he has an opportunity to respond.

THE CHAIRMAN: No doubt Mr. Bowsher will bear that in mind.

MR. BOWSHER: Yes, indeed. Noted. I am not going to engage in a debate about it now.

Sorry, I am not sure in the excitement I caught the final bit of your answer. How does that correspond, then, with your low-load analysis?

A. So in my low-load analysis I deduced that the existing satellite could service about 20 planes with that low-load scenario. If, therefore, the satellite had, let's say, ten times capacity then it could serve 200 planes. If it had 20 times capacity it could serve 400 planes.

As we have heard this morning there are about 550 planes in total, but the point has been made that it may not necessarily be the case that Inmarsat services all of those planes.

Q. Thank you. I am now going to look at the high load very briefly, for five minutes, I am probably looking at the one Viasat secret in the case, which is those yellow pages, so perhaps I could go to private just for, I hope, just five minutes.

THE CHAIRMAN: Yes, we will go into private again.

MR. BOWSHER: I should emphasise, these are, I believe, the only actual -- this and their representation in a witness statement are the only actual Viasat secret, I think, that we are concerned with in this case.

(2.05 pm)

Hearing in private (redacted)

(2.13 pm)

Hearing in public

MR. BOWSHER: Then, again, looking at the high load issue, if we could go to that LSE report that has now been looked at a few times, and we look at those graphs.

THE CHAIRMAN: Which bundle should we be in?

MR. BOWSHER: Sorry, it is E3/96, pages 33 and 34. The Viasat figures we have just been looking at are obviously current figures.

A. Yes.

Q. A lot of questions put to you on the Viasat figures are therefore what the situation is today, and you have already pointed out one of the limits there.

When you look at the European figures, and even if you take out the red and the pink, how does that compare with your expectations of growth when you look at the Viasat figures we were just looking at?

A. Yes. So as we discussed this morning, even if we

exclude the orange and the pink, there is a 10-fold increase in revenue. What we have seen in the world of mobile and home broadband telephony is actually the cost per bit tends to fall over time, therefore a 10-fold increase in revenue would like indicate an even greater increase in data volumes than that. So my anticipation would be at least a 10-fold increase in usage, but most likely significantly more than that.

Q. Where does that take you in these various facts, where does that take you in your high-load scenario. You have been challenged about your high-load scenario. Having heard all those comments on it today, where does that take you? If you want to go back maybe to your second report.

A. Yes. So ...

Q. The numbers are set out on page 39 of your first report, if that is what you are looking for.

A. Yes. So paragraph 114, page 39 of my first report suggests that the low-load scenario is 0.02 Mbits per passenger. The high-load scenario, 0.29 is about a factor of about 15 greater than that, therefore the sort of growth that we see in the LSE report would indicate that kind of level of growth.

Q. Some comments were made as to why you had used the market figures for the whole market, the 550 planes

rather than some lesser number. Can you just explain, why did you make an assumption that you were measuring by reference to the whole market rather than a fraction of whatever it is that Inmarsat are actually using?

A. Yes, sure. My observation is so far as I am aware this is the only network of this kind that is currently proposed to be installed across Europe and therefore would likely command a very sizeable fraction of the market for these kind of services.

THE CHAIRMAN: Say that again?

A. As far as I am aware, the ground network that is being proposed here is the only one that is being proposed within Europe. I am not aware of any other competitors that are employing a network of this kind. Given its advantages in terms of its ability to support much higher data rates and therefore meet passenger expectations better, I would envisage that it would be able to command a very large percentage of the marketplace. That is conjecture, of course, but that would be my expectation.

MS. WALKER: If I could, just two questions. Recognising that this may be the only combined satellite and ground market offering --

A. Yes.

MS. WALKER: -- what are the other offerings which could

provide a similar service?

A. I believe they are the existing satellite services that we have heard some mention of, both from Inmarsat and some of their competitors at the moment?

MS. WALKER: And presumably the take-up rate, presuming that this is the only offering and a better offering in terms of the receiving of data, would depend upon the pricing policy, would it not?

A. Absolutely, yes.

DR. ELPHICK: Am I right in thinking you were saying that this being the only proposed combined system you appear to be saying it would therefore have significant potential benefits for passengers?

A. Yes, I do not think combined is the issue here, I think it is the ground element.

DR. ELPHICK: Yes.

A. Because that enables the delivery of vastly higher volumes of data as we have already been --

DR. ELPHICK: So passengers will benefit significantly because of the ground-based component?

A. Yes.

DR. ELPHICK: Thank you.

MR. BOWSHER: Just arising out of that, are you using, therefore, a whole market number on the basis of an assumption as to what Inmarsat will achieve in the

market?

A. That may be slightly too strong, and I guess there perhaps should be a bit of a range given to that, I did not assume the whole market, but I would anticipate achieving a substantial fraction of it. I think it would be difficult for me to put a percentage on that at this point in time.

Q. If they do not achieve that aspiration, how does that affect your high-load/low-load scenario comparisons by reference to what either their original satellite would have done or, for example, the EchoStar satellite?

A. Mm. Yes, clearly if the percentage of the market that they achieve is significantly smaller, then they need less capacity. Eventually, as that becomes sufficiently small, it could be delivered entirely by satellite, depending on how small in the usage levels.

Q. Then the last topic I wanted to cover which to some extent is asking you about document which we know are not your documents, it is E3/114. You will have seen this is the Brice Dorman document.

A. Yes.

Q. You were being taken to pages 10 and 11.

A. Yes.

Q. If I can go to page 11, which is the UK scenario, on the basis that we know a lot of these documents use

a UK-based operator, so it is perhaps an easier comparator.

A. Yes.

Q. You were asked a number of questions about the middle column, and this linguistic issue about utilise and touch?

A. Yes.

Q. Do you use that data at all in your report?

A. No, I look purely at the first numeric -- the second column, the percentage of flight time.

Q. The one that has 6.7 per cent against 150 kilometres?

A. Yes.

Q. Can you then explain what it is that you understand that 6.7 per cent to mean in the 150-kilometre terrestrial coverage world?

A. Yes, I understand that to mean the percentage of total time of all of the flights within the European base that are outside of the coverage of the ground component whilst remaining inside of the coverage of the satellite component.

Q. Do you use the third column at all? Sorry, the fourth column? The last column?

A. No.

Q. Just one moment. (Pause).

Could you just clarify, why did you take the second

column as being a more meaningful statistic to use rather than the third and fourth?

A. Yes, because we are comparing the capacity of the systems and it is the percentage of time that satellite is being used by the aeroplanes that dictates the amount of capacity that is being required from that satellite.

MR. BOWSHER: I have no further questions for Dr. Webb. Thank you.

THE CHAIRMAN: I think Dr. Elphick has some questions.

Questions by THE TRIBUNAL

DR. ELPHICK: I have just one question, Dr. Webb, which is your first statement, paragraph 41, at the end of that, so at the top of page 17 of tab 8.

A. Yes.

DR. ELPHICK: In the last sentence you make a statement which seems quite a significant statement you are making. It says:

"Thus, it is my opinion that the ground stations in the EAN system simply cannot be controlled by the satellite resource as required in Article 8(3)(c) of the MSS decision."

A. Yes.

DR. ELPHICK: The first point to make is that the words "controlled by the satellite resource" do not appear in 8(3)(c), but they do appear in 8(3)(b), so we can

presume that is what we are talking about.

A. Thank you.

DR. ELPHICK: But if 8(3)(b), what it says is that it shall be controlled by the satellite resource and network management mechanism.

A. Okay.

DR. ELPHICK: So my question is, the words "controlled by the satellite resource", to be, as a non-technical specialist, sounds very different from the "controlled by the network resource and network management mechanism". Does it sound different to you?

A. It does, sir, yes.

DR. ELPHICK: If you had had the full quotation, you have a very sort partial quotation from 8(3)(b) --

A. Yes.

DR. ELPHICK: -- but suppose you had had the full quotation, including "a network management mechanism", would you have reached a different conclusion?

A. I think I would, sir, yes. With "network management mechanism" I could read it to mean the controlling mechanism on the ground.

DR. ELPHICK: So your conclusion that -- because it is quite an important paragraph, this, where you say that it cannot be controlled, you would now say it can be controlled because we have a full quote rather than

a partial quote?

A. Yes, sir.

DR. ELPHICK: Thank you very much.

THE CHAIRMAN: Did you look at the document in which those words appeared before you wrote this report?

A. I did, sir, yes. Clearly with not enough attention.

THE CHAIRMAN: How come you only used part of the definition when you expressed your view?

A. I do not recall that point in time, sir.

THE CHAIRMAN: Right. thank you.

MR. BOWSHER: Can I ask a question arising out of that?

THE CHAIRMAN: Yes, you may.

Further re-examination by MR. BOWSHER

MR. BOWSHER: It is file F/6, and you have to go through to page 21 where you find 8(3)(b), which is what you have just been asked about.

The phrase we are looking at is in the third and fourth lines, up to the semi colon.

A. Yes.

Q. Is it your understanding -- what is your understanding as to what that phrase means, "Satellite resource and network management"?

THE CHAIRMAN: Does it matter? This is a question of construction for us.

MR. BOWSHER: Well, it may refer to something technical, so

in that sense I would suggest that from an engineering perspective what it actually refers to may be relevant to your question of construction.

THE CHAIRMAN: You mean it may be a technical term of art?

MR. BOWSHER: It may be a technical term of art or it may make sense if one understands what it physically refers to: where is it, what is it?

THE CHAIRMAN: Well, let us start by establishing whether it is a technical term of art. If it is not, then this witness's views on construction are not going to help at all. If there is then another question, we will address that.

Dr. Webb, let us look at it this way, you see the actual words used, all the words used?

A. I do, sir.

THE CHAIRMAN: Do they have, in your experience, a technical significance or are they normal "technical" words which are strung together to describe a concept?

A. I think the latter, sir.

THE CHAIRMAN: The latter, right. So your next question is does it refer to something specific?

MR. BOWSHER: Does your understanding of those words, do they refer to a single specific notion or a number of different notions? Is it clear to you what that refers to in this sort of system, or does it refer to a range

of possibilities?

A. I think for me the key question is actually the word "and" between "satellite resource" and "network management system". I do not tend to think of the two as necessarily going together, and so I do not fully know how to read that. I would normally read the "satellite resource" to mean something on the satellite itself. I would normally think of a network management mechanism as something that can reside anywhere but manages an overall network.

DR. ELPHICK: Presumably it must be to do with including the complementary ground components, must not it, because that is how the sentence started. So I just presumed the network mechanism is referring to the totality of what is on the ground and what is in space.

A. Yes, I would think that is a ...

DR. ELPHICK: A reasonable assumption?

A. Yes.

THE CHAIRMAN: As an engineer, does it make sense if you read it as made up of two elements, either the satellite resource management mechanism and the network management mechanism wrapped up in one thing, the same thing doing both? So, in other words, satellite resource on the one hand, and network on the other, are both qualified by management mechanism, or they both qualify management

mechanism, whichever way one wants to look at it?

A. I can imagine a management mechanism that controls both elements of this network, the satellite and the ground system.

THE CHAIRMAN: Right.

A. I find it hard to envisage a mechanism where the satellite resource and the ground network combine to control something.

THE CHAIRMAN: So you can imagine an outside mechanism, as it were, managing the network and the satellite resource.

A. Yes.

THE CHAIRMAN: But you say, what is it you have difficulty envisaging?

A. Effectively the use of the word "and" again, so having some sort of joint management that resides both in a resource -- a management resource and in the satellite. I would assume from reading "the satellite resource", but that is not clear to me entirely.

THE CHAIRMAN: I do not think we are going to be able to take this any further, Mr. Bowsher.

MR. BOWSHER: Much obliged.

Further questions by THE TRIBUNAL

MS. WALKER: I have just one more question.

THE CHAIRMAN: Yes please.

MS. WALKER: Just technically, can I ask you, then, in the light of that, and I am sorry if I have been slow with the understanding of the technical aspects, but where you think in the Inmarsat system the network management mechanism resides?

A. Yes, I believe that resides on the ground in an entity that they called the Meet-Me Point, I think, in some documents.

MS. WALKER: Right, that makes sense to me. Thank you. Thank you.

MR. BOWSHER: I have no further questions.

THE CHAIRMAN: Mr. Ward, do you have any questions arising out of our questions?

MR. WARD: Sir, thank you, no.

THE CHAIRMAN: Good. Thank you, Dr. Webb, would you like to step down.

MR. BOWSHER: May Dr. Webb be released?

THE CHAIRMAN: Yes, if he wishes, yes.

The next witness is?

MR. HOLMES: Sir, the next witness is Ofcom's Dr. Harrison.

THE CHAIRMAN: Right, is Dr. Harrison going to give his evidence standing up or sitting down?

MR. HOLMES: Sitting.

THE CHAIRMAN: Mr. Ward, are you going to seek to cross-examine this witness?

MR. WARD: No, I am not.

THE CHAIRMAN: Thank you.

DR. DAVID MARK HARRISON (Sworn)

THE CHAIRMAN: Do sit down.

Examination-in-chief by MR. HOLMES

MR. HOLMES: Could Dr. Harrison please be handed bundle D. Dr. Harrison, could you turn to tab 2 of this bundle, please. Do you see there a document entitled "Witness statement of David Mark Harrison"?

A. I do.

Q. Could you turn to the ultimate page of the document, and do you see there a signature?

A. Yes.

Q. Is that your signature?

A. Yes.

Q. Is this document the witness statement which you have given in these proceedings?

A. Yes.

Q. Are there any corrections or clarifications you would wish to make to the evidence which is contained therein?

A. No, thank you.

Q. Just by way of very uncontentious matters, you are Ofcom's director of technology and strategy; is that correct?

A. That is correct.

Q. You hold a doctorate in electrical and electronic engineering?
A. That is correct.
Q. Were you involved in making the decision which is the focus of these proceedings?
A. No, I was not.
MR. HOLMES: I am grateful. If you could stay where you are, I understand that Mr. Bowsher will have some questions for you. Thank you.
THE CHAIRMAN: Mr. Bowsher, can you give us your road map, please, or your topics.
MR. BOWSHER: My topics are technical operation --
THE CHAIRMAN: Are you happy to do that in the presence of the witness?
MR. BOWSHER: Yes, I think so.
Sort of overlapping topics, really: technical operation of the EAN, capability in operation of the EAN and its components, and --
THE CHAIRMAN: Sorry, start again. Technical?
MR. BOWSHER: Operation of the EAN. The capability of the operation of the EAN and its components and how that might correspond to market expectations, the high-load/low-load issue, and then -- yes, relationship with expectations, market expectations for the EAN service, so I have said the same point twice.

THE CHAIRMAN: Right. Thank you.

Cross-examination by MR. BOWSHER

MR. BOWSHER: Good afternoon, Dr. Harrison.

A. Good afternoon.

Q. Just to clear a few thickets away, you were not part of the decision-making team at Ofcom that considered the application for a ground station, terrestrial base station licence, were you?

A. That is correct.

Q. So you are not here giving evidence about what or was not considered by Ofcom?

A. I am not.

Q. As I understand it, you are therefore really addressing two broad topics: how Ofcom understands that the EAN will work, and responding to certain factual issues raised by Dr. Webb, particularly around performance?

A. That is correct.

Q. As I understand it, you have identified in your statement the matters that you have taken into account in reaching your conclusions, in particular, that you have identified those at paragraph 8 where you specifically identify the relevant documents that you have referred to. I do not think I have an updated version which cross refers them to the exhibits bundle, but I think they are all in the exhibits bundle

somewhere now.

A. Okay.

Q. Am I right that you have not looked at documents submitted by Viasat to Ofcom in the course of the process?

A. After submitting my statement, or before?

Q. Well, before you wrote the statement had you taken account of documents written -- sent by Viasat to Ofcom? They are not listed, I just wanted to clarify.

A. No.

Q. Am I right that when you talk about coverage, you have -- I just want to cover a couple of sort of terminological questions. Where you refer to coverage in paragraph 9 of your statement, am I right in thinking that what you were referring to is the ability -- the area over which there is a reliable connection to the radiocommunication that the EAN is generating; would that be fair?

A. That is fair. Really what I am referring to is there being enough signal at a sufficient strength to be usable within the footprint. So it is where there is a strong enough signal to be usable.

Q. You are not necessarily making any observation about whether or not you are going to be able to download from Netflix on that strength?

A. No, that comes -- that is a separate issue.

Q. If you could turn to bundle B, tab 7. I should at this point say there are various topics I will put to Dr. Harrison which involve looking at confidential documents. I am going to try to avoid us having to read them out. I do not think I need to get that far, but if I stumble, I am at some point going to have to look at those Viasat documents because I do not want to deal with those with Mr. Sharkey as he is not in the ring, so it may be if I get to a hitch, I will postpone it and we will do it in one hit at the end, if I can put it that way.

If you turn to tab 7 you will see this is the response by Inmarsat to the first information request which you will have seen, and you will see that question 2 on the third page is:

"How will the EAN service be offered to airlines"?

Do you see. By all means read the whole question, but I was not going to read it all in at this stage.

A. Yes.

Q. The response to this question is a document that we must be careful not to read out, at the moment, at least, which is at tab 8. It is in yellow. At page 13 we have the technical description and the coverage discussion starts at 6.3 on page 14; do you see that?

A. Yes.
Q. I am not going to read it out, but you can see in the first paragraph of 6.3 that it is fair to make a certain distance assumption as to how far the ground stations are able to reach beyond the coast, in the last line of the first paragraph, is that not right?
A. That is correct.
Q. Presumably that is the assumption on which Ofcom have worked?
A. When I did my analysis of how the system may or may not work, I took into account that base stations could be placed near the coast. They would have, as we have heard earlier, a range of about 150 kilometres, which would mean that there would be some parts of the sea and some parts of the terrain which would not have coverage. That is what I have taken into account.
Q. We can see this reflected in the map which is on the following page at page 15, which you -- I think it must be the same map that you have lifted into your witness statement, and although it appears confidential in a number of places, I think what I am about to ask has been treated as being in public. We can see from that, can we not, that the coverage of the ground station system covers, I think it is 28 countries, and we see the areas that are problematic. They have been

mentioned before: Bay of Biscay, south of Portugal, somewhere in the Balkans, an area in the North Sea, and those flying to see England playing Belgium this afternoon will be disappointed because they will not be able to reach it in Kaliningrad, but other than that, as far as one can tell from this, it is a reasonably comprehensive coverage from the ground station?

A. Yes, I did note, when I was looking at this, that it does stress that it is an indicative map, so it is not a perfect representation, but I used it as a guide for where coverage may or may not be provided by the CGC in the satellite system.

Q. But in terms of -- that may be an indicative guide, in terms of going beyond the mere indication, you have the picture on page 6 of your report which reflects -- I know it is marked "indication", but it reflects actual locations of ground stations, does it not?

A. Yes.

Q. We can do a little bit better than that in terms of, at least, Ofcom can do better than that in terms of its own actual knowledge as to where the ground stations are going to be in the UK, because if we turn to tab 25 in bundle B and go to page 11, we have a list of them, do we not?

A. Yes.

Q. This is now no longer indicative. This is the network, at least as concerns the United Kingdom, is it not?
A. Yes, I think the indicative that I was referring to earlier was the coverage, not the location of the sites.
Q. Okay. Have you analysed the effect of these actual locations at all?
A. No.
Q. Then I will not ask you about that then.
You say in your statement ... there is nothing, therefore, in the material that you have received, is there, that suggests that there is any, beyond these patches that we see in the map, that there is going to be any remote location that is not covered by the terrestrial ground station system, is there?
A. No, I think that is right, I think it is the exact locations of where those not-spots would be that the gaps in coverage, it is where the ambiguity is.
Q. You mean the gaps that are shown on figure 03?
A. Exactly.
Q. So leaving that aside, was it your impression that this is a ground system designed to leave, as you put it, no not-spots?
A. It is a system, as I understand it, that is designed to provide coverage where it can, and using 300-odd base stations situated throughout Europe, a lot of the

landmass can be covered, but there are parts of the landmass where coverage was not feasible and there was coverage that was not feasible in some of the sea areas as well.

Q. If you then put file B away for the moment. If you turn to paragraph 18 of your statement, can I just make sure that I have understood what you are saying here. Is it right that given that you are dealing with a system where there is a high capacity connection provided by the terrestrial station, and lower capacity from the satellite station, you are expecting that the satellite element would only be used when the quality of the terrestrial connection falls below the required threshold?

A. It is a little bit more than that, actually. So I think what we are really saying is that the satellite is providing coverage, providing wide area coverage throughout Europe. It can provide a certain amount of capacity, but not enough to service all of the planes travelling throughout Europe. The CGC will be used to service where it can the planes travelling over it, and it is those two things in combination that give the coverage in capacity for the Inmarsat system.

Q. As we have seen from the map, the CGCs -- to say the CGCs will cover where they can, that in fact means, does

it not, leaving aside these identified problem locations, they will cover everywhere?

A. They do not cover everywhere, they cover the terrain where it is feasible to provide it and there are gaps throughout Europe where the CGCs cannot provide coverage.

Q. Where are those gaps? Other than the gaps we have seen here, where are these gaps that you refer to?

A. The ones we saw previously, so the gaps in coverage are over the sea paths and parts of the Balkans.

Q. If I refer to those as the gaps on the map, to use a -- just to be clear.

A. Okay.

Q. There are no other gaps than those that are shown on the map; is that right?

A. Not from this indicative map. If you looked in more detail you might find something, but not from what I can see here.

Q. On the basis that that shows general coverage, leaving aside those specific gaps, you would expect that in the area where there is terrestrial coverage that, given its higher capacity, it would be that terrestrial component that is providing the EAN service to aircraft, would you not?

A. That would be the most likely scenario, but I do note

from some of the descriptions that Inmarsat provided about how their system can operate that they can use the satellite connection as well, even when the aircraft is travelling in those locations. So I think you would have both of those options open to you. But as you rightly say, there is a lot more capacity in the CGC part of the system so it is more likely that that will service the connections to the planes.

Q. Is there any -- given the fact that you are -- the EAN is using the satellite specifically to cover those gaps on the map --

A. Yes.

Q. -- it would presumably be conserving its capacity -- such satellite capacity as it has, to cover those gaps; would that not be right?

A. I think under peak load scenarios that would certainly be the case, but I suspect there would be opportunities when there were less aircraft flying in the air for the satellite to also be used to service capacity to planes travelling, even in the areas where there are CGCs. But at periods of peak demand, I would expect that most of the capacity being supplied to planes travelling over where there is CGC coverage would be provided by the CGC network.

Q. It would seem, would it not, to be the intention of this

network to provide the high capacity, high performance CGC coverage wherever it can, and reserve the satellite capacity for those few locations where the CGCs cannot do the business?

A. Yes, that is right. Just going back to the initial point, the real role of the satellite is to provide wide area pan-European coverage, and that is why it is so well suited to filling in those gaps.

Q. So in reality it will only be those flights that cross the gaps for the time that they are in the gaps that the satellite component is actually likely to be used?

A. They would be the planes that would be most likely to use the satellite connection, but I would not exclude the possibility of aircraft travelling over land paths to also make use of the satellite connection at periods when there is not peak demand on the network, but at peak demand I would take the point that planes travelling outside the range of the CGC are those that are most likely to use the satellite connection.

Q. I do not want to spend too long going back into the technical data about these two components, but in what circumstances would a plane flying from London to Edinburgh over a busy area, clearly well within the terrestrially covered zone, in what circumstances would it ever need to go to the satellite segment?

A. For example, if the CGC was to malfunction and to operate at lower power, you might want to favour the satellite connection over those locations.
Q. Right. So am I understanding, again, to put it rather colloquially, that, again, leaving aside the gaps, everywhere else, the satellite is a fall back position?
A. I think the way I would look at this as an engineer is you have got two essential components: you have got satellite providing wide area coverage and some capacity, and you have CGC providing some coverage and lots of capacity. You put those two things together and they work to provide comprehensive coverage and capacity throughout Europe.
Q. At paragraph 16 you hypothesise that it was more likely that planes flying in and out of the UK will at some point be covered -- will go out of the terrestrial range than those from other parts of Europe. Am I right that you had not at that point done any actual work on statistics in that regard?
A. No, to be fair, that was just a simple visual inspection of the map itself.
Q. So you had not looked, for example, at the material produced by Mr. Dorman in that regard?
A. No, I do not think that was available to me at that time. In fact, I know it was not available to me at

that time.

Q. You had no comparable material of your own to think about?

A. No.

Q. Have you subsequently gone to look at Mr. Dorman's analysis and considered whether there is any reason why you would challenge that?

A. I have had a look at his analysis. At first view it looks to be broadly aligned with what I would have expected to see from that sort of simulation, so I have no reason to believe that the results, as he found, would be inaccurate.

Q. Then if we are comparing the capacity of satellite with the capacity of the ground-based network, we are comparing two comparable, similar concepts, are we not?

A. I do not think we are, actually. I think from an engineering perspective it goes back to what I was just trying to explain, that really what you are trying to do is provide coverage in capacity. You need those two ingredients wherever you are in order to deliver a good quality of service. The actual quality of service that you need to deliver depends -- will determine what those two ingredients need to look like, the coverage and capacity. It is quite artificial, in my view, to either just look at coverage or to look at

capacity and consider those ratios.

I think for an integrated system such as the one that has been proposed here by Inmarsat, you need to look at those two together, because it is those two together that will dictate the quality of service that is delivered to passengers on planes.

Q. But the comparison of the capacity of the satellite with that of the ground-based network tells you, does it not, what the ability is of a user, able to use either network, is actually able to deliver; is that right?

A. I think you need to take it a stage further, which goes back to your earlier point, which is how many planes actually travel outside the range of the CGC, because they are the planes that are going to rely on using the satellite. So those are the ones that need to have enough satellite capacity to provide the connections to the passengers on the planes then. That will be a much smaller number than the total number of planes flying throughout Europe.

So I think when you are looking at that ratio you need to think about the number of planes that are in and out of range of the CGC at any point in time, if that is clear.

Q. I think you say you have seen this number before. If you could take E3/114.

THE CHAIRMAN: 11 what?
MR. BOWSHER: 114.
THE CHAIRMAN: Thank you.
MR. BOWSHER: The figure that would seem to be the fair figure to take as to the plane that you were just referring to --
A. Yes.
Q. -- is on page 11. If you look at the table on the top of page 11, second column, last number, 6.7 per cent; do you see that?
A. Yes, I do see that. I actually think the EU scenario is probably the more relevant one here, because this is clearly a pan-European network. It is not a network that is simply designed to support planes in and out of the UK, but I take the point if we only look at planes in and out of the UK --
Q. The numbers are either 8.9 per cent or 6.7 per cent, are they not?
A. They are.
Q. On any view of the total flight time of planes over Europe, less than 10 per cent of the total flight time is in the space where it would be having to rely upon satellite coverage, that is right, is it not, that is what this shows?
A. That is right, if we assume that you can achieve the

maximum 150 kilometres range of the CGC base stations. It would be slightly above 10 per cent if the range of those base stations were a little bit less than that.

Q. We have the figures here to indicate a little bit of sensitivity, though?

A. We do.

Q. You would presume, would you not, that at the very least, those designing the network of ground components would go out of their way to make sure that they actually placed some of those ground stations near the coast so as to ensure that they were able to make the most, as it were, of --

A. As best you can. But it is always difficult to secure exactly the sites that you would really like to use, so that is not always possible.

Q. If we can just go back to, then -- we can put E3 away and go back to the marketing material at B/8. I just want to read out one paragraph which ...

THE CHAIRMAN: Do you need to read it out?

MR. BOWSHER: It is page 14, 6.3, under the heading "Coverage", I just wanted to read the text. So what Inmarsat said they were achieving was:

"The coverage area for the European CGC network is geared towards the high density airline route network."

B/8. 14. 6.3.

MS. WALKER: Thank you.

MR. BOWSHER: Sorry:

"The coverage area ... is geared towards the high density airline route network."

So am I right, that means that you are being told by Inmarsat that they are placing CGCs in a place that is useful to catch aeroplanes?

A. That would be logical, yes.

Q. That would make sense.

"Over the landmasses the cell radii will be sized in order to provide maximum capacity to the required coverage and within the coastal areas, the cell radius can be extended to around 150 kilometres to cover a major portion of the air traffic in these regions."

So your understanding would be, presumably, from that that the intention was to ensure that the CGC network was placed in such a way that firstly it caught as many aircraft as possible, if I can put it that loosely?

A. Yes.

Q. And went as far out to sea as possible?

A. Yes, and just to go back to the earlier point, you cannot always secure these high mass sites in the exact locations that you would like because often there is a lot of sensitivity around putting base stations right on

the coastline so sometimes you have to set them inland a little bit.

Q. I think what I wanted to go to next may be sensitive so I am not going to read it out. Just above the heading 6.4 there is a line, there is a heading, "6.4 On-board equipment" and there is one line I would like you to read to yourself without reading out, because I think this might be sensitive?

THE CHAIRMAN: Beginning "Where only MSS ..." Do you see that? Just below the plan, the map, there is a line which starts "Where only MSS ..."

A. Oh sorry, yes.

THE CHAIRMAN: Read that to yourself, please. Do not read it out.

A. Yes.

THE CHAIRMAN: Have you read it?

A. I have read it.

MR. BOWSHER: My understanding is that is describing an eventuality which may happen presumably only where you are out of the CGC range; is that right?

A. Yes.

Q. And it would be fair at that point that the service is not providing the same level of service as can be expected from the network overall?

A. That ...

Q. I am being deliberately vague.

MR. HOLMES: Sir, I do not believe this sentence should be regarded as confidential and I do not want to have Dr. Harrison to have any difficulty in responding in order to ...

THE CHAIRMAN: I struggle to see the confidentiality.

MR. HOLMES: It has been mentioned in open court on at least two occasions now, the point which is contained in this sentence.

MR. WARD: We have no objections about it being read at all. I am sorry to be slow to respond.

THE CHAIRMAN: I know you have to get your instructions. Right, we can now all read it.

MR. BOWSHER: We can now all read it. What that is saying is there may be circumstances beyond the CGC range where all that the system can do is provide cached content to users?

A. I do not quite read it that way. It seems to be referring to in-flight entertainment and I am not quite sure what exactly is encompassed by in-flight entertainment. One might imagine it is to do with the videos that you might be able to access on board and when you are in the range of CGC you might have access to a wider range of films than if you are relying solely on the satellite, in which case you would be diverted to

a server hosting content on board. That server may also host, for example, the top 100 Netflix films, the top clips from the BBC iPlayer and other sources, in a way to try to service as much of the demand for video as possible but without having to use the connection over the satellite.

But it is difficult with this short phrase to know exactly what is in scope and out of scope for in-flight entertainment.

Q. Whatever IFE precisely covers, that indicates, does it not, that there may be circumstances where a different service, not a live, interactive communication is provided, but a different cache download service is being provided through this system?

A. Yes, I think in practice what would happen is that the connection for, what I would call the long-tail content, maybe people browsing the web, sending messages and e-mails, that would continue, but if somebody wanted to start a new session of video and you were in one of these not-spot areas, relying solely on the satellite, you would be most likely, logically, directed to a cached server on the plane which would be storing films. So you might have access during that period to a more limited range of films than you otherwise would have had.

But I would expect that the things like core services, things like web browsing, e-mail, social media, you would still be able to access those services.

Q. So, therefore, during that period when you are out of the ground station connection, the MSS as a whole, the service as a whole is not delivering the same service as is expected of the ground service, the ground station service?

A. It would not be offering the same -- I suspect it would not be offering the same in-flight video service, that would be my logical conclusion from it, but I cannot be absolutely certain of that.

THE CHAIRMAN: Well, what you understand is presumably this: the ground service is capable of providing a pretty good service, streaming video, films on demand, and so on.

A. Exactly.

THE CHAIRMAN: Do you say there are any circumstances under which realistically, even inside one single aircraft, this satellite system could be relied upon to provide that sort of heavy duty service at all?

A. It could, yes, absolutely.

THE CHAIRMAN: Sorry, to the number of aircraft to whom it might need to provide it during these periods?

A. Yes, I suspect we will get to the low and the high scenario, but certainly under the low scenario you would

expect some video content to be delivered within that particular capacity/demand scenario, and therefore, yes, you would be able to deliver some video services even if the satellite was -- even if the plane was travelling purely within the satellite coverage.

THE CHAIRMAN: But if you are offering a service in which you are not offering sort of pot luck depending on the other demands of the service and how many other aircraft happen to be flying across not-spots and so on, you are going to have to provide a reliable way of providing this in-flight entertainment, are not you?

A. That is right. I think -- it is a little bit sketchy, but speaking as an engineer, if I was designing this system what I would do is I would certainly rely on cached content on the aircraft for the most popular content, the most popular films and the most popular iPlayer video sequences so that you would never have to service those over the satellite, it would (inaudible) could do so, and what that does is it frees up capacity for what I would call the long-tail activities, the things that people really do need that real time connectivity for, things like voice calls, e-mails, social media updates, those sorts of thing.

THE CHAIRMAN: In other words, never mind the theory as to whether this satellite could deliver a film to some

users under certain conditions, if you are going to be offering a standard service you would need to have cached content, that is pre-stored content, on the plane itself?

A. I think it would be a logical approach. In the early deployment of the system when you have not got too many passengers and too many planes accessing it you might not need to rely on that, but I think as a forward-looking strategy for management capacity, using cached content would certainly be a logical approach.

THE CHAIRMAN: Yes. Thank you.

MR. BOWSHER: I am conscious I did not ask what time you wanted to take a break for the shorthand writers' break.

THE CHAIRMAN: We will just carry on a little longer because we are going to go later, if our shorthand writers can bear with us for a few more minutes, then we will have a break, a slightly longer break.

Just before we go on, since we have broken our train of thought, Mr. Bowsher, about that, you indicated I think yesterday that you were going to be two hours with one witness, presumably this one, and one hour with the other one.

MR. BOWSHER: The other way around, I think, yes.

THE CHAIRMAN: The other way around. So you plan to be one

hour with this witness, is that correct? So you are three hours in aggregate, because you mentioned two hours before lunch, which suggested an aggregate.

MR. BOWSHER: I was aiming for two but expecting three. Between two and three. I mean, I am being intentionally --

THE CHAIRMAN: Right. So you plan to be, at the moment, no more than an hour with this witness; is that right?

MR. BOWSHER: That would be my hope, yes.

THE CHAIRMAN: Right, it may have to be your plan, Mr. Bowsher, just so you know, because we are not sitting until 7 o'clock or 8 o'clock so we can finish this case. The other counsel were to a degree, Mr. Ward less than Mr. Holmes, time-limited, and you are going to be the same. You should assume -- I did not notice when you started actually, it was about 2.30. So you should assume you are not going to have much more than an hour with this witness, or if you do, it will eat into your next one.

MR. BOWSHER: Let me come on, then -- I want to come back to that in a moment, but first I want to look, then, in your statement at page 11. Paragraph -- were you in court today?

A. Yes.

Q. So you heard more than enough about high-load and

low-load scenarios, but let us go back to it anyway. If I can try and take it shortly, where Dr. Webb ended up on high-load -- on low-load scenarios is that he stood over his figures and, as I understand it from your paragraph 27, you are essentially saying that while you might quibble with one number or another, you end up in roughly the same -- sorry, I am in the wrong spot -- from the next couple of paragraphs, 28 and onwards, you end up in roughly the same place as him on the low-load scenario?

A. That is correct. On the low-load scenario we are in the same place.

Q. On something which is inherently unknowable, if you loosely put it between 2 and 20 planes, we are in the right sort of area; is that fair?

A. I think, just to unpack that, I think there are a couple of aspects to the low-load scenario. There is how much capacity each user will use on average, and I think 20 Kbits/s on average was the number that William Webb recognised and is a number that we would recognise.

I think then turning that into a number of planes is linked to the number of passengers and take-up and I think we are broadly aligned there.

So if you take the low-load scenario, you take the capacity of the satellite, where I think we are broadly

agreed, then you get to an ability to service approximately 22 planes.

Q. I am just trying to translate that back into what we have just been talking about in terms of what services are actually going to be delivered. That in short means that at the low-load scenario the satellite might be able to meet between -- whether it is 2 or 20 planes, that happen to be in the gaps on the map, if I can put it that way.

A. Yes.

Q. Once you start getting to somewhere between 2 and 20, you are going to have to start relying on other content; would that be fair?

MR. HOLMES: There was a premise in that question, I think just for the avoidance of doubt and to make sure that Mr. Bowsher correctly heard the last answer, I wonder if Dr. Harrison could clarify the number of planes which he said would be served, because I think you presented a range which differed from what I heard Dr. Harrison to say.

THE CHAIRMAN: Yes.

A. So based on my calculations I calculated that 22 planes could be provided with a connection on the low-load scenario.

MR. BOWSHER: You are quite right, I did not hear correctly.

So taking your number 22, once you get beyond 22 planes on a low-load scenario, using the satellite service in the gaps, wherever those happen to be, in a sense the system will start, but the next person who comes on will not be able to use the MSS in that area?

A. It would not be as catastrophic as that in practice. So the congestion on the internet is not a new thing. It happens all the time. So we all will have experienced a web page just taking a little bit longer to download, those sorts of things would happen. It would not just stop. Things might slow down, and you would have to go a long way beyond that before things would actually start to stop and certainly prevent new people connecting to it.

Q. If we are in the high-load scenario, the system is going to stop at a much smaller number of planes, is it not?

A. It would, but as I think we explored this morning, the high-load scenario does not, in my view, represent a plausible one.

Q. Right.

A. Could we just come back to the low scenario, because it has been titled a low scenario, but actually when you look at the capacity that is being delivered under the low scenario, it is still a few hundred Kbits/s for the passengers that would take that service. That is more

than adequate, going back to the earlier question about would that be sufficient to deliver to a percentage of those passengers video or other services, so whilst it has been caricatured as a low scenario, it is actually quite a capable connection and can deliver a wide range of services.

Q. Okay. Let's come to that. You have characterised Dr. Webb's higher scenario as relating to peak bit rates, but if you go to D/9, page 5, paragraph 16, you will see where Dr. Webb addresses some of your comments. Firstly, do you see, paragraph 16, page 5, paragraph 16(a), he is right, is he not, if you are into video streaming and that is what the service is that is aspired towards is going to enable, that is not a peak activity: that is a long, continuous activity which users will be using. So you cannot regard that as some sort of exceptional peak activity, can you?

A. It is not peak in that respect. It was peak with respect to that being representative of the actual bit rate that you would need to deliver standard definition video. So I think, as we heard earlier, depending on the type of video that you are accessing and who the video provider is, they will set different bit rates to deliver what they will call standard definition video. Some will set that at 500 Kbits/s, some will set it at

300 Kbits/s. If you are streaming high motion sports content which needs more bits because there are more things taking place in the pictures, then you might use 1.5 Mbits/s.

So the point I was trying to make here was that if you assume that everybody required 2 Mbits/s to deliver standard definition video, and that was not the peak number but the average number, that would be overly pessimistic in estimating the capacity that passengers would need to access video services.

Q. But if you go on to page 6, just the following page, you will see that it is not Dr. Webb's assumption that everyone will be using video. On the contrary; he has a much lower percentage, 10 per cent is his assumption. So your criticism does not seem to be based on a true premise?

A. That is not quite what I was trying to say. I think the way he has done the calculation is to assume that everybody who is accessing video will be using 2 Mbits/s. The issue I am raising is I do not believe that would be the case, I think some people would be accessing video in standard definition at 0.5 Mbit/s, even 300 Kbits or 0.3 Mbits/s. Granted, some might be more towards the 1.5 Mbits/s, but if you were to look at what the average was in terms of the bit rate used to

deliver video to passengers in standard definition on the plane, I do not believe 2 Mbits/s is the right number; I think that is too high.

Q. Okay, well to look at it the other way around, if we take it for the moment that the aspiration of this service is to meet the demand of users who are used to a home broadband service, if I can put it that way, it is relevant, is it not, to look at what consumers have come to expect from their home broadband because that is what they will be measuring against when they are sitting in the plane. They will not be thinking what the satellite could do, they will be thinking how does this compare with what I usually experience when I watch a film?

A. I think in reality it is a subset of what people do at home. So we think about the real world scenario of people going on planes, they are taking their smartphone and they are taking their tablet. Granted, people will be using those devices in their home, but we should really only be thinking about the capacity they would use on those devices which would then be exported, for want of putting it a better way, on to usage on the plane.

What you would want to discount from the calculation is streaming to children in their bedrooms, because

really the capacity calculations we are doing here are per passenger, we are not doing them per household or per family, so you would want to discount any usage by other people, and you would also want to discount usage on devices that you simply could not take onto plane like large screen TV sets and full blown games consoles.

Q. Let us unpack this. The first point, and I suggest it is not a terribly good point, if you as a family have a certain demand at home, that is likely to be replicated in terms of the number of users on the plane. You are likely to be all sitting there doing your different thing, and if you are users of home broadband you are likely to be doing similar things, all of you individually in the plane, are you not?

A. I think that is fair, but when you do the calculation, that is where it breaks down. So if you do a calculation based on an assumption for consumption per passenger based on a per household number, which is the home broadband number that was presented in -- that I think you are referring to, the 4 Mbits/s, that is too high, that is not a per passenger number, that is a per household number and includes consumption on devices that you simply could not take on to a plane so I do not think it is a fair number.

Q. There are two points: Firstly, the number of users.

The number of users is probably going to be the same, will it not?

A. The calculations that have been done have been per passenger, so it needs to be a per passenger number; it cannot be a per household number.

Q. I will start again. If a household of four people has a certain usage, assuming they are using the same equipment, which I will come on to in a moment, those same four people are going to be using the same -- they will have the four-person demand when they move to the aeroplane, will they not?

THE CHAIRMAN: Do you mean in terms of data or do you mean in terms of the activity --

MR. BOWSHER: The activity. There are still four users.

THE CHAIRMAN: I think you are going to be at cross purposes unless you make that clear. If they all four watch films, they will be watching films on the plane.

MR. BOWSHER: Yes, that is the first point.

THE CHAIRMAN: Never mind the data consumed at the moment which is no doubt a function of the device you are talking about.

A. That is right. I think there is a separate point, though. So if you take a capacity number on a home broadband connection, that connection is effectively serving, on average, three or four people. What you do

not want to do is take that number and import that into a calculation of capacity usage per passenger: you would need to divide that number by the average number of people in the household.

DR. ELPHICK: That must be right.

THE CHAIRMAN: Yes.

MR. BOWSHER: In any event, as Dr. Webb has already explained, whilst he has started his calculation from a home figure, his high-load scenario -- high usage scenario is a fraction of what you would expect from the home broadband figures; is it not?

A. It is. If I were doing this calculation I would not use the home broadband number, I would use capacity usage on to smartphones which Ofcom reports on annually, as it does home broadband usage, and that is 100 times less than the home broadband usage number.

I am not arguing that the usage on the plane would be as low as that because you might argue that people would make more intensive use of their smartphone when on the plane, but you are looking at those orders of magnitude between what people consume on smartphones today and what the home broadband usage numbers tell you, it is 100 to 1.

Q. The reality is on a plane people are more likely to be using a larger device, are they not, like a tablet or a

laptop so that your smartphone figures are not necessarily going to be fair. They may be an underestimate?

A. They would be an underestimate, but there is 100 to 1 difference.

THE CHAIRMAN: Is that a convenient moment for our break?

MR. BOWSHER: Yes, sir.

THE CHAIRMAN: 10 minutes.

(3.25 pm)

(A short break)

(3.38 pm)

THE CHAIRMAN: Mr. Bowsher, in view of the timings that are involved and the timings of needed departure of members of the Tribunal, we must make sure that we have all the evidence finished in this case by 5.20 at the latest. There will be bits of housekeeping. I hope we would not have to go on that long, but we may. There are bits of housekeeping to be done which will take the last few minutes. So that must be your target and you must leave some time for re-examination. I do not know whether there will be much, but we do not yet know.

MR. BOWSHER: Thank you, I am much obliged.

THE CHAIRMAN: So you must use your time wisely.

MR. BOWSHER: Yes.

Can I go to E3/113, it is the confidential document,

I have already mentioned to Mr. Ward and I think the court has already been more or less sorted.

THE CHAIRMAN: Well, I can recognise at least one person who is not within the circle, I think. Are you going to need non-circle people excluded?

MR. BOWSHER: Non-circle people excluded. It is only three or four questions but then I am finished. Sorry, I have not been able to see quite who is going in and out. Sorry. I am much obliged.

(3.39 pm)

Hearing in private (redacted)

(3.51 pm)

Hearing in public

THE CHAIRMAN: Mr. Holmes, are you going to want to cross-examine Mr. Sharkey?

MR. HOLMES: No, sir.

THE CHAIRMAN: Thank you.

MR. PATRICK VINCENT SHARKEY (Sworn)

THE CHAIRMAN: Do stand or sit, as you like, Mr. Sharkey.

Examination-in-chief by MR. WARD

MR. WARD: Could Mr. Sharkey be given bundle D, please. Could you turn to tab 4, please, Mr. Sharkey. Are you Patrick Sharkey of 99 City Road, London, EC1.

A. I am, indeed.

Q. Turning to the last page of that document, is that your

signature at the end?

A. It is indeed.

Q. Is this your witness statement in this case?

A. It is indeed, yes.

Q. Is there anything in here that you would like to change or qualify?

A. No.

Q. If you could turn now to tab 7 of this bundle, is this your second witness statement in this case?

A. Yes, it is. Yes, indeed.

Q. On the last page, is that your signature?

A. Yes, that is correct.

Q. Is there anything in this document that you would like to change or qualify?

A. No.

Q. Finally, just for clarity and context, if we turn back to your first statement, on page 2 in paragraph 5 you explain your job title and you say:

"I am an engineer specialising in satellite and wireless communication systems with experience in specification, design, development, test and operation of mobile, fixed and broadcast radio frequency communication systems."

You say you have been employed by Inmarsat since 2001; is that correct?

A. That is correct.

MR. WARD: Thank you. I will sit down. Others will have questions.

Cross-examination by MR. BOWSHER

MR. BOWSHER: Good afternoon, Mr. Sharkey. A few questions.

Could you take file E1, please, and go to tab 7. I am going to have to ask you for some information because these are things that you know that I do not, and this is the press release concerning the originally planned Inmarsat satellite, and what I wanted to get is a sense of how that compares with what you have now launched, do you see?

So if you see on the first page of that the original plan was for -- it is in the second paragraph -- a payload generating 9 S-band user spot beams in 2 polarisations. It identifies the size of the 12-metre diameter aerial. Then if we go over the page, it has payload power of 8.5 kilowatts. That is your understanding, is it, of what the originally planned satellite was based on?

A. I was not part of the development team that looked at that original satellite. I know a great deal about the as-built satellite, but to the extent that I can talk about this topic, what appears to me here seems to be perfectly in keeping.

Q. The Hellas Sat 3 satellite on which your payload now is comprises -- your payload comprises three beams; is that right?
A. Correct, yes.
Q. With a lower payload power figure than we have here for this EuropaSat S-band satellite, that is correct, is it not?
A. Correct, yes.
Q. I think Dr. Webb has estimated, although it is obviously not his expertise, more yours, that the power of your Hellas -- the payload you have on Hellas Sat 3 is about a quarter of what is envisaged on the EuropaSat; is that right?
A. I think the power figure quoted here for our satellite is a little bit low, but 2 and 8, more or less, a factor of 4.
Q. It may be in the light of your answer that you do not know the answer to this either: whether or not the significance of the nine beams in two polarisations means that one is talking of a threefold or a sixfold increase in capacity due to beam size; is that right? Do you know the answer to that?
A. It would be a threefold capacity increase. So -- and this is, perhaps, a slightly technical issue. For this type of satellite it would not be practical to attempt

to use the two polarisations to double the capacity.

Q. Taking the power increase and the beam increase, therefore, you have approximately a 12-fold increase in capacity, do you not, if you had gone on this original solution?

A. No, you have a 3-fold increase.

Q. So the increase in power you do not regard as useful?

A. So as was presented by Dr. Webb in his submission, he included some material related to the famous Shannon law, which is the standard technique that a radio engineer would use in order to determine the theoretical capacity of a radio system, and the Shannon law says, in very simple terms, that the capacity in bits per second is directly proportional to the available spectrum, but it is not directly proportional to the quantity of power that you have. So you cannot multiply the power times the bandwidth; it is simply not the case, as Dr. Webb explains.

Q. Even on that basis, whatever the power position, the Hellas Sat 3 payload represents a significant reduction in capacity, does it not, of the satellite segment of your EAN provision, 3-fold on your view?

A. That is correct, we have very clearly changed the balance of the components in the S-band solution in order to reflect a different balance of performance,

risk and so forth.

Q. If you could ...

THE CHAIRMAN: Sorry, on the Shannon's law, and forgive me, Mr. Bowsher, and tell me if you want me to not ask this question -- two questions: if one applies Shannon's law what is the relationship between an increase in power and an increase in capacity, or an increase in delivery? Is it skewed by the log base 2?

A. That is exactly it, yes. So it really depends on your operating point. So Dr. Webb, in his submissions pointed out that one factor is signal-to-noise ratio. If we were operating with a very low signal-to-noise ratio, then adding more power would have a very substantial increase in capacity. If we are operating at higher signal-to-noise ratios, then adding capacity may indeed have an almost negligible improvement. It really depends on the operating point that we are working at.

Specifically related to the power operating point, as you have pointed out, there is a figure here that says that the payload power in our satellite is 2 kilowatts, that is 2,000 watts. In the link budgets that Dr. Webb has put in his first submission, he presumes that the payload delivers 100 watts, so there is a disparity between Dr. Webb's submission and what is

here.

THE CHAIRMAN: Then my other point is, the polarisation, what is the significance of the polarisation, you have got nine beams with two polarisations? What is the significance of the polarisation?

A. On an S-band mobile satellite, much like the L-band mobile satellites that we typically operate, the only benefit -- the significant benefit of using polarisations is to provide you greater separation between beams where you are using the same frequency, so it allows you to reuse the frequencies a little bit closer. That would not be the case for a satellite like the satellites that, for example, our colleagues at Viasat use where, in those higher frequencies with very much more precise antennas, with better discrimination between the polarisations, you can make use of the same frequency in the same coverage twice over by using two different polarisations. You cannot do that in L-band. Inmarsat has never been able to do that and you cannot do it in S-band for mobile terminals. It would not work.

THE CHAIRMAN: So what it does, it helps you to use frequencies more efficiently in the fuzzy areas at the edge of each. Each beam, or each cell. Each beam, is that right?

A. Yes. Yes. Absolutely.

MR. BOWSHER: If you could take file B and go to tab 8. This is Inmarsat marketing information which was provided by Inmarsat to Ofcom in response to a request. I can take you to the request but I do not think it matters particularly, but this was provided -- it is a document presumably written for an airline; is that right?

A. I would stress this is marketing material, not engineering material, but absolutely correct.

Q. It is a document written for an airline.

THE CHAIRMAN: B/8, are we?

MR. BOWSHER: B/8, yes. Sorry, did I not say that? It is marketing material prepared for an airline but it is a document which was provided to Ofcom pursuant to Ofcom's request, which you can see in the previous tab, it is the third page of the previous tab if you wanted to see the question. It is at B/7, and you can see the question that they raised, "How will the EAN service be offered?"

A. Okay.

Q. Do you see that? B/7, third page, question 2:

"How will the EAN service be offered to airlines?"

So it was put forward to Ofcom in answer to that question. If you could turn to page 15.

Can I just read the first line?

THE CHAIRMAN: Do not read it out. Point the witness to it.

MR. BOWSHER: The first line.

THE CHAIRMAN: Of what?

MR. BOWSHER: The first line:

"The EAN consists of two parts, a satellite terminal --"

THE CHAIRMAN: Do not read it out just in case there is a sensitivity.

Just read the first line of paragraph 6.4, Mr. Sharkey, would you please, and tell us when you have read it. The first sentence, basically. Yes?

A. Yes.

THE CHAIRMAN: Right.

MR. BOWSHER: Do you see that?

A. I have got that.

Q. That is how the EAN was presented to airlines and to Ofcom. In paragraph 18.2 of your statement, page 5, tab 4, page 5, this is your first statement, do you see that, 18.2. This is under the heading, the paragraph begins:

"The EAN platform is made up of several components which are briefly described below."

In the second you refer to something called the "S-band terminal". That, can I suggest to you,

Mr. Sharkey, is not how this platform was presented to either Ofcom or to purchasing airlines, is it? It was not presented as comprising something called the S-band terminal?

A. I think that is incorrect. I am not sure which of this I am allowed to read out, but the text in yellow that is confidential talks about "a something", and the text at paragraph 14.2 talks about "the terminal": I am not sure I understand the distinction.

Q. If you read on in the paragraph, the S-band terminal, it is suggested here that the S-band terminal you are describing is a single terminal comprising both the elements that we see, plus more, that we see in pictures under paragraph 6.4; do you see that?

A. Okay. Got you.

Q. I am suggesting that paragraph 18.2 has been rather carefully crafted to meet the point made in Viasat's appeal and does not actually reflect the way in which Inmarsat presented matters to either purchasing airlines or to Ofcom.

A. Okay. So we are delivering an EAN product. My approach for that product is what we describe as a shipset consisting of a number of different boxes that are installed on the aircraft.

To the extent that we deliver something, that is

an individual, an indivisible set of pieces of equipment.

Q. I do not think you have taken issue, have you, with Dr. Webb's proposition, I think it is in paragraph 37 of his first report, that it is the modem that converts the electrical signal to a digital data stream and creates something usable for the user; that is right, is it not?

A. That is what a modem does, yes, correct.

Q. Each of the two -- each of the antennas, the one facing up and the one facing down, has a separate modem, does it not?

A. Yes. Absolutely, it does indeed.

Q. So that what comes out of each separate modem is a separately usable data stream, if I have got that right?

A. Is a separately -- well, it comes out of each of the modems and then goes into our communications manager where we combine the two data streams and then a single data stream comes out of that to the wireless access points on board the aircraft, and that is the service we provide to the cabin.

Q. But each modem itself creates a signal which could be sent on to users without going through that additional hub.

A. So you are quite correct in the sense there are two

separate radios and there are two separate sets of antennas, two antennas at the bottom of the aircraft, one antenna at the top of the aircraft. We have developed the system in such a way where we have tested the individual pieces separately, so we have flown flights with just the satcom system around Europe and we have flown flights with just the CGC system around Europe and then we have integrated the two together into a single shipset and flown that together, and that is the system that I, managing the engineering, has delivered to our business unit as the EAN product.

THE CHAIRMAN: Did you say you have integrated them into a single chipset?

A. A single shipset, with an "s".

THE CHAIRMAN: Shipset, sorry.

A. Yes, apologies, that is something we often get wrong ourselves.

MR. BOWSHER: I think that illustrates -- maybe, just to make sure I have got the point. So the fact that you have been able to test these two systems separately means that in principle, each antenna and modem is producing a separately usable signal which could be used within the aircraft; is that right?

A. We do not supply market, design or deliver the system to be used separately; we only supply it with the

communications manager, which combines the two, and there is another element in the ground -- in the network which combines the signals at the other end. So we have two transport links over the satellite and CGC bound together at the ground and at the aircraft.

Q. I follow that. Can we go back to my question? You have flown these two systems around separately, one operating independently. The two systems produce a usable signal independently of each other; is that not correct?

A. Absolutely correct, yes.

Q. One does not need the other to function?

A. Well, if you were to supply this as an EAN product, you would need both.

THE CHAIRMAN: Can I see if I understand this by reference to a slight home-spun analogy. Imagine a central tank which supplies water to a consumer. It is fed by two separate pipes coming in at the top, which are not linked, they come from two separate supplies, and the tank supply combines the water and gets fed out to the consumer.

You could turn off each tap and still have a supply for the consumer in this analogy; right?

A. That is correct.

THE CHAIRMAN: Am I right in thinking that at a fairly crude level, but I hope informative level, that describes the

process of feeding the two signals in this case. Each of the two signals is like a separate tap, a water supply, which are feeding into the central server, as it is in this case, and that then gets fed out to the consumer?

A. That is correct, with one subtle caveat, and Dr. Harrison made this very well, one of the routes is better in terms of coverage and the other route is better in terms of capacity.

THE CHAIRMAN: Certainly, one has a lot more water coming in than the other, but nevertheless they both do it.

A. Indeed.

THE CHAIRMAN: They may both, in theory, this is where the analogy does not work so well, but in theory, they could supply at the same time, but if it is convenient to have only one tap supply or the other tap supply, then that has to be determined by something, and the analogy is not so good here, that is determined by somebody sitting in a building somewhere else who by electronic means can remotely switch from one tap to the other, and that is your ground thing which determines whether the aircraft takes a signal from the earth or the sky; is that how it works?

A. That is absolutely correct. Yes, indeed.

THE CHAIRMAN: Right, so the switching thing is like

a remote server for the taps, as it were, if you like?

A. Yes.

THE CHAIRMAN: Right. Thank you.

MR. BOWSHER: Let me turn to standards. I do not think -- you agree now, do you not, with Dr. Webb that the DVB-SH standard is an appropriate standard for use on both satellite and terrestrial application?

A. So the DVB-SH standard that we were talking about in the documentation, if you were to use it in a way that the two paths speak the same language is really only designed for broadcast applications.

Q. That is not what you said in your statement, is it? Maybe I should come back to that point.

The LTE language which you are using for ground communication is a product -- I am not sure whether it was written by, but I think it is, I think, proprietary to Deutsche Telekom; is that right?

A. No, that is categorically wrong. It is a product of the European Standardisation Institute which is a body which is related to CEPT, which we have talked about earlier on, so it is a European standard.

Q. It is the standard that Deutsche Telekom uses on its mobile phone network?

A. It is the standard that every mobile phone network uses more or less in the modern world.

Q. In this case, you are using existing Deutsche Telekom towers in order to fit equipment to create the ground stations; is that not right?

A. Let me just clarify that. When you say "towers", I presume you mean the metalwork that is on the ground upon which you erect your specific equipment that is designed for your particular application.

If I understand where you are going with this, is that you are trying to determine whether or not the EAN ground segment is a system that is designed or developed and deployed specifically for Inmarsat, and is exclusively --

Q. I think you are overthinking the question. Are the ground stations Deutsche Telekom ground stations? You are right, we are talking about the towers, we are talking about the physical structures on which the equipment is being placed: are they Deutsche Telekom towers that are being used; is that correct?

A. So we are talking about the towers; correct?

Q. Yes.

A. Not necessarily. Generally speaking we have tried to use existing towers because in general it is exceedingly hard to find and build new towers and get planning permission for them so, wherever possible, we have acquired space on existing towers, not necessarily

Deutsche Telekom's, from many other providers, Abertis, Arqiva, Europe has a number of different tower companies and those tower companies have been put to work installing the Inmarsat equipment.

Q. So the ground network is built upon existing mobile phone stations not necessarily owned by Deutsche Telekom; is that right?

A. Not necessarily mobile phone stations. Our goal is to try and use relatively high towers, so we have used towers that may carry television services or radio or things like that. Not necessarily mobile phone.

Q. You are using these existing structures to fit the ground stations in locations which you have identified as being, presumably, the optimal location for the equipment; would that be right?

A. So if you are interested in the details about this, we choose the optimal locations to begin with in our radio network planning and then we adapt those locations to find sites which have existing towers, where possible to avoid having to build new towers, because that is an extraordinarily difficult and expensive thing to do.

Q. You have, for example, sought, presumably, we have seen elsewhere in the documents, to make sure that you have good coverage in places where there are dense -- where there is dense airline traffic. That has been one

criterion?

A. In general, our goal is to maximise coverage first. So we have tried to get a reasonable spread.

Q. Okay. I was going to come on to that but I will do it the other way around. So you have started by getting the reasonable spread, presumably including making sure the coastline is as well covered as possible, presumably?

A. Not necessarily, the goal is contiguous, using as few towers as possible. We have not explicitly attempted to get towers as close as possible to all of the coasts, both for the reasons that Dr. Harrison explained in his statements, that finding towers close to the coast can be difficult from a planning permission perspective, but also if you attempt to do that you will leave larger gaps than you would otherwise do so.

Q. So the design of the ground station network has been to ensure that the ground station network itself achieves maximum coverage; is that right?

A. Yes. At reasonable cost.

Q. Right. And am I right, therefore, that it is -- the satellite has its own different coverage map, which we have seen many times. Is there any instance where you have sought to -- where you have identified that there is a lack of satellite coverage and you have sought to

place a specific ground station there because of the lack of satellite coverage?

A. No, categorically not, because we are not allowed to put towers outside the satellite coverage.

Q. So you have never sought -- although have you ever looked at the capacity or ability of the satellite to deliver the service and sought to improve that with a specific ground station?

A. I am not sure I fully understand where this goes. I think in general, and it may be this does not answer your question, the goal of the satellite is to maximise coverage at the expense of density. The goal of the CGC network is to maximise density, but it does not really provide the blanket coverage. We try and stretch both of those two components so that they try and make up for one another. In some cases we cannot always do that but we do the best we can.

THE CHAIRMAN: I think the question is this: imagine it wants to know whether you have done this, you have looked at your map and looked at your coverage and seen that is not a very good place for satellite coverage, we had better have a mast covering that. Have you ever done anything like that?

A. I do not think so, no.

THE CHAIRMAN: No. It would not make much sense, would it,

because the satellite basically covers everything, and you have you assumed that, have you not?

A. I have designed that.

THE CHAIRMAN: Yes, quite. Within those three lozenges, it is covered there, so the exercise I have just described would be a meaningless one in that context?

A. I think so, if we interpret that way.

MR. BOWSHER: I may come on to some of the numbers, but the power capacity and the capacity of the ground-based network is generally much greater than that of the satellite, is it not?

A. So let me see if I can repeat that back to you. You are saying the power of the ground network?

Q. The capacity of the ground network is greater than that of the satellite segment.

A. In terms of aggregate bits per second, that is absolutely correct, yes, indeed.

Q. So your expectation is that you will be -- that the service will primarily be providing a service through the ground station to customers in general?

A. So if you are saying will the ground network in general provide a greater bit rate to the customers in aggregate compared to the satellite, that is absolutely true. Your second point follows directly from your first.

Q. And any given plane and any given user in a plane taking

off from any airport, as they take off, when they start to use the service, the expectation will be, will it not, that they are using the ground-based service?

A. Yes. Yes.

Q. The only --

A. Well, let me just qualify that. The way that we prepare and develop the system is that as soon as a user -- an aircraft in this case -- comes in to any sort of coverage within the constraints of the radio regulations and the radio standards, we switch on the respective radio and make sure that the aircraft is up and running so that in every part of the coverage where we can, we will have an active satellite link and in those places where we have a CGC link, we will switch that on as well.

So in the landmass coverage, which has both, both systems will be up and running and active. But clearly where we have both systems up and running and we have the CGC, it is very likely that more of the traffic will go through the CGC, although that is a policy setting, it is not necessarily dictated by the design of the radios or the engineering.

Q. When you say a policy setting, that is set by the fact presumably that the CGC itself has that much greater capacity and will be on its own able to presumably

service the needs of all the passengers on board; would that be right?

A. So when I say a policy setting, you will recall that in our design we have a communications manager on the aircraft and a routing manager at our Meet-Me Point, and by "policy setting" I mean that we will dictate which route the traffic will go over in order to reach the aircraft.

DR. ELPHICK: The Meet-Me Point is on the ground?

A. That is correct, yes.

THE CHAIRMAN: That is the notional distant tap that I have ...

A. Exactly.

THE CHAIRMAN: Not tap, but controller of the tap.

A. Yes, it directs the traffic either over the satellite or over the ground network.

THE CHAIRMAN: Can I just -- I do not think I will be treading on Mr. Bowsher's toes, I just want to understand what goes on here just a little more. That actually tells the things in the aircraft to effectively switch themselves on or off or take in traffic or not, is that right, the notional tap?

A. Mm-hm.

THE CHAIRMAN: So does it work something like this: the aircraft is flying and it comes to a point, let us say,

where it is taking signal from the ground and then it starts to go over the sea, so a signal is somehow sent from the aircraft to the ground to say: I am struggling here, can I have a signal from somewhere else, please, and the computer on the ground says: yes, certainly, and it turns on the satellite tap; is that basically how it works, in milliseconds?

A. Yes, that is a good analogy, yes.

THE CHAIRMAN: When it begins to approach the land again and it begins to sense that it can pick up the ground signal, it sends a signal to the notional tap controller and says: I am getting a ground signal here and the notional tap controller will or may say: okay, turn off the satellite feed, you can now take it from the ground; that is how it works at that end of the journey?

A. In general, yes, and in general that would be an appropriate way for us to dictate the policy setting on the aircraft.

Now, for some types of traffic it may be that we leave that traffic constantly on the satellite. Alternatively there may be things where we would not necessarily want to use the satellite segment, because it would be a wasteful use of satellite resources. But you are right in general for the Netflix case or whatever, that would be the kind of thing that we would

do.

THE CHAIRMAN: Through what medium does the aircraft transmit this -- or the bits on the aircraft transmit the "Please help me" and "Turn me on or off" back to the ground controller?

A. In general we do that over the satellite. We try and keep the high integrity signalling over the satellite where we have greater coverage and continuity. That is the direction that we have been given to --

THE CHAIRMAN: So if a satellite -- the satellite itself feeds the tap control things on and off?

A. Yes, I would stress that we are talking about control signalling which does not take very much capacity out of the network. That is correct.

THE CHAIRMAN: Never mind, I am just trying to understand in general terms how it works.

A. Yes.

THE CHAIRMAN: So that is the communication part in relation to the "Please help me where I should take my water from".

A. Yes, that is correct, yes.

DR. ELPHICK: Just to make sure I have got it as well: a communications manager on board the plane sends a message to the Meet-Me Point on the ground via the satellite?

A. Approximately, yes. That is correct to the extent that we need to talk about this.

DR. ELPHICK: Broadly.

A. Essentially the radios are constantly measuring the link quality in both directions over both links, and that information is consolidated and that influences the decisions as to how the traffic is sent.

THE CHAIRMAN: Is that consolidated by the communications manager on the plane?

A. Yes. Indeed.

THE CHAIRMAN: Right.

DR. ELPHICK: Thank you.

MR. BOWSHER: Over the landmass, Mr. Sharkey, the terrestrial link quality will always be better than the satellite link quality, will it not?

A. Presuming that we have good quality links from the ground network, I think we have talked about this issue of mountains. I think it is worth stressing that the complementary ground component network towers are several hundred kilometres apart and we have designed it so that the service level agreement on the ground component network is met only above a certain altitude. As you can imagine, as the aircraft drops below a certain height, it may be several hundred kilometres -- well, it may be a hundred kilometres from

a tower and as you go down a little bit closer to the ground you may not be able to see the tower; it may be obstructed by hills or trees or buildings or whatever. These towers are relatively far apart. Does that make sense?

Q. Okay. So your qualification is mountains. Can I come back to mountains in a moment?

A. Mm-hm.

Q. Leaving aside the mountain situation, I think you are agreeing with me that the technical link quality will always be substantially better than anything the satellite can provide over the terrestrial -- over the landmass?

A. So subject to questions --

Q. Subject to a malfunction.

A. -- about failures and so forth, I think Dr. Webb did some arithmetic for the signal-to-noise ratio from the complementary ground component network, and he quite rightly pointed out that the signal-to-noise ratio for the complementary ground component network is very good, and that is inevitable because the satellite is so much further away: 36,000 kilometres away. So inevitably the link quality on the satellite network is weaker ex any failures.

Q. And so the operation of this switching system will

always, will it not, effectively default service to the ground service, if you are over the landmass, unless there is some malfunction or other specific issue?

A. No. No, that contradicts what I have said a few minutes ago. We open the path from the aircraft through both of the links, the one that goes up over the satellite and the one that goes directly to the ground, and then there is a policy onboard the aircraft that dictates which traffic goes where.

It is perfectly possible to give that box some policy that says that certain types of traffic, whatever you wish, only go over the satellite or vice versa. It is really --

Q. I thought you said your policy switch to the terrestrial service. I thought you said that was what your policy switch was doing, was switching to the terrestrial service when you are over the landmass.

A. You are telling me what the policy is.

Q. That is what I thought you had said.

A. I am explaining what the policy engine, which is the box that actually executes the policy, I am telling you what that can do. You are giving me direction as to how it is configured.

Q. Am I right that it is configured to use the better higher capacity service from the ground station when it

is over landmass?

A. So I do not operate the network but I would presume that for bulk traffic, given that there is more capacity on the ground network, that for that type of traffic, if it does not have a particular value of particular availability considerations, you would more likely put it over the ground network than over the satellite network if you can, but that does not necessarily mean that you would always use that policy setting for all types of traffic under all conditions and, indeed, as I explained, for example, the control traffic that we used to manage the system is more likely to go over the satellite.

Q. But the traffic that you are using to provide users with the best possible consumer experience is going to be run through the ground stations whenever it can be, as I think is consistent with what you are saying; is that not right?

A. If you define best possible user experience by peak bit rate, then absolutely, because the ground network provides the highest peak bit rate. So that is absolutely consistent, correct.

Q. And you would not, therefore, be able to meet your marketing aims -- whether we call them aims, promises, whatever, what you have said to airlines you will be

able to achieve -- without using that level of service which the ground components can provide.

A. So you are going into marketing and traffic statistics material, which is not my area of expertise. I think Dr. Harrison covered that topic exceptionally well, so I would not necessarily propose to add anything to his statements on that topic.

THE CHAIRMAN: You have confused me now, Mr. Sharkey. The communications manager on the plane, I had understood that to be feeding data about the quality of signal back to the tap controller so the tap controller could decide on the ground whether to route signals through the satellite or the ground. Something you said about three minutes ago suggested that that communications manager on the plane was doing something more than that. It, itself, was deciding where to take the signal from; in other words it itself was effectively deciding which tap it wanted to turn on. Now, where is the decision taken as to which tap to use so that the aircraft systems know which to take the signal from?

A. My apologies if I misspoke. I can assure you that all policy is set from the ground.

MR. BOWSHER: Right.

A. It is simply the case that in executing the policy for traffic that leaves the aircraft, either via the

satellite or via the ground, we have to send the policy settings to the aircraft so that you can throw traffic one way or the other.

THE CHAIRMAN: So it is as I originally thought: the ground does the thinking and bits on the aircraft will do such execution as is necessary?

A. Indeed, the bits on the aircraft are essentially done, that is quite correct.

THE CHAIRMAN: Right. Thank you.

MR. BOWSHER: So can we just look -- the malfunctions I see is an issue. If something malfunctions you may have to revert, there may not be a ground station available.

In terms of the mountains, can I ask you to -- I cannot see what you have there, but file B/22, I do not want to read this out, it is a description of the European Aviation Network, and we see from the description -- I think it may be yours -- the only passage I wanted to take you to is, if you look at page 36, and there is a reference there to the altitude of aircraft at the top of page 36, you may want to double-back and see what it is talking about. Is that not telling us that there is not going to be an issue, if I can loosely put it, any issue with interference below a certain altitude with this system and, in reality, there is not going to be an issue with

mountains anywhere in Europe because that can be dealt with simply by designing and appropriate siting of ground stations.

THE CHAIRMAN: Which paragraph should we be reading for these purposes? What are the first few words of the line you want us to read?

MR. BOWSHER: Yes, "... when the aircraft ..."

THE CHAIRMAN: Just that sentence?

MR. BOWSHER: Yes. (Pause).

A. So I presume I am not permitted -- this is going to be quite hard to talk around it without saying what it is.

Okay, so you are asking whether the material that appears here in any way suggests that the mountain issue that we describe will be inapplicable, and my answer to that is no. So ... how can I do this?

THE CHAIRMAN: If you need to do it elaborately then we will again go into private for a few moments. Do you think you can do it without?

A. I think I will have a crack at it. Let us see what happens.

We have said, and I think you know, that the EAN CGC towers have a range of, at maximum, 150 kilometres. I think that has been said widely in the last couple of days. So let's take a hypothetical example where an aircraft is at a distance of 100 kilometres from

a tower, which is absolutely reasonable. Imagine now that the aircraft is at the height that is quoted there. So if you were to sit down and do a little bit of very elementary arithmetic, you would see that compared to the distance from the tower, the height that the aircraft is at is very small; and therefore the angle that the tower is firing towards the aircraft is almost horizontal; and therefore any obstructions, not just mountains but tall buildings, hills, and so forth, is likely to obstruct the line of sight signal from the ground tower in that instance to the aircraft.

MR. BOWSHER: Just to be clear, if you go a bit further on, a few lines down, there is a heading "Conclusion" on the same page, and we can see that the EAN will function only in those parameters, without reading it out, and if you will read the rest of the paragraph.

A. Sorry, just explain to me which --

Q. "As the EAN will function ..."?

THE CHAIRMAN: Where it says in the middle of the page, left-hand side, almost halfway down, in bold:

"Conclusion: as the EAN will function above ..."

A. Ah okay.

MR. BOWSHER: So it is dealing with a slightly different point here, but that tells you, does it not, where the EAN will be functioning?

A. That is correct. Although the text is talking about the interference into adjacent bands. I am not sure how this is relevant. As I have said, and I was using that altitude figure there, I think this proves my point.
Q. Is there any actually identified place in Europe where this is a problem?
A. How do you mean?
Q. There are a finite number of mountains. You have set up a network of ground stations to provide, presumably, the best possible service; have you identified in setting up that network a place where this is a problem?
A. I do not know off the top of my head.
Q. Is this not just a theoretical problem that can be resolved by appropriate design of the ground station network?
A. We could absolutely put dramatically more towers into the network, but for reason of cost constraints my chief financial officer is very keen that I use the minimum possible number of towers, and that happens to be 300.
Q. And no one has said to you in designing that network: look, we need one here because of a particular mountain obstruction?
A. No.
DR. ELPHICK: I think, Mr. Sharkey, I find your argument rather convincing. You said you have a height above the

ground which is much, much smaller than the distance to the ground station, and therefore the angle is very small, and therefore there are quite frequently going to be hills and mountains in the way. That was the essence of your argument?

A. Yes, so we are talking about aircraft operating at lower altitudes. I am very keen to try and avoid that situation where at all possible, because clearly having line of sight is desirable.

DR. ELPHICK: Desirable, yes.

MR. BOWSHER: Just to resolve, maybe before I move on, if you go to Dr. Webb's second report, tab 9, page 18, and this is even more elementary than elementary, perhaps, if this had been an actual problem, it could have been resolved in the way that is shown at figure 5; is that not correct? It is on page 18.

A. Page 18, sorry. That is absolutely correct. We could deploy towers in the remoter parts of the Alps to try and address these problems. Providing microwave links to mountainous districts is relatively expensive: where possible I would try and avoid that.

Q. Can I suggest that this really illustrates the nature of this service, because in fact if this were a satellite system with a few complementary ground components you would be looking at where there were problems with the

satellite provision, is that not right?

A. That is reasonable to say, absolutely.

Q. Whereas your approach here is, and the way you have framed the mountains problem, is that you seek to get best performance through the ground stations and only in those circumstances where the ground stations fall short do you default back to the satellite?

A. I tend to think of it in a slightly different way in the sense that we have put blanket coverage of the satellite everywhere, thus coverage, and we are now adding additional capacity within that coverage in order to improve the availability, if you will, of the service. I appreciate that the two are different ways of looking at the same thing.

Q. From the point of view of the airline or the user getting the service, what they are getting is a ground service unless they are in one of those patches on the map where the ground service is not reaching; is that not right?

A. Well, it depends on the type of application, as we have discussed before, that we put over the different paths on the system, but I would presume that from a user experience perspective using the ground segment in order to soak up the customer demand would be a good thing to do, because that is where we have the capacity. Put the

demand where the capacity is available where possible.

Q. I mean, you have said that you are looking -- and Mr. Pearce I think says in his statement -- you are looking to aspire towards the home broadband type experience. You are only going to achieve that for the consumers across Europe in your design through the ground stations, is that not right?

A. At the moment when I am flying on a passenger plane in Europe, which regrettably I have to do quite a lot in my current role, with a number of European suppliers, I find that the bulk of the airlines that I travel on have no bandwidth provision whatsoever.

Absolutely, we and Viasat all aspire to achieving home broadband type services. I think we need to do this to some extent the best we can. You are quite correct in terms of home broadband experience that the best home broadband experience, or the best service which is like home broadband experience, would be that which is predominantly carried over the CGC simply because that has the greatest peak bit rate.

Q. I am not sure why you are equivocating, Mr. Sharkey. If you go to tab 4 you will find your first statement. D/4.

A. Yes.

Q. Paragraph 34. I thought this was a simple point:

paragraph 34 and 35 tells us what you are designing to achieve is something that, as far as possible, approximates to someone's home experience and to do that, the reason why you can produce this great innovative service which does not exist anywhere is because you are able to use the ground stations; is that not right?

A. The innovation comes from the fact that we are combining satellite and ground.

Q. Are you not trying to achieve, to do as you say in the previous paragraph:

"Passengers would be able to enjoy an extremely reliable and continuously high bandwidth broadband service that matched their expectations on the ground whether via their home broadband or from their wireless 4G service. This will transform the passenger experience, drive operational efficiency and open new revenue streams."

Now, you may not be a marketing person but that sounds like someone selling to me a service that gets as near as possible to my home broadband experience, my home television experience, when I am in an aeroplane; is that not right?

A. That is absolutely correct. The challenge that we face is in delivering that kind of --

THE CHAIRMAN: Never mind the challenge. I think what Mr. Bowsher has been trying to get you to accept over the past three minutes is what seems to be the starting point here, which is you are trying to reproduce, insofar as you can, an experience which is like the home user's broadband experience. That is a "yes" or "no", I think.

A. Oh, absolutely. It is --

THE CHAIRMAN: Stop. That is a "yes". Now go from there, Mr. Bowsher.

MR. BOWSHER: Let me attack it in a different way.

THE CHAIRMAN: We do want to finish by 5.20.

A. I am sorry, yes.

MR. BOWSHER: If you were to turn off all the ground stations and just rely on the satellite, you could never come anywhere near that; would that be right?

A. Presuming that you were attempting to carry all of the capacity on the satellite, however the reason for these policy engine boxes that we have been talking about is to ensure that the parts of the system which have the greatest coverage carry less of the demand because we have less capacity --

THE CHAIRMAN: Mr. Sharkey, please listen to the question, then we will finish this quicker. Mr. Bowsher simply wants you to imagine, improbable though it is, you turn

off everything but the satellite: would you be able to deliver this quasi-broadband-like experience just through the satellite?

A. So the answer to that is categorically no, simply because we cannot supply all of the aircraft with all of the capacity.

MR. BOWSHER: Vice versa, if something goes wrong with the satellite and you are running just the ground components, you will be able to match exactly what you have said here from the ground service except in the gaps in the map and if there is a malfunction of one of the towers. That is what I am suggesting.

A. Indeed, but as we have said, the gaps in the map are tangible.

Q. That is, if there is any additional use from the satellite, it is simply to achieve those two things because that is the only additional thing that the satellite actually provides beyond what -- in meeting your home broadband aspirations, that is the only thing that the satellite provides?

A. For the home broadband type application that is a reasonable statement to make, absolutely correct.

Q. Can I just double-back on something? We were talking about language a moment ago and you said something which surprised me but I did not have all of the references to

hand. You said something about DVB-SH and did not accept, again, a premise which I thought was simple. If you go to tab 7, that is your second witness statement, and go to paragraph 6, you accept in your second statement, do you not, that:

"It would be technically possible to use an identical protocol for two separate transmissions."

You accept that both segments could have used an identified protocol such as DVB-SH which is geared to the standard.

A. Sorry, I did not quite get that last clause?

Q. Sorry, I thought you had accepted from your second statement that you thought it was technically possible to use an identical protocol for two separate transmission paths to different terminals, one satellite and one ground terminal. I thought that is what you were saying here in paragraph 6.

A. I believe I am. Can you carry on? Sorry.

Q. There is no restriction to broadcast service, is there, in what you have said there, is there?

A. So that is a slightly different topic. We were talking about --

Q. No, no. The context for this, if necessary we have to go all the way back, but the context for this was that you were saying that Dr. Webb was wrong in suggesting

that you could have a common language for the operation of the system, and I had understood you were agreeing with him that you could have a common language.

A. I think we should go back to the original statement about DVB-SH rather than this one, because I think we changed the discussion slightly. I am happy to talk about this, it is quite a straightforward topic.

Q. Time is a bit limited. Can I go a different way. It may be that others will come back with you on this. If you go to E3/120.

A. 120?

Q. 121, sorry, my fault. This is the fact sheet for DVB-SH, and it tells you at the first line what it is:

"DVB-SH is the name of a transmission system standard designed to deliver video, audio and data services to vehicles and hand-held devices."

That description describes something, does it not, which is able to do exactly what Dr. Webb says, and run as the language for running services both to satellite and to the ground?

A. Okay, so let me specifically take you to the two bullet points immediately above this diagram. I have not seen this piece of paper before, but I can talk to it with no problem at all.

So there are two different versions of DVB-SH. The

lower two, the second bullet, talks about SH-B, and SH-B uses two different wave forms, one called TDM and the other called OFDM. One goes over the satellite, one goes over the ground segment, they are two different languages. SH-A uses OFDM over both links, over the satellite and the terrestrial link, and I absolutely agree that that is a technology where you use the same language over both satellite and CGC, but it is for the specific and very narrow case where you are broadcasting to the user. So not only are you talking the same language, but you are talking in harmony: the satellite and the CGC signal effectively reinforce one another; it is a broadcast technology.

Q. Then I am puzzled as to why you said what you did in your second witness statement, Mr. Sharkey, because at paragraph 6, where you looked at this, and you were addressing the question whether you did or you did not agree with Dr. Webb, I do not understand you to have at any point raised this question that there was a qualification about whether it was for broadcast services or not?

A. I think that was -- I touched on that in the first witness statement. I am doing this from memory, you will have to excuse me.

I would stress DVB-SH is designed for hand-held. It

really is not designed for this kind of application.

Q. What I am puzzled about. You have said:

"It is technically possible to use an identical protocol."

I do not understand how it is that you can appear to have agreed, made a general agreement here that it is technically possible to use an identical protocol without any limitation here and yet now you are rowing back on that agreement.

A. So we are talking about -- we are talking about -- okay, so this is where I accept that there was a little bit of finesse because, as I said, Dr. Webb and I were slightly talking at cross-purposes in our original statement, and I tried to clarify it here.

My main statement, and the one that I think is crucially important, aside from these low level details, is that if you were to design a radio system and it was not required that you used the same wave form, then you would absolutely try and optimise the designs of the wave form for the two different links and those designs would make them essentially not the same language.

I mentioned, you may recall, that our LTE system only works up to 150 kilometres. If we were to change LTE to work over the satellite, we would have to break the wave form and it would be no longer compatible with

the standard. It would not be LTE. A satellite LTE system would not be able to talk the same language as a CGC LTE. That is not to say that you cannot design a wave form that can be used over both, I would say it would not be efficient for this application, and that is my key point, and I think Dr. Webb essentially agreed that as well.

Q. I have quite a few more things to cover and I need to march on.

Mr. Sharkey, if you want to just put E3 away. The satellite terminal that you refer to, to use your language, is that capable of communicating with satellites other than S-band satellites?

A. No, you design satellite terminals specifically to address a particular frequency band. We would be able to talk to EchoStar satellites but not Viasat satellites, for example.

Q. Well, if you take B/12, page 43, again, I am not going to ask you to read it out.

THE CHAIRMAN: Sorry, E/12?

MR. BOWSHER: B/12, page 43. I hope I can take this quickly. It is a very large slide, I am not going to ask you to read out the text, but it seems to me what you have said cannot be right in light of the design information that you have been supplying here.

A. So this is a suggested product that we have never built which contains two separate antennae elements, one tuned to S-band and one tuned to L-band and we combine the two together under the same radome. They are separate antenna.

Q. So that is not this satellite terminal at all?

A. I have not seen this document before, but let me just -- maybe it is talking about a different solution.

Q. This document is provided to Ofcom in response to a question. If you go back still behind tab 12 at page 9, under (x), I can read this, it is not marked Ofcom asks you to:

"... provide marketing material for the EAN using each type of antenna."

It then identifies various things and then says:

"Inmarsat promotes the EAN to airlines as a prepackaged solution."

And you say:

"Attached to annex 4.10 to this response are the materials we provided at the interior aircraft exposition."

Are you saying you are providing to Ofcom in answer to their questions material relating to a product you have never produced?

A. So I have to admit I have not seen this documentation

before, and it is numbered -- so I simply cannot talk to this topic, but I can absolutely assure you that we have never built anything along the lines of the product that is mentioned on page 43. It appears, and I may be mistaken, that the heading, or the front piece of this, says "Presentation to the Inmarsat plc board of directors", so I presume that this is not marketing material but it is stuff that is intended to give our directors some discretion as to which products they tell me to build. I have not seen this before.

Q. Well --

A. But I think it is beside the point because we have never built it, it does not exist.

Q. This material presented to us as the material provided in answer to that question, so I am in no better position to help than you, but there we are.

A. Okay, if it is my error, I apologise, but I presume not.

Q. Capacity, can we deal with that briefly. We have talked a little bit about the original 9-beam satellite in comparison with the current payload you are sharing on Hellas Sat 3. We know that EchoStar has 180 beams. That is plainly, is it not, a satellite which would be able to provide very much more capacity to provide a service of the type that you are providing for the EAN; is that not right?

A. So Dr. Webb and I discussed it in the paperwork and we at least agreed that the common ground was a factor of 25. I would consider that a maximum of what that satellite can provide compared to ours. Dr. Webb suggests that it is the minimum.

Q. At that level it would certainly meet Dr. Webb's low-load scenario, would it not, EchoStar on its own?

A. I am not hugely familiar with the load scenarios. I believe Dr. Harrison has talked about the traffic issues in great depth. I do not feel terribly qualified to talk about scenario planning in terms of traffic.

Q. I think Dr. Harrison took his numbers, he suggested 22 aircraft as his number this afternoon, and if we multiplied that up to the EchoStar capacity we would get, I think -- well, towards 500 aircraft, would we not?

A. So the 22 aircraft, that sounds perfectly reasonable to me. I think as far as 500 is concerned, that would require the aircraft to be distributed so that there was an even number of aircraft in every beam on the EchoStar satellite, so the same number of aircraft over the vicinity of, say, Cardiff compared to Croatia. I do not think that is a realistic traffic pattern.

Q. So if you are talking about 180 beams and you are saying: well, the weakness here is you might have an

uneven distribution of traffic within the 180 beams and that is your problem, is that not exactly what a complementary ground component is for, to meet the problem that if you have a -- that if beam 179 is one which typically gets overloaded for whatever reason, you cannot fix it on the satellite, so you put a CGC there to add to the capacity in that area?

A. I would not necessarily confine CGCs or the expectation as to what CGCs are doing or, indeed, our interpretation as to what CGCs are doing, to that particular scenario.

Q. But that is something they could do, is it not?

A. And they could do more.

Q. That is one thing they could do, is it not?

A. I do not disagree. Absolutely.

Q. Thank you. If you have 180 beams you can, can you not, shift capacity between one beam and another, you can dynamically shift that capacity.

A. Only up to a certain limit. In my experience with satellites of that design it is only possible to put approximately 5 per cent of the capacity into any one beam and approximately 20 per cent of the capacity into any cluster of seven beams. If you exceed that constraint you wind up in a situation where the multi-port amplifier starts to distort the shape of the beams and you run into problems.

So yes, you can shift capacity, absolutely, but the degree to which you can shift it is not completely flexible.

Q. So if you are using EchoStar, and let us say Inmarsat fails to get the whole market, it gets half the market, 200 planes, with EchoStar, Inmarsat would be able to meet the capacity requirements of 200 to 300 planes, perhaps with some dynamic movement of capacity and some complementary ground components in particularly taxing locations, would that not be fair?

A. It is certainly one thing that you could do, I would agree.

Q. I had some questions for you on capacity, but I think in the light of what you have just said, I am not sure you would think that you are the person to deal with them.

In your statements you refer to a transparent bent pipe digital processing system, is that not right? That is just a contemporary description of what allows a signal to come from the ground to the satellite and then get routed back down; that is just a common description of what it is that allows the signal from the ground up to the satellite and then back down again?

A. The digital processing element means that there is a much greater degree of flexibility than the straight repeater, but in essence, yes.

Q. That would be industry standard 2018 for Viasat, Inmarsat and pretty much anyone else, would that be right?
A. No, not necessarily, most payloads are analogue.
Q. For Viasat and Inmarsat that would be standard, would it not?
A. No, Inmarsat's most recent satellites, the GX satellites, are analogue.
Q. I can take you to it, but it is standard on the Ligado satellite, is it not, that you can dynamically allocate coverage and capacity. Presumably you can do -- would that be standard on a modern satellite?
A. Yes. As I explained, the sort of constraints that you face with the EchoStar satellite would absolutely 100 per cent apply to the Ligado satellite. It is a very similar design.
Q. Can I just go back to one topic which we have touched on. It is E3 -- you can put B away and look at E3, tab 127. I do not think this has a page number. The third page from the end, thank you. The third piece of paper from the end, it is five pages from the end.
A. So what is the title of the page, I am sorry?
Q. The title of the page is "Integrated network".
A. Got it, yes.
Q. Just to see what this is, this is "Inmarsat Aviation

overview" presented by the managing director of Inmarsat, it includes a lot of material. This, as I understand it, that picture with the integrated network with the plane, indicates the expectation that Inmarsat is providing connection not just to your Hellas Sat but also to other satellites available; is that not right?

A. Let me see, on this illustration there is an aircraft with four antennas, so that is what it is showing, although I would observe it would be really very unusual and, indeed, in a short-haul aircraft, impossible to fit that many antennas to any one aircraft, so I presume this is an illustration of all of the different solutions that Inmarsat provides for aviation connectivity, not something that you could provide to any one aircraft, unless, perhaps, it was an A380.

Q. I do not know why your managing director produced this but he has produced this presumably as a depiction of something useful rather than fanciful. That would seem to suggest that what is being sold is a system which can connect all of these different connections to all of these different satellites, GX we have heard about, EuropaSat, that is historic, but -- and that is presumably, is it not, what is being contemplated by this picture?

A. So let's take the example of an A380 being a very large airframe for long-haul routes which has a lot of space and therefore plausibly could install a lot of antennas. In that instance, I would presume it would not be a bad idea to at least try and persuade a reluctant airline customer to fit a very large GX antenna for long-haul routes with medium capacity, an Alphasat antenna, perhaps for safety services for the cockpit, and an EuropaSat S antenna and CGC antenna for high-density traffic in the European area, so that as the aircraft flew, say, from Dubai to Europe and on to America, we could switch between the three systems, although it would require quite an accommodating airline to give us such a large amount of real estate on the aircraft.

DR. ELPHICK: Is not the key point, Mr. Sharkey, that each antenna only communicates with one satellite, not with three?

A. Correct, yes.

DR. ELPHICK: That seems to be the fundamental point.

A. Absolutely, yes.

MR. BOWSHER: If you go two pages back to the Inmarsat solution, what is being offered or sold or whatever is a solution which enables, as they use the phrase there, an integrated network is a solution that communicates with all of these different satellite communications, is

that not right? If you go back to the heading "the Inmarsat solution"?

A. I see no particular reason why an aircraft fitted with, say, GX over Europe and S-band over Europe should use both simultaneously over Europe.

THE CHAIRMAN: Mr. Bowsher, this witness will have to have a quiet word with his managing director, but subject to that, where is this line going?

MR. BOWSHER: Well, that this product would enable you to communicate not just with the EAN satellite, the Hellas Sat satellite, but other satellites are also available for communication.

DR. ELPHICK: Surely in that case there will be several lines coming out of each antenna, not just one. You would have an antenna and you would have three lines coming out for three satellites; is that not the point of my previous ...

A. One antenna for each of the different technologies, L-band, S-band --

THE CHAIRMAN: Before we devote any more time to this, can I have an answer to my question please: where does this particular line go?

MR. BOWSHER: It does not follow that if you are outside the ground network that you are having to communicate to the Hellas Sat satellite in order to pick up the coverage

because there are other satellites which can be used, other satellites which Inmarsat are able to use for the signal.

THE CHAIRMAN: You are putting this forward as a theoretical possibility or as a real life practical solution?

MR. BOWSHER: It is their marketing material, it is what they are putting forward. I do not know whether it is or it is not.

THE CHAIRMAN: Supposing it is right; then what?

MR. BOWSHER: Well, it emphasises the fact that the EAN is not being marketed as an integrated whole between the Hellas Sat 3 and the ground stations; it is a ground station network with some other -- the possibility of other satellite communication.

THE CHAIRMAN: Let's see if we can take this shortly. These documents seem to show that one solution for extending coverage is to have an aircraft communicating with at least three satellites, that is what this seems to show; yes?

Could you say "yes" for the tape?

A. Yes, yes, sorry, apologies. Yes.

THE CHAIRMAN: Yes. You as an engineer do not seem to like that particular solution because you think it is impractical on most aircraft.

A. I am sure airlines would thoroughly resist this because

every antenna that you add is an extraordinarily expensive thing to put on and adds weight and drag and so forth.

THE CHAIRMAN: But it is at least a theoretical possibility?

A. Oh, indeed, and one might imagine that an airline, if they really wanted to, could take an antenna from a completely different supplier and add that as well and integrate that too. It is absolutely up to them. I would rather they did not, but they could.

THE CHAIRMAN: Right. So it is a theoretical possibility, you do not see it as a practical possibility for the reasons you have given. That is where we are so far.

A. That is correct, yes.

THE CHAIRMAN: Right.

So, Mr. Bowsher, this witness accepts that it is a theoretical possibility, but he does not like the practicalities. Where do we go from there?

MR. BOWSHER: It may be that I cannot take it very much further with him. Just to say, that means -- you see, if this is a marketing document, it would seem that Inmarsat is marketing a solution which may not even have to have all three of the different terminals, but is able to take on board satellite providing -- supplementing the ground stations from other satellites, would that not be right?

A. Yes, although having said that, we are supplying the EAN system with the S-band satellite and the CGC together.

MR. BOWSHER: I am conscious of the time, sir.

THE CHAIRMAN: Good.

MR. BOWSHER: The one topic I just need to cover briefly is capacity.

If we could just take your first statement, Mr. Sharkey, at tab 4. Can I just check, you are talking here at 59 onwards, you are talking about relative capacities of the satellite and CGC network, and you go through this in a little detail, but you come up with a conclusion that even if Inmarsat had used a 9-beam satellite or a 180-beam, a similar ratio would have been produced. This is the 99.9 per cent capacity ratio. Have you actually checked the capacity calculations that Dr. Webb did or have you gone from the end and assessed what you think the likely --

A. I am presuming that Dr. Webb is correct, more or less. He has come up with a figure for the satellite capacity. I have grave concerns with the way that he arrived at that, but I think the end result is in the right order of magnitude. Not because I believe Dr. Webb in any way has done any incorrect arithmetic, but simply because he did not have the insight as to how he would build a satellite like this, and so his assumptions,

understandably, were incorrect.

THE CHAIRMAN: But he gets the right result, broadly speaking?

A. In terms of data rate, more or less. In terms of signal-to-noise ratio, his famous quality ratio, he is miles out.

MR. BOWSHER: I am sorry, I did not catch it, in terms of what?

A. Signal-to-noise ratio, in terms of power, I made this point earlier on.

MR. BOWSHER: I have no further questions. The one point arising out of this that I was concerned about was that from E1/7, the document about Thales, it seemed that Mr. Sharkey was raising an interpretation of the data, or data which were different from that which Dr. Webb had addressed when he was drawing suppositions from that data, and I wondered whether it was appropriate in some way for Dr. Webb to address the question that was put to him in light of what has been said, because there is, now, a different factual premise involved, this discrepancy around the payload power on the first satellite which was never used.

THE CHAIRMAN: I am afraid I do not understand what you are talking about, Mr. Bowsher. Do you have another question you want to put?

MR. BOWSHER: No, I do not. I have no further questions for this witness. I just wonder whether --

THE CHAIRMAN: If you have a question for this witness you just have a couple of minutes in which to ask it if you wish.

MR. BOWSHER: No, I have no further questions.

A. I am happy to address it, if it is required.

THE CHAIRMAN: No, thank you.

Mr. Ward, is there any re-examination?

MR. WARD: Just two points, if I may.

THE CHAIRMAN: Right.

Re-examination by MR. WARD

MR. WARD: Could you pick up bundle B again, and turn to tab 22 where you were asked -- tab 22, page 36.

THE CHAIRMAN: Sorry, tab?

MR. WARD: 22 of bundle B.

THE CHAIRMAN: Thank you.

MR. WARD: Tab 36, and I, like you, will endeavour not to read anything about in this section where there was some questioning about this, which was linked to mountains, the questions, but I am going to ask a blatantly leading question about what this is about and you can tell me whether it is right. Is this passage not dealing with the question of interference rather than matters of line of sight and towers and coverage and that kind of thing?

A. You are 100 per cent correct. It is trying to explain how we go about making sure that we do not cause problems to adjacent users of interference such as terrestrial telephone networks.

Q. Thank you. Then the other question relates to, if you go now to bundle D, and turn up tab 8, page 33.

DR. ELPHICK: Sorry, bundle D?

MR. WARD: D, please, the witness statement bundle.

You had a discussion with Mr. Bowsher about the extent to which the EchoStar satellite would have generated useful capacity, and you made an observation that -- forgive me, I wrote this down roughly -- to realise the notional capacity of the EchoStar capacity, you would need an even number of aircraft in the beams, and on page 33 here is a diagram that Dr. Webb produced of the representative coverage map for the EchoStar satellite; do you see that? It is a sort of honeycomb imposed over Europe.

Could you just help the tribunal with explaining what that diagram is showing and how it relates, if at all, to the point you made?

A. So the diagram that you see here is a honeycomb pattern imposed over the landmass of Europe. Each of those cells in the honeycomb pattern represents a beam that the satellite is focusing on the ground. In order to

realise the maximum capacity of that satellite, it would require each of those beams to contain precisely the same demand, that is to say the same number of aircraft and aircraft passengers all drawing the same amount of capacity from the network.

In practice, the aeroplane traffic is concentrated over peak routes and at certain times of the day there are very hot spots and other parts of the day those hot spots are cool.

In order to achieve this notional 25 times capacity that we are talking about, this would mean that you have the same demand in northern Finland as you do in southern Italy, which I think is unrealistic in reality.

MR. WARD: I have no other questions. Thank you.

THE CHAIRMAN: Thank you, Mr. Sharkey, if you would like to step down.

We have now reached nearly 5.30 and for reasons entirely beyond his control Dr. Elphick is going to have to leave us now, but we only have administrative matters and I am quite happy that he should leave, I trust nobody is going to take an objection to that. There will not be any stuff material to our decision which will now go on.

Housekeeping

THE CHAIRMAN: Right, a few housekeeping issues in relation

to final submissions. Tomorrow is your day for writing your final submissions. I do not know what time you had anticipated getting them to us. I had assumed it was 4.30.

MR. HOLMES: Sir, the order is for 4.00 pm but if the tribunal is content with 4.30 I am sure we would all be grateful.

THE CHAIRMAN: We are actually going to give you another hour and a half or two hours. We are content to have them by 6.00 pm tomorrow evening so that we have them to ruin the rest of the weekend but not before 6.00 pm.

MR. HOLMES: I am sure that is appreciated by both myself and the other counsel.

THE CHAIRMAN: I am not promising that any part of my weekend will be ruined but it is available for ruination if I wish it, so 6 o'clock tomorrow. You need not deliver the hard copy at that time, but electronic copies should be delivered to the tribunal and to us personally at the e-mail addresses, which are on a piece of paper which the referendeur will give to you, there is only one copy, you will have to copy them down accurately, please, in due course.

We would then like paper copies to be available, colour coded as before, please, each of you retaining your colours ... (Pause).

In that case could you also ask someone to walk round coloured copies here by 6 o'clock here on Friday, by the same time. The more important thing for 6 o'clock tomorrow is the digital copies.

MR. HOLMES: And just to be clear, the digital copies in Word format, presumably sir, based on your previous --

THE CHAIRMAN: In Word format, please, yes.

Just a couple of things about them. One rule that you must obey is that you are not allowed to incorporate by reference from your opening skeleton arguments. We propose to read one document from each side and not one plus chunks from another. That means you may want to do some cutting and pasting if you wish to remind us of material in your opening skeletons, I can well imagine that you will, but that is up to you. We will not be re-reading your opening skeletons, or at least not unless we choose to do so, so for the purpose of understanding your final skeletons everything must be in one document.

We do not want huge tomes and I wondered if anybody had given any thought to the page limits which you think would be appropriate before I pronounce any. Have any of you given any thoughts? If anybody is going to say 150 pages, I am going to say certainly not.

MR. HOLMES: No, sir. We have been preparing, obviously, as

we go along, and I understand from my junior that our current page count is around 80 pages. If that makes your hair stand on end obviously we will do our best to cut that radically.

THE CHAIRMAN: Not quite that bad but that is at the upper limit of what I had in mind. I am not saying that if you turn up with 82 it will be kicked out, but we do not want to see 100, 120, we do not think this case calls for it, and there is a point of time at which lengthy skeletons just become obstructive.

MR. HOLMES: That is well understood sir, I am grateful.

THE CHAIRMAN: So I think we will say 80, which is a limit, not a target, and it is up to you how you use it.

In order to assist you, because you are going to have to incorporate some stuff that you might not have been planning to incorporate from your opening skeletons, you might find it difficult to do that with the beautifully crafted and elegant prose that I am sure you will otherwise try to achieve. If it does not fit neatly, it does not matter. What is important is the message, not the presentation.

Similarly, if you wish to save yourself some time and space by including things in bullet points without definite and indefinite articles, again, the form does not matter as long as the content gets over. You are,

of course, not allowed to cheat by having 80 pages of Arial 6-point. Times Roman -- that is an extreme example, but I have had examples of people who have tried to do that with slightly bigger, but not much bigger than 6-point, so I think for the avoidance of doubt, nothing smaller than Times Roman 12-point although I am not specifying that as the font, and line spacing no closer than 1.5 spacing, certainly not single spacing, please. That may all sound very tedious but we are the ones who have to read them and understand them in a day.

I do not think -- there are no other directions that I wish to give. Is there any assistance that you think we can give as for the next time round.

MR. BOWSHER: Again, it may sound rather silly, a quick question, but when you read the skeleton, will the tribunal have available the legislation and the authorities bundle?

THE CHAIRMAN: Oh yes. You can assume we will have available to us all the bundles that we carry around. You can cross-reference into documents. You do not have to set out every documentary reference. It is just that we do not want to have to read chunks of your opening skeleton as well as --

MR. BOWSHER: No, no, absolutely understood. I just wanted

to be --

THE CHAIRMAN: When we come to final submissions I think we will start at 10 o'clock to give ourselves a good day for final submissions, we will start at 10 o'clock on Tuesday, and when it comes to final submissions have you agreed a division of labour? You can divide the time up, you can do the maths. If you take a little bit of time out at the end to go back up the line by way of replies, then the rest of the time will work out at something like two hours each, something like that, during the day, just divide the time up. You will be largely held to that.

There is one thing you will certainly want to bear in mind. The way we will find your final submissions most helpful will be structured thus: first you will be asked to deal with any questions that we have. There will be some, but I hope not a lot. The next most important thing you must do is meet the case of your respective opponents, so far as you have not already done so in your skeleton argument, so that is where we will hear your answers to their skeleton arguments, and then such time as is available, if you wish to do it, can be devoted to expanding on your final submissions.

We do not expect you to stand and take us through your skeleton arguments. You can assume that they will

be read and, in due course, understood. That is the way in which we will find your final submissions most helpfully structured.

That may mean that you will not spend a lot of time going through the points of your skeleton arguments. You may need at the end to go through some key points, that is a matter for you, with the time that is available. The unknown for you is how many questions we will have. I think you can assume that we will have some but not too many, but the most important thing for us is that you deal with the arguments of your opponents, so we have those clearly at that point in the proceedings.

Are there any other questions with which we can help you about procedurally the way forward?

MR. HOLMES: We should thank the tribunal for having sat such a long day today.

THE CHAIRMAN: Well, it is the tribunal staff, and actually in particular our shorthand writers who are often overlooked and never should be because it is harder work for them, I think, than for any of us, when we sit this late, so we will express our gratitude to them as well. We will try not to do the same to you on Tuesday but we cannot promise.

Is there anything else? No?

MR. BOWSHER: I do not think so at the moment.

THE CHAIRMAN: We would find it helpful to have the witness statements digitally, and the main documents digitally, by which I think I basically mean bundles E1 to E3. And I think the authorisation bundle as well in PDF, so we have the authorisation bundle scanned and E1 to E3 scanned so we have those available to us digitally, and then Word copies of the witness statements, because I assume it is easier to do them in Word copy. We would like to have them on USBs, and I know they are sensitive documents, so they will have to be password protected USBs if that can be arranged.

MR. HOLMES: When do you need those, sir?

THE CHAIRMAN: Unless you hear to the contrary during the course of Monday you can make those available to us on Tuesday, so they can be securely handed over to us and you can assume that we will handle them in such a way as will respect the confidentiality, the contents of those documents.

E1 to E3 and the authorisation bundle, if you scan those in text-readable PDF, that will be the most helpful way of dealing with it.

Good. If there is nothing else, then we will resume at 10 o'clock on Tuesday morning. Thank you all very much.

(5.38 pm)

(The hearing adjourned until 10.00 am on Tuesday, 3 July 2018)

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