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Case No: HP-2021-000022

IN THE HIGH COURT OF JUSTICE
BUSINESS AND PROPERTY COURTS OF ENGLAND AND WALES
INTELLECTUAL PROPERTY LIST (ChD)
PATENTS COURT

The Rolls Building
Fetter Lane, London EC4A 1NL

Before: MR. JUSTICE MEADE

Between:

(1) NOKIA TECHNOLOGIES OY **Claimants**
(2) NOKIA SOLUTIONS AND NETWORKS OY

- and -

(1) ONEPLUS LIMITED TECHNOLOGY (SHENZHEN) **Defendants**
CO., LTD
(2) UNUMPLUS LIMITED (t/a OnePlus)
(3) GUANGDONG OPPO MOBILE
TELECOMMUNICATIONS CORP, LTD
(4) OPPO MOBILE UK LTD
(5) ASCENSION INTERTNATIONAL TRADING CO.,
LIMITED
(6) REALME MOBILE TELECOMMUNICATIONS
(SHENZHEN) CO., LTD
(7) REALME CHONGQING MOBILE
TELECOMMUNICATIONS CORP LTD

Hearing dates: 22-25 November and 1-2 December 2022

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LLP**) for the **Claimants**

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International LLP**) for the **Defendants**

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INTRODUCTION

1. This is a further trial in a global battle. The Claimants (“Nokia”) allege that the Defendants (together, “Oppo”) have infringed European Patent (UK) No. 2 981 103 B1 (“the Patent”) by the sale of certain mobile phones with 4G/LTE and 5G functionality.
2. In another trial in the battle, in a separate action, I held in a judgment of 9 November 2022 ([2022] EWHC 2814 (Pat)) that a Nokia implementation patent was valid and infringed by Oppo. By contrast, this trial concerns a standards essential patent (SEP).
3. Oppo does not in general deny essentiality/infringement; a theoretically possible scenario, in which Nokia would have had to fall back on a dependent claim whose infringement by 5G functionality would depend on a construction issue, fell away. So this trial was really about validity. Oppo says that the Patent is invalid on multiple grounds.

CONDUCT OF THE TRIAL

4. The trial was conducted live in Court and there were no COVID issues.
5. At the parties’ request, an amount of time for closing oral submissions was allocated at the PTR which was, by current standards, unusually long. I am grateful for the parties’ foresight, because it turned out that there were a number of unusual features of the case which benefited from more time.

THE ISSUES

6. The issues are:
 - i) The identity of the skilled person. By the oral closings this had fizzled out into near- if not total agreement.
 - ii) The scope of the common general knowledge (“CGK”). There were three specific areas of disagreement going to individual items of technical understanding, but also a dispute of wider impact about how to assess CGK in the unusual circumstances of the case. That dispute went to whether Oppo could legitimately mosaic two prior art citations together.
 - iii) Anticipation over European Patent Application EP 1 971 097 A2 (“Woo”). Woo is a novelty-only citation.
 - iv) Obviousness over two pieces of prior art:
 - a) Tdoc R1-073595 entitled “Group-based Re-Ordering Method of ZC Sequence in RACH” (“ZTE”), submitted to RAN WG1 (“RAN1”) for its meeting #50 held on 20-24 August 2007.
 - b) Tdoc R1-073501 entitled “Preamble Index Mapping for Non-Synchronized RACH” (“LGE”), submitted to RAN1 in the same circumstances.

It is accepted by Oppo that neither ZTE nor LGE on its own renders the Patent obvious. Its case is that starting from ZTE it was obvious to identify LGE and then combine their teachings in a particular way.

- v) An allegation of added matter.
 - vi) An allegation that all the claims of the Patent are invalid on the basis of excluded subject matter.
7. At trial Nokia said that claim 6 could potentially survive the excluded subject matter if claim 1 failed. Oppo said that claim 6 was not infringed by 5G functionality. But as I have mentioned above this fell away; Oppo pragmatically accepted that its attack on claim 1 for excluded subject matter was no better than its attack on claim 6.

DECISIONS IN OTHER PROCEEDINGS

8. I was referred to the following decisions in other proceedings (I do not summarise various other proceedings in which no decision has yet been given) on related patents:
- i) Daimler AG (and one of its suppliers) previously brought a revocation action in Germany against the German counterpart of the Patent. Another separate revocation claim was made by another of Daimler's suppliers. On 14 April 2021, the German Federal Patent Court gave a preliminary opinion that it was inclined to reject challenges, in particular on added matter, novelty, and obviousness over the combination of ZTE and LGE. The actions were withdrawn before any final decision.
 - ii) Currently, there are on-going parallel proceedings in Germany, the Netherlands and Sweden between Nokia and companies in the Oppo group concerning the counterparts of the Patent.
 - iii) In Germany, there is a validity action pending before the German Federal Patent Court. A date for the hearing has not yet been fixed, but is expected to take place sometime in 2023. In infringement proceedings, the Mannheim Regional Court found for Nokia on infringement and refused a stay pending the outcome of the revocation proceedings, partly based on the Daimler litigation.
 - iv) In the Netherlands, a judgment on validity and infringement was handed down by the District Court of the Hague on 7 September 2022. Oppo advanced similar obviousness and added matter arguments as it does in these proceedings. Novelty over Woo was not in issue (there was another novelty attack not run before me). The court found that the Dutch counterpart was inventive inter alia over the combination of ZTE and LGE, did not contain added matter, and was not invalid for excluded subject matter. Dr Cooper provided evidence for Oppo for this case, as I discuss below.
 - v) The Patent was granted without any notice of opposition being filed in the EPO. However, there have been decisions and preliminary opinions in the EPO concerning opposed divisionals in the same family:

- a) An opposition by Daimler was filed against a divisional application in the same family (EP 3 220 562), the claims of which are very similar to the Patent save that certain features from claim 1 have been moved to dependent claims. The OD (hearing on 30 April 2021, reasons given on 28 June 2021) rejected anticipation by Woo, obviousness over the combination of ZTE and LGE, and added matter.
 - b) There was also an OD hearing scheduled for 1 December 2022 (i.e. after trial) concerning an opposition filed by Oppo against another divisional application in the same family (EP 3 537 635), which again has similar claims compared to the Patent. The Opposition Division gave a positive preliminary opinion on validity in March 2022, again rejecting added matter, and obviousness over the combination of LGE and ZTE. I was told after trial that the OD upheld the divisional with the deletion of some dependent claims, but reasons are not available yet.
9. These decisions thus related to obviousness, novelty, added matter and excluded subject matter. Obviousness is always heavily evidence-dependent and I do not think I can derive any useful assistance on that from the decisions, though I note the result was consistently the same as I have reached.
10. As to the other issues, they are largely or entirely ones of law and interpretation of patent documents (although I have found some of the evidence that I received on anticipation and on excluded subject matter of relevance, as I explain below). So I might in principle have regard to them.
11. Oppo argued that:
- i) Two of the decisions are only preliminary (the German Daimler opinion and the OD preliminary opinion on '635, which has now been overtaken by the decision of 1 December for which reasons are not available);
 - ii) The skilled person was defined differently in them;
 - iii) Anticipation by Woo was only determined as a live issue in any of them by reference to a point on lack of assignment of priority which was conceded by Nokia in this action. This seems factually not quite correct since the OD rejected Woo in its decision on '562 both on that ground and on the basis of lack of support in PD8 for certain claim features. It is however fair to say that the OD's reasoning was quite brief and not on the same substantive issues as arise before me;
 - iv) The OD's decision on added matter in relation to EP 3 220 562 was inconsistent with the provisional opinion on EP 3 537 635. I could not understand this and if there is an inconsistency it can only be that the '635 preliminary opinion rejected the attack for a different reason. It did not reject Nokia's argument made before me; and
 - v) That the only Court that has considered excluded subject matter was the District Court of the Hague in reasoning too brief to be helpful.
12. I agree with Oppo on points i), ii) and v).

13. Although Oppo may have got the facts a little wrong on Woo I think the OD's decision on '562 does not address the specific points put to me, probably because the issue was argued differently or less fully. So while I note that the OD's conclusion was consistent with my own, I do not rely on it.
14. On added matter, I have found the other decisions helpful to consider, in particular the OD's decision on '562 with which the District Court of the Hague agreed. They are consistent with my reasoning and the conclusions were the same. I would have reached the same conclusion without them, however.

THE WITNESSES

15. Each side called one expert. Nokia's expert was Prof Marcus Purat. Oppo's expert was Dr David Cooper.
16. Each has been an expert on multiple previous occasions here and abroad. Neither side made anything of this, and I did not think that either expert showed any sign of it affecting their independence.
17. Neither side criticised the manner in which the other's expert gave their oral evidence, and I agree that both did so very fairly. Their answers were responsive to the questions and to the point. They made concessions where appropriate.
18. Against the above generally positive picture, each side made some narrower and focused criticisms of, or comments on, the other's expert.

Prof Purat

19. Prof Purat is an academic at the Berlin University of Applied Sciences and Technology, having been there since 2003. Prior to that, from 1997 to 2003 he was at Siemens where, from 1999, he worked on standardisation activities. He was head of the Siemens RAN1 delegation. His work, however, related to UMTS and he was not directly involved in LTE, although he followed some relatively general literature in the field.
20. As I will describe further below, Prof Purat's evidence differed significantly between his first and second reports as to the identity of the skilled person. This was not a criticism of him, but a function of his instructions. Counsel for Oppo submitted that he did not reconsider his evidence on the CGK once he had narrowed the conception of the skilled person that he was applying. In my view this was merely a formalistic objection and Prof Purat had in mind the right skilled person well before he gave his oral evidence. I decline to discount his evidence on the CGK, or otherwise.
21. Oppo also made the point that Prof Purat had seen the Patent before he saw his report, having done some work on it in 2016-2018. Oppo's position was that this had two consequences: first, that Prof Purat was in the same position as Dr Cooper in terms of having seen the Patent before, and second that during that earlier period Prof Purat "would have been" applying the same broad concept of the skilled person (Oppo's written submissions said CGK, but it meant skilled person) as in this case. As to the first, I do not think there is any meaningful correspondence between Prof Purat and Dr Cooper and this was a weak, late attempt to equalise matters when it was obvious that Dr Cooper had a

significant problem in the way he had been instructed, as I address below. As to the second, it is just another facet of the skilled person point that I have already addressed.

Dr Cooper

22. Dr Cooper's experience has been in telecommunications, since 1987. During the 1990s he represented NEC in relation to GSM and UMTS standardisation. That work was in relation to RAN4. It was put to Dr Cooper that he had not checked whether RAN4's working practices were the same as RAN1, but he explained that he thought they were the same and no differences were put to him so this was inconsequential and it was clear that he understood the way that Working Groups operated very well. Indeed he later did further standardisation work for Panasonic on GSM, GPRS and EDGE, and kept up to date on UMTS and LTE standardisation efforts.
23. Thus Dr Cooper was well able to explain how the Working Groups operated so as to assist the Court in relation to the underlying situation going to the argument that ZTE and/or LTE were CGK, or that it would be obvious to find the latter from the former. However, his conception of the legal standard applicable to whether something was CGK was unclear and changeable, in part I think because of his involvement in the Netherlands proceedings to which I refer below.
24. In addition, I think it was significant that Dr Cooper's technical work on standardisation was in RAN4 and not RAN1. Those Working Groups clearly interacted, as I will touch on below, but they were dealing with different technical subject matter, and as to RAN1 Dr Cooper was operating on the basis of, essentially, reading himself in for the purposes of litigation over the last couple of years. Prof Purat was a better guide in relation to the thinking of the RAN1 community, and I take account of it, although this must be tempered by the fact that his contact in relation to LTE was less direct.
25. A more serious problem with Dr Cooper's evidence was his involvement in the parallel litigation in the Netherlands, in the course of which he put in written evidence. There is nothing wrong with that in itself, and Dr Cooper acknowledged that he had done so, and exhibited his evidence from those proceedings.
26. Dr Cooper was cross-examined about his involvement in the proceedings in the Netherlands, and was taken both to his report there, and to briefs filed by Brinkhof, who were representing the Oppo company (called Orope) being sued by Nokia there. It transpired that Dr Cooper had contributed to the briefs extensively; this emerged when it was pointed out that text in his report for this action was very similar to text in one of the briefs, with Dr Cooper explaining that that was because of his involvement with it.
27. I do not think there was anything wrong, in itself, with Dr Cooper reusing text that he had written for another purpose previously, but I do think it was unfortunate that he did not acknowledge how the overall exercise was done, and in particular that he had been so intimately connected with Orope's case being developed.
28. The overall effect is a significant lack of transparency about the way in which Dr Cooper's views were formed, and an inability, in particular, to have any confidence that the idea of combining ZTE and LGE came from Dr Cooper himself, originally.
29. Dr Cooper's evidence was also appreciably inconstant in relation to the way in which he envisaged the skilled person combining ZTE and LGE. At one important point in his oral

evidence he accepted that the skilled person would not spot the problems with ZTE unless they had read LGE. This was quite different from his written evidence. Oppo sought to plug this hole in its arguments by saying that the problems with ZTE were in fact evident without reference to anything else. I address those attempts when I come to ZTE, but they cannot meet the fact that Dr Cooper did not have a clear picture in his own mind of the overall shape of what he was putting forward, and this reduced my confidence in him as being able to put himself in the shoes of the ordinary skilled person.

30. Taking these points all together I have reached the conclusion that I can put significantly more weight on Prof Purat's evidence. But at the same time, I make it clear that these are not criticisms of Dr Cooper's integrity or independence. Giving evidence on obviousness is inherently a challenging exercise and it was certainly made no easier in this case by the unusual nature of Oppo's attack.

THE SKILLED ADDRESSEE

31. There was no dispute on the legal principles applicable.
32. Prof Purat in his first report envisaged the skilled person as being one of four classes of person, with the members of two of those classes not being closely connected with RAN1; he further expressed the view that information would only be CGK if known to all four classes.
33. This caused Nokia a potential sufficiency problem with the Patent, since the CGK necessary to understand and implement it is (as is common ground) not to be found in any textbook but only within RAN1. So Nokia instructed Prof Purat to proceed, from his second report onwards, on the basis that the skilled person was either a RAN1 delegate, or someone supporting a RAN1 delegate.
34. No material difference in relevant knowledge or access to materials was argued for between a delegate and a supporting person, so I can just envisage the skilled person as a RAN1 delegate.
35. To this extent there was, by the rather roundabout route I have described, more or less agreement between the parties. But a remaining point at issue was the level of focus of the notional skilled person on the specific problem which the Patent addresses. It was common ground that there was a focus on the RACH in RAN1 at the time, but the RACH was not "an established field" in the sense considered in the authorities such as *Illumina v Latvia* [2021] EWHC 3121 (Pat), and the *Optis v Apple* cases that I decided ([2021] EWHC 537 (Pat), [2022] EWHC 561 (Pat)).
36. Oppo accepted that there was no such established field but sought to meet the point by saying that there was a "focus" on the RACH in RAN1, and then that within the RACH field there were only 3 main remaining issues, one of which was the ordering of ZC sequences for RACH preambles, which the Patent concerns.
37. The importance of this argument comes later in the analysis, at the stage of deciding what was CGK; Oppo seeks to narrow the spotlight to half a dozen specific proposals in Tdocs. I explain that below.

38. I reject Oppo's argument on the skilled person. Talking about "focus" sounds alluring and purposeful, and there will have been some real people within RAN1, just a few, who had that actual focus. But the "focus" argument is just a semantically different way of getting to the "blue Venezuelan razor blade" result deprecated by Birss J (as he then was) in *Illumina v Latvia*, and is inconsistent with the approach of basing the analysis on an established field.

THE COMMON GENERAL KNOWLEDGE

39. As I have said in the Introduction above, there were a small number of discrete matters in issue on the CGK, and a general point which I deal with in the section on the law and in the section "Events at RAN1".

CGK – the law

40. At a high level there was no dispute about the applicable law:
- i) The CGK is the common knowledge of the skilled person, necessary to the competent performance of their work. It also has to be regarded as a "good basis for further action", and in general something which has never in fact been used will not be CGK, although this last point has to be modified by the proposition (not applicable in the present case) that it can be common general knowledge that something is the subject of scientific doubt. See *Terrell on the Law of Patents*, 19th Ed., 8-61 to 8-67, *General Tire & Rubber v Firestone* [1972] RPC 457 at 482, *Merck v Ono* [2015] EWHC 2973 (Pat) at [24].
 - ii) The mere publication of information in a patent specification or scientific journal does not prove that it is CGK. The information has to rise to the standard just identified (*General Tire* again).
 - iii) CGK is not limited to what the skilled person has memorised and has at the front of their mind but includes that which they know exists, and would refer to as a matter of course, but this does not make everything "on the shelf" CGK: *Raychem's Patent* [2009] RPC 23 at [25].
41. Information which falls short of CGK can be brought into an obviousness attack, if it is proven that the skilled person faced with the problem to which the patent in suit is addressed would acquire it as a matter of routine (*KCI v Smith & Nephew* [2010] EWHC 1487 (Pat) at [108]-[112] approved on appeal: [2010] EWCA Civ 1260). This is conceptually distinct from CGK and arises as part of the obviousness analysis below. I mention the point now because it is Oppo's fallback in case it fails on CGK.
42. The above concepts of CGK have to be applied flexibly. In some mature fields there are well known and detailed textbooks and such books are a classic way of proving CGK. But other fields, younger or less academically directed, are not the subject of textbooks. That does not mean there is no CGK, it just means that it comes from other sources and its proof may be more challenging.
43. The field that I am considering in this judgment is unusual because the topic, use of ZC sequences for RACH preambles, was a very narrow one and concerned a problem which had arisen only fairly close to the priority date. Furthermore, developments and

communications were very rapid. It was possible for things to become accepted and known to those working in the field in a short space of time.

44. Again, there clearly *was* CGK (and the parties have agreed a long and detailed statement of it) but identifying it, especially at its margins where there are disputes, is unusually difficult in this context.
45. In the circumstances, I think it is especially important to bear in mind that one is concerned with information that was generally accepted. It may be misleading to focus on individual documents. The CGK will have come from, among other sources, communications among RAN1 members by email or orally at meetings, and Tdocs, but that does not make all such communications CGK as to their full contents. What matters is information that became generally accepted; individual people in real life will have read different collations of documents from which they obtained the same information of this kind in the end. It is perfectly possible that from reading a collection of individual Tdocs the notional skilled person would derive some basic concepts that they could see were repeatedly used, reliable and the basis of the overall direction of RAN1, while other ideas, specific to only one or two Tdocs perhaps, were not.
46. Nokia said that CGK ought best to be identified from meeting minutes or from statements of agreed conclusions at meetings, so that Tdocs should be completely ignored. In general, and in other cases, that approach might provide good guidance, where a problem is worked on over time so that a clear written consensus emerges. The problem in the present case, however, is that the things that Nokia accepts were CGK and are necessary to work the Patent are not in meeting minutes. This just fortifies my views above: from a broad reading of a number of Tdocs and the like, one can identify what was commonly known and accepted.

Agreed CGK

47. As is now general practice in the Patents Court, the parties produced an agreed Statement of Common General Knowledge (“ASCGK”). I have edited this down to remove material of lower relevance, and to delete some footnotes that went into more detail than I thought was necessary. I have also removed some diagrams to save space. In particular, I have removed the three diagrams which went with section J, illustrating Dr Cooper’s three limitations; they were useful but I consider that as the arguments have developed they are not necessary. Removal of material does not mean that it is not CGK.
48. Sections A to D are general introductory material which is likely to be familiar to those who have been involved in this kind of litigation. The detailed material that is (mainly) specific to this dispute follows in sections E to L. Section M is a summary, for which I am grateful. It is a useful reference but too high level for a reader unfamiliar with the area to use to learn the technology. I have numbered the paragraphs sequentially from 1 rather than continue the paragraph numbering of this judgment; these paragraph numbers do not exactly match those in the parties’ document because of my editing.

A. Development of telecommunications standards

1. 3GPP specifies telecommunications standards including the evolved radio access referred to as Long-Term Evolution (LTE), which is a 4th generation cellular technology.

2. 3GPP is divided into "Technical Specification Groups" (or "TSGs"). Each of these groups is in turn subdivided into different working groups. For example, the working group responsible for specification of the physical layer of the radio interface (i.e. the radio access network) is called 3GPP TSG RAN WG1 (sometimes abbreviated to "RAN1" or "WG1").
3. Working groups are attended by representatives from a range of industry participants, including manufacturers of mobile stations, manufacturers of network infrastructure equipment, network operators, chipset producers and sometimes other interested parties (e.g. academics or government representatives). Within the framework of these meetings, technical proposals called "Tdocs" are submitted for new aspects of the standard or for proposed changes to existing aspects of the standard. Joint Tdoc proposals can be made by multiple working group participants, and this can have the pragmatic benefit that a proposal may be more likely to ultimately succeed and be approved for inclusion in the relevant standard.
4. The standardisation process is an iterative one. Participants put forward Tdocs via the 3GPP email reflector in advance of working group meetings, which are then considered for potential inclusion in the standard, with various technical proposals being analysed and debated. These Tdocs are publicly available via the 3GPP server and can be accessed by anyone who is interested in them as soon as they have been distributed via the 3GPP email reflector. Once consensus is reached within a working group as to the best way forward, that technical aspect is set out in a "technical specification" or "TS".
5. The TS documents collectively form the LTE standard, and set out the technical requirements for mobile stations and network infrastructure equipment. Tdocs and Change Requests do not form part of the standard, unless and until they are approved and formally adopted into a TS. Technical Reports or "TRs" are also produced within 3GPP; they are important 3GPP internal working documents but do not form part of the LTE standard.
6. These TSs, and TRs, are a key set of resources for engineers working to develop the LTE standard. These standardisation documents are typically an engineer's first port of call when looking to develop a technical aspect of the standard. TSs, and TRs, along with Tdocs and Change Requests also form a repository of contemporaneous technical information which can be arranged in chronological order.
7. Tdocs in particular are not typically stand-alone documents – they must be understood in their own specific context. This is apparent from the fact that Tdocs may not explain the technical aspects that they discuss in detail (or at all), because that knowledge is assumed for engineers working on that technical area of the LTE standard. Tdocs frequently reference TSs, TRs and other Tdocs. (Cooper 1 §7.4-7.11 and Purat 2 §18)
8. In preparation for any RAN1 meeting, the agenda for the upcoming meeting would be circulated via an email reflector chain in advance of the meeting, with the expectation that attendees would come prepared to discuss the topics listed. Preparation would typically include reading the Tdocs relevant to their work and to the relevant points of discussion set out in the agenda. These Tdocs would normally be distributed via the 3GPP email reflector several days in advance of the relevant RAN 1 meeting, along with an indication of the relevant agenda item. (Cooper 1

§7.12, Purat 2 §19, and Cooper 3 §3.5)

B. Status of the LTE standard at the Priority Date

9. 3GPP initiated work items to develop the LTE standard as part of Release 8. As of the Priority Date the LTE standard was still in development, with Release 8 only being finalised in December 2008. (Purat 1 §32 and Cooper 2 §4.3)
10. The Skilled Person would refer to the most recent version of TS 36.211. At the Priority Date this was version 8.0.0 (uploaded on 27 September 2007). (Purat 1 §32 and Cooper 2 §5.2)
11. The Skilled Person would also:
 - a. read the minutes / reports of RAN1 meetings and matters of significant recorded agreement and working assumptions would become part of their CGK at least by the time the minutes were approved. Dr Cooper's view is that the skilled person would consider draft meeting reports to be a reliable basis for further work. (Cooper 1 §7.3(b), Purat 2 §13, §§15-17, and Cooper 3 §3.1-3.3);
 - b. read technical proposals / submissions circulated ahead of RAN1 meetings and discussions on the RAN1 email reflector, and certain fundamental concepts which had been discussed in those submissions / emails would be CGK (influenced by how fundamental the concepts are as well as the intensity and duration of the discussions) (Cooper 1 §7.3(c) & §7.12, Purat 2 §§14, 19, Cooper 2 §5.5, Cooper 3 §§3.2, 3.5).

C. LTE networks

12. A base station within the LTE network is called the eNodeB ("eNB"). A mobile station in a cellular network can also be referred to as a mobile terminal or a user equipment ("UE"). (Purat 1 §42 and Cooper 1 §7.15)
13. LTE is a cellular network. The area covered by a base station in LTE is called a cell. The radius of a cell varies depending on the setting in which the eNB is deployed. LTE supports cells with a radius of less than 1km, to a radius of over 100km. (Purat 1 §42 and Cooper 1 §7.13 and §7.16)
14. Cell planning and configuration are complex tasks and mobile operators generally favour a standard which allows simple planning and configuration, while also allowing them enough flexibility to optimise individual cells for their local environment. For example, when planning and configuring a mobile network, operators take into consideration (amongst other things) the likely number of connected devices in an area and the speed those devices are likely to move at. As each cell has a limited capacity, cells will generally be smaller in size in areas with a high density of users (e.g. a city centre) and larger in size in areas with low user density (e.g. rural environments away from major settlements or transport corridors). (Purat 1 §43 and Cooper 1 §7.16)

D. LTE Random Access

15. The LTE random access process is focused on establishing a connection between the UE and eNB for further data transmissions. The random access process is used when

a UE first accesses the network, i.e. for initial access (and sometimes for handover).

16. The process can take two distinct forms: contention based and non-contention based.
17. In both contention based and non-contention based random access, a UE transmits a random-access preamble on the physical random access channel (“PRACH”). The preamble can perform two functions: (1) enabling uplink time synchronisation and (2) providing a temporary identifier for a UE which can be used to allocate radio resources for further communications with the network. (Purat 1 §47 and Cooper 2 §5.7)

E. LTE PRACH and preamble formats

18. A UE transmits a random access burst using a time and frequency resource reserved for the PRACH, i.e. a time and frequency resource which an eNB expects to contain random access bursts.
19. By the Priority Date, the exact time and frequency structure of the LTE PRACH and random access bursts was still under discussion by 3GPP. The following principles had been set out in section 5.7.1 of TS 36.211 v8.0.0:
 - a) A random access burst would consist of a cyclic prefix of length T_{CP} , and a preamble of length T_{PRE} as shown in Figure 5.7.1-1 (reproduced below). (Purat 1 §49).

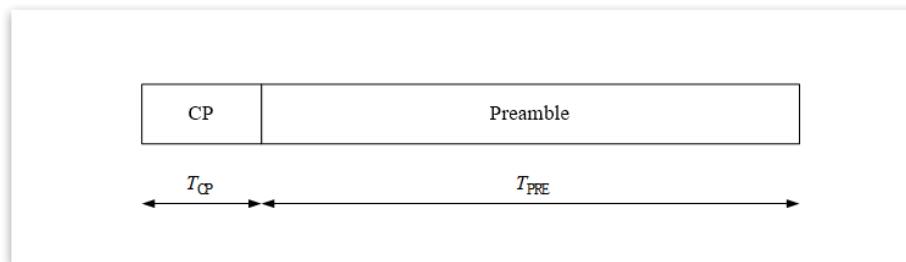


Figure 5.7.1-1: Random access preamble format.

- b) The preamble would be generated from Zadoff-Chu (“ZC”) sequences with zero correlation zone. (Purat 1 §49 and Cooper 1 §7.28)
- c) The values of T_{CP} and T_{PRE} would depend on the frame structure and a burst format configured by higher layers. (Purat 1 §49)
- d) The subframes which could contain a random access burst would depend on the PRACH configuration value although the details of this had yet to be specified in Table 5.7.1-2 of TS 36.211 v8.0.0. (Purat 1 §49)
- e) In the frequency domain, the random access burst would occupy a bandwidth corresponding to 6 resource blocks each of 180kHz, i.e. a total of 1.08 MHz (Purat 1 §49)

F. Uplink time synchronisation

20. To ensure that subsequent communications from the connecting UE arrive at the time expected by the eNB (and to avoid causing interference to the communications from other UEs), a UE must compensate for the time of flight when transmitting uplink

signals. (Purat 1 §51 and Cooper 1 §7.25)

21. The timing advance of a given UE is determined by the eNB by observing when the preamble arrives. It is only possible for the UE to align its transmissions with the subframe timing at the base station once it has been informed of the correct timing advance by the base station, which learns this by observing the preamble sent by the mobile station. The preamble itself is sent before the timing advance is known. (Cooper 1 §7.26)

G. UE identification

22. In addition to allowing the calculation of a timing advance, LTE random access preambles allow for initial identification of a UE during the random access procedure. In any cell containing more than one UE, situations may arise where multiple UEs send random access bursts using the same PRACH time-frequency resource. To enable the network to allocate resources to a specific UE the random access bursts must be designed in a way which allows the network to distinguish between access attempts from different UEs. (Purat 1 §52 and Cooper 1 §7.22).

H. Zadoff-Chu (ZC) Sequences

23. LTE random access preambles are generated from ZC sequences with zero correlation zone, generated from one or several root ZC sequences. The ZC sequences used in LTE have a length of 839 elements. (Purat 1 §53 and Cooper 1 §7.28).
24. ZC sequences are complex-valued mathematical sequences and belong to a broader class of sequences with constant amplitude and zero autocorrelation. They are defined for the purposes of LTE random access by section 5.7.2 of TS 36.211 as follows, where u is the u^{th} physical "root sequence" number, N_{ZC} is the sequence length (839) and n is a counter for the samples of that physical root sequence: (Purat 1 §55 and Cooper 1 §7.28)

The u^{th} root Zadoff-Chu sequence is defined by

$$x_u(n) = e^{-j \frac{\pi u n(n+1)}{N_{\text{ZC}}}}, \quad 0 \leq n \leq N_{\text{ZC}} - 1$$

25. Each element of the sequence is a complex number made up of a real and an imaginary part. (Purat 1 §56 and Cooper 1 §7.30) This formula also determines the "natural ordering" of ZC root sequences which gives a "physical" index ordering. (Cooper 1 §7.28)
26. The properties of ZC sequences allow preambles based on different sequences to be distinguished by the eNB even when they occupy the same PRACH resource. The specific preamble used by a UE can then be used as a temporary identity in the subsequent signalling which is used to communicate the timing advance parameter and the resources the UE can use for subsequent communications with the eNB. During cell planning 64 distinct preamble sequences are assigned to each LTE cell and in contention based random access the mobile station can select at random any of these 64 preambles to communicate a random access request to the base station.

(Purat 1 §53 and Cooper 1 §7.23).

27. In the case of non-contention based random access the base station instructs the mobile station to use a preamble sequence that is reserved for that mobile station alone, i.e. it is not one of a set of 64 preambles available for use in that cell in the contention based random access procedure. (Cooper 2 § 5.7)

Cyclic shifts of ZC sequences

28. In addition to defining ZC root sequences based on the parameter u , it is also possible to generate cyclically shifted versions of the u^{th} root sequence. Section 5.7.2 of TS 36.211 v8.0.0 defined these cyclically shifted versions of the u^{th} root sequence as follows, where N_{cs} is the cyclic shift value: (Purat 1 §57, Purat 2 §30c and Cooper 1 §7.29)

$$x_{u,v}(n) = x_u((n + vN_{CS}) \bmod N_{ZC})$$

29. In principle, 838 unique cyclically shifted sequences can be generated from any one root sequence having a length of 839 elements, all of which are mutually uncorrelated. However, in practice, separating the different sequences by a cyclic shift of just 1 symbol may be insufficient and much larger cyclic shifts may need to be applied to ensure reliable separation – see further below. (Cooper 1 §7.35)

Properties of ZC sequences

30. ZC sequences have the following properties which make them particularly suited for use as random access preambles in LTE:
- a) **Constant amplitude (CA):** ZC sequences have a constant amplitude. This means that, plotted on the complex plane, each element of the sequence lies on the perimeter of a circle. While ZC sequences have a constant amplitude, the process of generating a time varying waveform within a certain bandwidth from a sequence will introduce amplitude variations in the resulting signal. However, while the signal generation process itself gives rise to amplitude variation, generating the signal from a sequence with constant amplitude is still advantageous. It helps maintain a low peak to average power ratio (“PAPR”) which is desirable for efficient use of power amplifiers in the LTE uplink. (Purat 1 §60 and Cooper 1 §7.29)
 - b) **Zero autocorrelation (ZAC):** The correlation between a ZC sequence and a cyclically shifted version of the same sequence is zero, i.e. the sequence and the cyclically shifted version are mathematically orthogonal to each other which allows them to be easily distinguished at a receiver. The eNB can use this property to estimate the time it has taken for the waveform generated by the sequence to travel between the UE and eNB. The eNB can also use the ZAC property of ZC sequences to distinguish between preambles which are sent by UEs based on different cyclically shifted versions of the same ZC sequence. The ZAC property therefore makes ZC sequences particularly suited for both uplink synchronisation and UE identification. (Purat 1 §60 and Cooper 1 §7.29)

- c) **Low cross-correlation:** In addition to zero autocorrelation between cyclically shifted versions of the same ZC sequence, where the sequence length is a prime number (e.g. $N_{ZC} = 839$) different ZC sequences (i.e. different values of u) also have low cross correlation. This also assists with distinguishing between preamble sequences sent by different UEs. (Purat 1 §60 and Cooper 1 §7.29)
31. ZC sequences come in pairs, one of which is the time reverse conjugate of the other. A root sequence a symmetrically pairs with root sequence $839-a$ where $a = 1, 2, \dots, 838$. (Purat 1 §63, Purat 2 §29 and Cooper 1 §7.30 & 7.69(b))

I. Cubic Metric (CM)

32. Signals are generated within a mobile station at a relatively low amplitude level, and are then amplified to boost their power sufficiently that they will be reliably detected at the base station. It is important that the amplified signal should exactly match the shape of the original analogue waveform, multiplied by the desired gain factor. Any distortion from the original shape of the signal to be amplified is called a “nonlinearity”, which produces an especially problematic type of interference. (Cooper 1 § 7.42)
33. To avoid non-linear distortions, a PA needs to operate within a linear range of operation. The boundary between linear and non-linear behaviour of a PA is referred to as the PA’s rated power. (Purat 1 § 67 and Cooper 1, §7.41)
34. Real world power amplifiers always slightly distort the signal. Typically, if the amplitude is too large, the amplifier slightly “clips” the peaks of the signal. Power amplifiers are subject to an engineering compromise: the more faithfully the amplified signal replicates the original signal, the less efficiently the power amplifier can operate. Furthermore, the greater the amplification, the worse the nonlinearities (e.g. the more severe the clipping). All power amplifiers produce nonlinearities to some extent. (Cooper 1 §7.43 and Purat 1 § 67)
35. Most signals do not have a constant amplitude and have a PAPR greater than 1. PAPR is the Peak to Average Power Ratio – the ratio of the power associated with the biggest peak in the signal to the average transmission power of the signal. To operate within its rated power, a PA will therefore need to reduce the average power it transmits a signal at to ensure that peaks in the signal are not transmitted with a power outside the linear region. This is known as power de-rating or power backoff. Signals with high PAPR will generally require more power de-rating than signals with low PAPR. (Purat 1 §§ 65, 68)
36. Cubic Metric ("CM") is a property of an analogue signal, expressed in dB. It is a measure of the additional power backoff required for a signal wave form compared to the power backoff needed for a reference wave form to achieve a given maximum adjacent channel interference. The CM value of a signal reflects the amount by which the amplitude of the signal varies. The concept and definition of CM in LTE was defined in the feasibility study for E-UTRA (i.e. LTE) at section A.2.1.6. (3GPP TR 25.814 v7.0.0). (Cooper 1 §7.40 and Purat 2 §23).
37. Power amplifiers are sensitive to the CM of the signal to be amplified. A constant amplitude signal has a small CM and can be amplified with high efficiency. A signal with a varying amplitude signal has a larger CM and cannot be amplified so

- efficiently. A mobile station can amplify a constant amplitude (low CM) signal so that it is sufficiently powerful to send it over large distances without generating problematic interference. However it cannot transmit a signal with a varying amplitude (i.e. a signal with a larger CM value) over the same large distance without generating interference. (Cooper 1 §7.44)
38. Although signals generated from ZC sequences have a relatively constant amplitude compared with some other types of signal, they do not have perfectly constant amplitude. There are differences between ZC sequences in the extent to which their waveforms have constant amplitude; for example, when successive elements in the sequence have equal amplitudes but opposite signs, the transmitted waveform (which interpolates a continuous path between these elements) will necessarily pass through values close to zero. There is therefore significant variation in CM between different RACH preambles corresponding to different ZC root sequences. In practice this means that RACH preambles with larger CM values would be prone to producing more problematic interference than others with lower CM values. (Cooper 1 §7.45 and Purat 2 § 23)
 39. Cyclic shifts of a root sequence have practically the same CM value as the root sequence itself. (Cooper 1 §7.45 and Purat 2 § 28)
 40. ZC complex conjugate pairs have the same CM value (when rounded). (Purat 2 §29 and Cooper 2 § Footnote 5)
 41. In LTE, data carrying signals can be sent using different modulation schemes that allow data to be sent at a slower or faster rate, at the cost of lower or higher CM. The mobile station continually adapts the modulation scheme that it uses depending on channel conditions, notably how far it is from the base station. While in a large cell and far from the base station (thus needing to transmit with high power), the handset uses the modulation scheme with the lowest CM value (and the lowest data rate). The lowest modulation scheme used in LTE for uplink data transmission is Quadrature Phase Shift Keying (QPSK).
 42. The signal which carries data itself has a CM value. QPSK has a CM value of 1.2dB. (Cooper 1, §7.49 and Purat 2, §24)

J. Known limitations re the assignment of random access preambles to cells

Limitation 1: The larger the cell, the larger the cyclic shift

43. The time of flight of a preamble may cause the preamble to look like a different cyclic shift of the relevant ZC sequence, i.e. to look like a different preamble. The further away the mobile station is from the base station, the more time shifted a preamble sequence will look when it arrives at the base station. If the time of flight of the preamble coincides with the size of cyclic shift being used to separate ZC sequences used by different mobile stations, the base station will not know whether the received preamble was a ZC root sequence sent from near the edge of the cell, or a cyclic shift of that ZC root sequence sent from closer to the base station. (Cooper 1 §7.36 and Purat 2 §22)
44. To avoid this ambiguity, preambles are separated by a cyclic shift which is larger

than the longest possible time of flight in that cell. This ensures that when the base station receives a preamble it can determine the time of flight and the required timing advance. (Cooper 1 §7.37 and Purat 2 §22)

45. The larger the cell, the larger the maximum time of flight for any preamble, and therefore the larger the cyclic shift required between preambles to ensure that they can be distinguished by the receiving base station despite the shift caused by the time of flight. A minimum cyclic shift (the number of elements shifted in the ZC sequence) applies to any cell but the larger the cell, the larger this minimum cyclic shift. The larger the minimum cyclic shift, the fewer cyclic shifts of the ZC root sequence are available for use as preambles in that cell. (Cooper 1 §7.38 and Purat 2 §22)

Limitation 2: Maximum cell size by cubic metric

46. Generally, the greater the distance between the mobile station and the base station the greater the amplification that is required. When the CM value of a ZC sequence is too high, the amplifier in the mobile station is unable to transmit that sequence with the amplification required for that distance. (Cooper 1 §7.48)
47. The result is that preambles with a higher CM may not be suitable for large cells and/or transmission power limited environments while those with a lower CM could be used in large and small cells and in power limited environments. (Cooper 1 §7.48 and Purat 2 §23)

Limitation 3: High mobility cells and Doppler interference

48. The Doppler effect describes the changes in frequency of any kind of waveform (whether a sound wave or electromagnetic wave) produced by a moving source. The Doppler effect introduces an additional constraint in respect of high mobility cells i.e. those cells in which at least some mobile stations are likely to be moving at high speed (for example, a cell covering a motorway, or a railway line). (Cooper 1 §7.50 and Purat 2 §25)
49. The Doppler effect can cause a root ZC sequence to correlate ("alias") with a cyclically shifted version of itself, making it difficult for the base station to determine whether the mobile station is nearby or further away. If the mobile speed is low, the "alias" signal is received very weakly at the base station, but for fast moving mobiles the "alias" is received more strongly at the base station while the root ZC sequence is received more weakly. For fast enough mobile speed, the received signal at the base station correlates better with the "alias" than with the root ZC sequence. For each ZC root sequence, there is a specific cyclic shift of itself with which it will alias due to Doppler, denoted "Max Ncs". Max Ncs imposes a maximum size of cyclic shift increment (Ncs) which can be used with a given ZC root sequence and hence imposes a maximum size of cell in which that ZC root sequence can be used, i.e. the Doppler cell size limit (sometimes referred to as "supportable cell size"). (Cooper 1 §7.51).
50. It was known within RAN 1 at the Priority Date that some ZC sequences were more sensitive to the Doppler effect than others (i.e. some ZC sequences had lower Max Ncs values than others). It was also recognized that Doppler resistant ZC sequences (i.e. ZC sequences with higher Max Ncs values) should be prioritised for use in high mobility cells, particularly large ones, whereas less Doppler resistant ZC sequences

were sufficient for ordinary cells that do not require high mobility (such as cells in a shopping centre or pedestrianised area). (Cooper 1 §7.55 and Purat 2 §25)

A note on terminology (not from the parties' ASCGK)

51. In the documents to which I will be referring and in the evidence and the parties' submissions, the concept of the maximum cell size limit imposed by the Doppler constraint was referred to by a number of different expressions: Max Ncs, (maximum) supportable cell size, maximum cell radius, Doppler cell size and other cognate expressions. Care is needed because the CM imposes a maximum cell size (see above) and sometimes the actual physical cell size is used, so just referring to "cell size" or "ordering by cell size" is potentially ambiguous, although the context indicates what is meant. It was not submitted to me that there were any relevant differences of meaning and the parties themselves used different expressions at different times. I have aimed to keep any quotes in their original expression; where I describe things in my own terms I have mostly tried to use "Max Ncs" itself.

Additional Doppler issue

52. Doppler can also cause a ZC sequence to alias with one or more cyclically shifted versions of itself, meaning that it can cause a given RACH preamble signature to alias to different preamble signatures derived from the same ZC root sequence. This imposes an additional constraint in high mobility cells because it means that once it is determined to use a particular ZC sequence cyclic shift as a preamble signature you cannot use other cyclic shifts of the same root sequence which would be affected by the aliasing issue, i.e. you are restricted from using those other signatures. This problem is not affected by the logical ordering assigned to ZC root sequences and cannot be overcome by means of a method of ordering. (Cooper 2 Annex)

K. Network planning

53. ZC root sequences have an intrinsic CM value and Max Ncs value, but these properties are not correlated with one another and vary in an independent manner between different ZC root sequences. (Cooper 1 §7.56, §7.59)

54. It is desirable for cell planning purposes to have contiguous runs (or "blocks") of ZC root sequences which are suitable for particular types of cells. (Cooper 1 §7.58 and Purat 2 §27)

L. RAN1 agreements re random access signalling and sequence allocation

55. ZC sequences can be reordered into a different order from the physical index - i.e. a "logical index" order, according to some desired property or properties. This ordering would be used by all base stations and mobile stations, thus the "logical index" would unambiguously identify a specific ZC root sequence to each device in the network. Once ordered, a block of ZC root sequences, all with consecutive positions in the logical index, could be used in a particular cell, and not in other nearby cells. (Cooper 1 §7.60-7.61)

56. As stated above, it had been agreed that 64 distinct preamble sequences would be assigned to each LTE cell and the mobile stations were to select at random any of these 64 preambles to communicate a random access request to the base station. By the Priority Date consensus had been reached within RAN 1 that, in order for the

mobile stations in a cell to generate this set of 64 preamble sequences, the index of a first root sequence and the size of the cyclic shift to be applied to the root sequence should be broadcast. The cell therefore broadcasts two values, which are used by mobile stations when making a random access: the index of a "first" ZC root sequence and a cyclic shift value. The mobile stations in the cell derive as many of the 64 sequences as possible from the first ZC root sequence, subject to the size of the cyclic shift, and if this does not provide 64 preambles they then continue with the next ZC root sequence in the logical sequence index and so on. (Cooper 1 §7.64-7.65 and Purat 2 §15 and §28)

57. RAN 1 had also reached consensus on restricting or 'quantizing' the cyclic shift values that may be broadcast up to a maximum of sixteen different cyclic shift configurations to allow for a reduction of overhead in signalling of the cyclic shift configurations. (Cooper 1 §7.66 and Purat 2 §34)
58. The exact definition of the ZC index number (i.e. how the ZC root sequences should be ordered) and the exact values of cyclic shift to be used were still to be decided. (Cooper 1 §7.66-7.68 and Purat 2 §15)

M. Summary of CGK

59. In summary, the following concepts were known as part of the CGK by the Priority Date:
 - a. ZC sequences used in LTE have a fixed length of 839 elements;
 - b. ZC sequences have a number of beneficial properties for use as random access preambles in LTE;
 - c. adjacent cells should use different ZC root sequences (and their cyclic shifts) as preambles to avoid inter-cell interference;
 - d. the larger the cell, the larger the time shift of the mobile station's signal when received at the base station, thus the larger the time shift by which ZC sequences must be separated;
 - e. the CM value of a ZC sequence imposes a maximum cell size due to amplifier constraints;
 - f. the cyclic shifts of a root sequence have the same CM value as the root sequence;
 - g. Doppler interference can distort the orthogonality of cyclically shifted ZC sequences in high mobility cells;
 - h. some ZC sequences are more susceptible to the Doppler effect than others, in the sense that for some sequences a relatively small time of flight will cause the received signal to alias to the same sequence with zero time of flight, but for some sequences this will only occur with a large time of flight;
 - i. ZC sequences therefore have a Doppler cell size restriction or "Max Ncs";
 - j. the Max Ncs values and CM values of ZC sequences are quasi-independent of the natural sequence numbering;
 - k. Max Ncs and CM are two unrelated problems faced when network planning; and
 - l. limited information (root index, and one of 16 possible Ncs values corresponding to the size of cyclic shift) would be broadcast by the base station to inform all

mobile stations of the available preambles within a cell.

(Cooper 1 §7.67 and Purat 2 §15-16 & 28)

Disputed CGK – circular interpretation of sequences

49. Oppo argued that it was CGK to interpret sequences of numbers in a circular or cyclic way. Examples given included clocks, compasses and modular arithmetic.
50. Oppo also pointed to what it said were examples of this in the telecoms field (from Oppo's closing written submissions):
 - i) The numbering of TDMA frames from 0 to 2715647 in GSM;
 - ii) The pattern for hopping between up to 64 frequencies used in GSM;
 - iii) The packet sequence numbers used in UMTS;
 - iv) The cyclic use of fifteen 8-bit pilot sequences for RACH messages in UMTS; and
 - v) The cyclic sliding window protocol used to reorder and avoid duplication of packets in UMTS.
51. Nokia said that some of these situations (the second and fourth) were closer to that of the ZC sequences for RACH preambles. It is not altogether easy to articulate the similarities and differences, but Dr Cooper, for example, agreed that the first and third examples above were ones where a finite range of numbers is used to count or signal steps in a process that could run indefinitely. That is not true of ZC sequences, where the resource is limited. That distinction cannot be made in relation to the other examples above, hence Nokia's acceptance that some are more similar.
52. Nokia said, and I agree, that this was not really a point about CGK but about obviousness. Dr Cooper fairly much accepted that. He said in cross-examination that he was not suggesting it was CGK to use cyclic interpretation for ZC sequences (which I agree with), but rather that it was an obvious desire to use cyclic interpretation when seeking to allocate blocks of contiguous sequences.
53. I conclude that at a very general level the idea of circular interpretation of sequences was CGK and in some instances the skilled person would face a task where it inevitably became relevant (such as the first and third above). But there was no CGK on the point relevant to the task that the Patent deals with; none that the skilled person would have in mind as they set about the task. On this issue, Oppo's approach, which I reject, was to identify a very broad conceptual proposition, so broad that in a sense it was bound to be CGK, and then seek to plug it in to the analysis of the present, concrete, narrower problem.

Disputed CGK – CM of QPSK as a threshold

54. There was a wide-ranging dispute about this point, which embraced a large number of RAN1 documents and also extended to technical documents from other aspects of LTE, and to the relationship between RAN1 and RAN4.
55. The basic technical point underlying this is not in dispute:
- i) Of the modulation schemes for user data in LTE, QPSK was the one with the best CM, and hence was the best for transmission over longer distances. Its CM is 1.2dB.
 - ii) All cells in LTE had to have the property that, at a minimum, QPSK modulated signals could be transmitted by a UE at the edge of the cell and be understood at the eNodeB.
 - iii) As a result, any ZC sequence with a CM less than that of QPSK could with confidence be used in any cell of any size.
56. Above the CM of QPSK one is into a sliding scale with increasing CM implying that the cells in which a ZC sequence could be used would get smaller. But that does not detract from the fact that the CM of QPSK is a cut-off: lower CM sequences are usable (from this point of view) in any size cell.
57. There is no doubting the logic or accuracy of this reasoning. The issue is whether it was CGK.
58. However, as the argument developed, it became more and more apparent that whether it was CGK was not important to the way that Oppo developed its case. The reason is that ZTE divides the ZC sequences into those with CMs below 1.2dB and those above, and calls out that this has the benefit that the ones with lower CMs are useful for larger cells. Oppo submitted that on this basis it did not matter whether a more detailed understanding of why the benefit would arise was CGK, and I agree. Nokia did not really have much to say by way of answer to this. Its defence to obviousness is not dependent on being right about this point of CGK.
59. In that light I am going to deal with the materials going to CGK quite briefly.
60. Oppo said that Prof Purat had two reasons for disputing whether the idea was CGK, namely:
- i) UE power limits and performance requirements were dealt with by RAN4 not RAN1.
 - ii) There were no pre-filing date documents that used the CM of QPSK as a cut-off for sorting (other than ZTE itself).
61. These are convenient headings to organise the materials, although I do not think it was for Prof Purat to come up with reasons why it was not CGK; it was rather for Oppo to show that it was.

RAN1/RAN4 liaison statement and response

62. Oppo did not in general dispute that it was indeed RAN4 that dealt with power limits and performance requirements. However, as one would expect the Working Groups communicated where they felt it necessary, and helped each other. The formal means for communication was by a liaison statement.
63. RAN1 sent a liaison statement, R1-070632, to RAN4 in the context of meeting #47bis. It identified the benefit of lower CM and identified certain CM-reducing techniques under consideration for the various modulation schemes. It asked three questions, of which the first two were relied on by Oppo, most particularly the second, which asked if a UE could be permitted to transmit QPSK with more than the nominal maximum power.
64. RAN4's response was R1-071211/R4-070297 and, unsurprisingly, its answer to the second question was "no", for three reasons (the answer to the first question was that it was possible to reach the maximum power for QPSK without the relevant CM-reducing technique, FDSS).
65. This interchange shows that there was an awareness of the importance of CM and that it was important in the context of QPSK. But I was unable to see how it could make CGK the much more detailed point urged by Oppo, that the CM of QPSK was a cut-off for ZC sequencing, a topic which is not even mentioned.

Documents referencing the CM of QPSK

66. Oppo organised its submissions by the type of signal to which the documents related and I will do the same.
67. In relation to ZC sequences used as RACH preambles:
 - i) Three pre-priority Panasonic Tdocs. The best of these for Oppo seemed to be R1-073622. Oppo referred to the following figures (with accompanying text):

Cubic Metric

Figure 1 shows the relation between the sequence index order and CM values of **Alt.1**. This ordering guarantees that they have similar CM properties among consecutive root ZC indexes when multiple ZC sequences are to be used in the same cell. Therefore, this sequence index order allows for a CM-based ZC sequence planning, for instance, root ZC sequences with low CM values can be allocated to larger cells under transmission power limited environment irrespective of low/middle mobility cell or high mobility cell.

Figure 2 shows the relation between the sequence index order and CM values of **Alt.2**. From the figure, it would be difficult to apply a CM-based ZC sequence planning, especially when large number of different root ZC sequences is allocated, because small and large CM values is usually mixed among allocated root indexes.

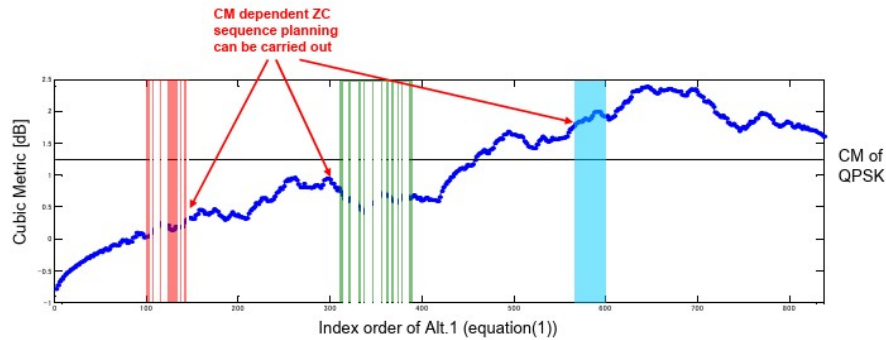


Figure 1 Pre-defined sequence index order and CM values (Alt.1, $K=839$).

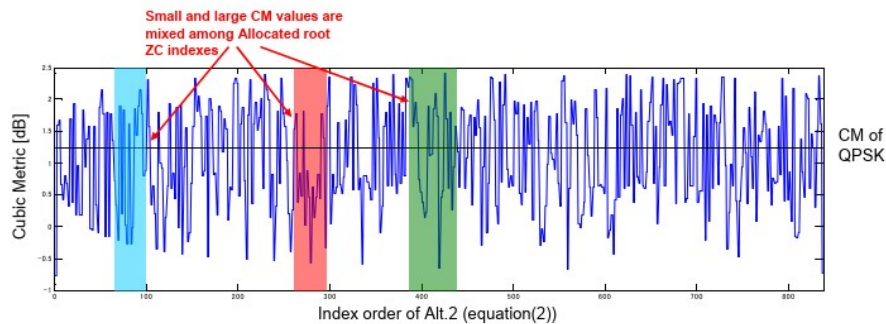


Figure 2 Pre-defined sequence index order and CM values (Alt.2, $K=839$).

and pointed out that as well as marking the CM of QPSK the document pointed out the benefit of low CMs for larger cells. However, the document itself was not said to be CGK and does not use the CM of QPSK as a cut-off.

- ii) ZTE itself. This was not CGK on my findings below. I discuss its teaching below.
- iii) A TI Tdoc from the filing date of the Patent, R1-074146. I found the language a little bit contorted but Prof Purat accepted that it disclosed the CM of QPSK as a threshold and I see no reason to doubt what he said. The relevant paragraph cites the RAN1/RAN4 liaison statement and for avoidance of doubt I do not think it follows that TI thought that the statement provided that there be a cut-off. It is just cited for the fact that the nominal maximum power could not be exceeded. This Tdoc was not itself CGK but of course can be evidence of CGK.
- iv) A further TI Tdoc on the same date stated the CM of QPSK without explaining its meaning to the reader. I do not think this takes matters further.

- v) Six companies submitted a Tdoc the day after the filing date (Panasonic, NTT DoCoMo, Huawei, LG Electronics, TI and Alcatel-Lucent). This clearly split ZC sequences into those with a CM less than QPSK and those with one greater, and said that there was no point sorting the former group any further (by CM). Prof Purat said, and I agree, that all the companies submitting the document understood the disputed point. Again, the Tdoc itself was not CGK but evidences how widely understood the point was. The fact that the document was submitted the day after the priority date does not matter; they obviously understood the point earlier.
 - vi) Panasonic submitted another Tdoc on the same day making the same point. This does not add anything.
68. Oppo submitted that on this basis it can show that 8 out of the 11 companies that made RACH submissions to RAN1 meeting #50bis had addressed the QPSK of CM as a cut-off (this includes Nokia and NSN).
69. I think in this unusual field where the sources available to prove the CGK are limited, for reasons given above, this is quite an impressive showing of a broad understanding among those working on the problem and is enough to hold in Oppo's favour on this point.

Other contexts

70. Since the materials concerning the RACH are enough for Oppo, little need be said about other non-RACH contexts. I record that Oppo relied on:
- i) An email exchange in April 2007. This was not very easy to follow and was introduced only for cross-examination. I do not think it carries any weight.
 - ii) A May 2007 TI Tdoc about using ZC sequences for multiplexing on the PUCCH. This is less clear than the RACH documents about the CM of QPSK actually being a cut-off. It is broadly consistent with Oppo's case but adds only a very little.
 - iii) A Sharp Tdoc from August 2007 concerning reference signals on the PUSCH/PUCCH. Very similar comments apply as for ii) but if anything this is more distant and weaker.
 - iv) A Panasonic Tdoc from August 2007 also concerning uplink reference signals. This more clearly splits ZC sequences into those with CMs above QPSK and those below. It fortifies Oppo's position that Panasonic had realised the point but does not go much further than that.
 - v) A discussion on the RAN1 email reflector in September 2007 about reference signals on the PUCCH. The context is again different but makes clear that how much a sequence falls below the CM of QPSK is inconsequential because of the power issues referred to above. The fact that this is merely an email chain reduces its significance, but it still has some modest weight.

71. Overall, these non-RACH materials would not have been enough on their own for CGK, but support Oppo's case on the RACH materials, which I have held above were enough.

Tension with the patent

72. Oppo submitted that there was a tension in Nokia's case because the Patent says rather little about the CM of QPSK. Prof Purat was asked about [0043]; it was said that everything down to line 48 was accepted by him to be CGK. In my view the Patent gives a short but adequate explanation of the significance of the CM of QPSK to its invention, and Prof Purat did not accept that everything was CGK down to line 48. The questions were a mixture of what was CGK and what the skilled person could understand.
73. However, that does not matter because I accept Oppo's case on this aspect of CGK based on the RACH materials identified above, and supported by Dr Cooper's opinion.
74. The fact that this was CGK does not mean that the skilled person would think it was always important, or the critical factor in decisions that needed to be made, however.

Disputed CGK – similarity of CM and Max Ncs in consecutive sequences

75. Oppo's argument on this issue started from the propositions that CM and Max Ncs were known properties of ZC sequences, would affect the suitability of a sequence for a given cell, and were not correlated. These matters were indeed CGK. They are also possible stepping stones along a path of reasoning leading to the conclusion that within continuous sequences it would be preferable to have similar CM and Max Ncs. They would also help the skilled person understand why such similarity was useful if they were told so. But the fact that a conclusion can be derived by reasoning does not make it CGK.
76. Dr Cooper addressed this topic in his first report, and then in his third report responded to what Prof Purat had said in his own second report. Prof Purat's emphasis was slightly different and rather less demanding: he said that what the skilled person would have in mind was having blocks of sequences that were suitable for use in a particular type of cell.
77. Oppo submitted that Nokia did not challenge Dr Cooper about this point. I agree that Nokia did not point to anywhere that he was directly challenged about whether this precise point was CGK, but Nokia took the stance that it was a point that really arose under obviousness, and Dr Cooper had a full and fair opportunity to have his say in his third report (which as I read his evidence is where he rather hardened his stance from consecutive sequences having to be suitable to having to be very similar).
78. Oppo did not point to anywhere where the proposition that it contends to be CGK was written down as such. I conclude that it was not CGK and accept Prof Purat's evidence that the CGK was that the skilled person would be looking for blocks of sequences whose characteristics were suitable for

particular cell types. As with the issue on circular interpretation, I felt that Oppo was engaged in expressing the CGK in just such a way that it would neatly slot into the obviousness analysis in due course, and not asking the more basic and more conceptually correct question of what the skilled person would have as basic knowledge at the outset.

Disputed CGK – ZTE and LGE

79. Oppo, and indeed, Dr Cooper were not clear or consistent about whether it was argued that ZTE or LGE were themselves CGK. In substance I think they were saying as much, even if they paid lip service to the proposition that individual Tdocs are not CGK.
80. Whether or not they were CGK depends in large part on what was going on in RAN1, so I will deal with that before I express my conclusion. The chronology will also be of relevance to obviousness in the event that ZTE and LGE are not CGK, and the secondary evidence relied on by Nokia.

Events at RAN1

81. Nokia provided a detailed chronology of events in RAN1 in the run up to the priority date and for some time after that, a somewhat simplified version of which is as follows:

15 August 2007	R1-073595 (LGE) sent to RAN1 email reflector
15 August 2007	R1-073501 (ZTE) sent to RAN1 email reflector
20-24 August 2007	<u>RAN1#50 takes place in Athens</u>
29 August 2007	Draft minutes of RAN1#50 sent to RAN1 email reflector
28 September 2007	US 976125P (Woo PD8) filed with USPTO
2 October 2007	EP application number 07117750.5 filed (Filing date of EP 103)
2 October 2007	R1-074145 (Texas Instruments, LG Electronics, Huawei) sent to RAN1 email reflector
2 October 2007	R1-074146 (Texas Instruments) sent to RAN1 email reflector
2 October 2007	R1-074148 (Texas Instruments) sent to RAN1 email reflector
2 October 2007	R1-074340 (Nokia Siemens Networks, Nokia) sent to RAN1 email reflector
3 October 2007	R1-074420 (Panasonic, NTT DoCoMo, Huawei, LG Electronics,

	Texas Instruments, Alcatel-Lucent) sent to RAN1 email reflector
3 October 2007	R1-074421 (Panasonic) sent to RAN1 email reflector
8-12 October 2007	<u>RAN1#50bis takes place in Shanghai</u>
8-12 October 2007	R1-074494 (Texas Instruments, Alcatel-Lucent, Huawei, LG Electronics, NTT DoCoMo, Panasonic) made available to participants at RAN1#50bis
8-12 October 2007	R1-074514 (Texas Instruments, LG Electronics, Huawei, Alcatel-Lucent, Nokia, Nokia Siemens Networks, Panasonic, NTT DoCoMo) made available to participants of RAN1#50bis
17 September 2008	EP 1 971 097 A2 (Woo) published

82. Oppo’s arguments relied on the materials provided in advance of the RAN1 meeting #50 in Athens in August 2007.

83. Oppo particularly drew attention to Tdoc R1-073404, which was on the RAN1 email reflector, which said the following:

1. *Root Zadoff-Chu sequence allocation and signalling method. The agreement is to signal one index number and a cyclic shift duration. However, the exact definition of the index number is FFS. Several proposals on this topic may be found in R1-072800, R1-072838, and R1-072864.*

Although there was no clear consensus on this issue, the majority of the participating companies expressed their preference for pair-wise ordering by CM as proposed in R1-072838.

Company	Ordering Preference
Alcatel-Lucent	CM
Ericsson	CM
Huawei	CM
LG Electronics	CM + supportable cell size
Motorola	CM
Nokia Siemens Networks/Nokia	CM
NTT DoCoMo	Supportable cell size
Panasonic	Supportable cell size
Samsung	Number of available cyclic shifts
Texas Instruments	CM
ZTE	CM + supportable cell size

84. Oppo points out that this was a small number of proposals and that only two, ZTE and LGE, were “hybrid” proposals (i.e. proposing the use of both CM and supportable cell size, which means Max Ncs).

85. It can be seen from the chronology above that both LGE and ZTE were sent to the email reflector six weeks before the filing date of the Patent, and that RAN1 meeting #50 was about a week after them, still closer to the Patent’s date.

Analysis

86. In my view, neither ZTE nor LGE was CGK. They were specific, detailed proposals that were under discussion, but they had not been accepted by the community as the way to go, or ever implemented. It is Oppo's own case that they had shortcomings. The fact that they at one time formed part of a relatively small pack of information, along with some other Tdocs, about the RACH preamble issue for a particular RAN1 meeting does not overcome the failure of their methods to meet the necessary quality of general acceptance.
87. It is, I would note in passing, perfectly possible and consistent with the principles applicable to CGK that *some* of the information in each document was CGK, and that the documents formed part of a wider pattern of communications within RAN1 making some information CGK. For example, and without specifically deciding it, it is quite possible that the information in the first couple of paragraphs of ZTE represented CGK and could be evidence of it.

THE PATENT

88. The filing date is 2 October 2007. There is no claim to any earlier priority date, so any reference in this judgment or the papers in the case to "priority date" are in fact to the filing date.
89. The majority of the contents of the Patent to which I was referred goes only to added matter and I will pick it up there. In this section I will outline the teaching of the examples to give a general idea so as to provide a context to the reader of this judgment for understanding the claims. I take this approach for readability, especially given that there are no disputes of claim scope, but bear in mind that the examples do not limit the teaching and that the specification must be read as a whole.
90. Figure 1 of the Patent shows a "first ordering scheme":

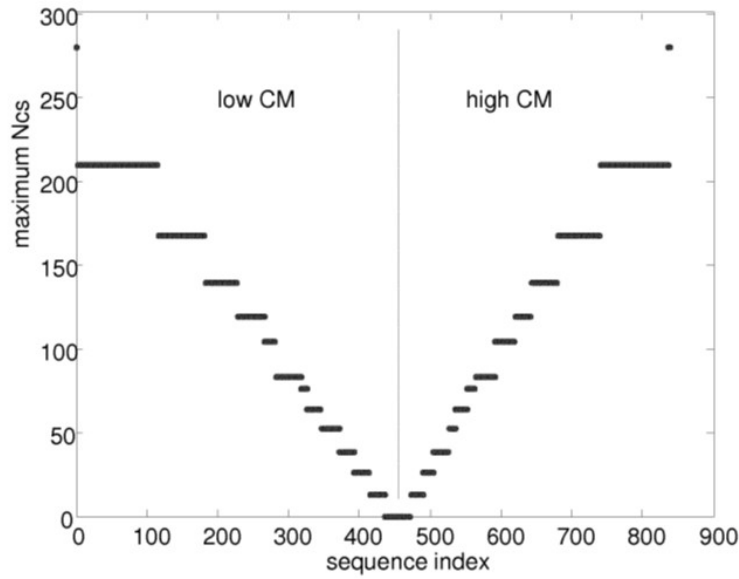


Fig. 1

91. In this approach (ZC) sequences are first ordered according to CM. Then they are divided into those with CM above or below a cut-off. The example cut-off used is the CM of QPSK. The low CM set is ordered according to decreasing Max Ncs and the high CM set according to increasing Max Ncs. The Max Ncs is quantised which is why the plot is formed of discontinuous horizontal bars and not a smooth line.

92. Figure 2 is a variant on this, referred to as the “second ordering scheme”:

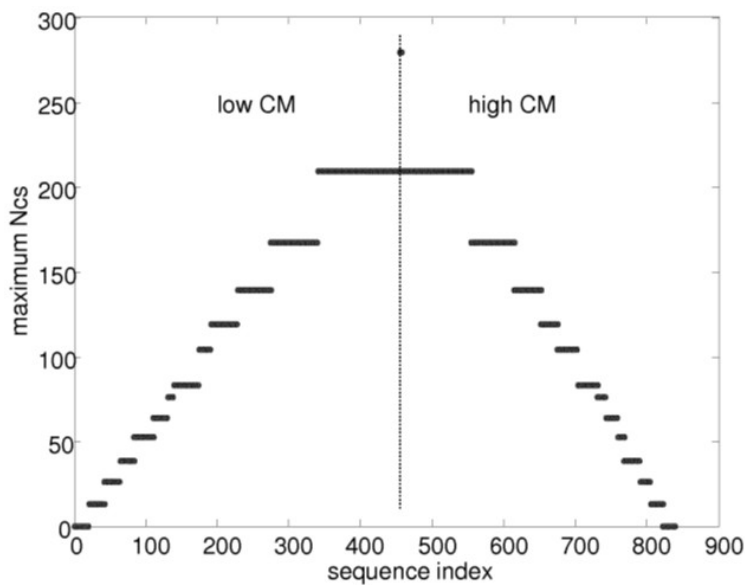


Fig. 2

93. The difference is that the low CM set is ordered with increasing Max Ncs and the high CM set with decreasing Max Ncs, so there is a mountain rather than a valley.
94. Figure 3 gives a “third ordering scheme”:

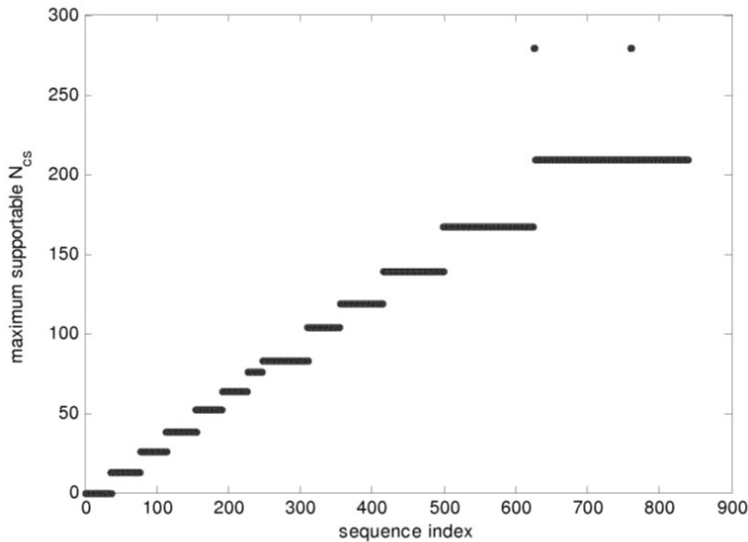


Fig. 3

95. Here, the sequences are split into groups according to Max Ncs and then within each Max Ncs group they are ordered by CM. The specification says that it is preferable to order the groups by CM in an alternating way, with one group ordered by decreasing CM and the next by increasing CM. Figure 4 uses this approach to show the CMs of the sequences that have been grouped by Max Ncs as described:

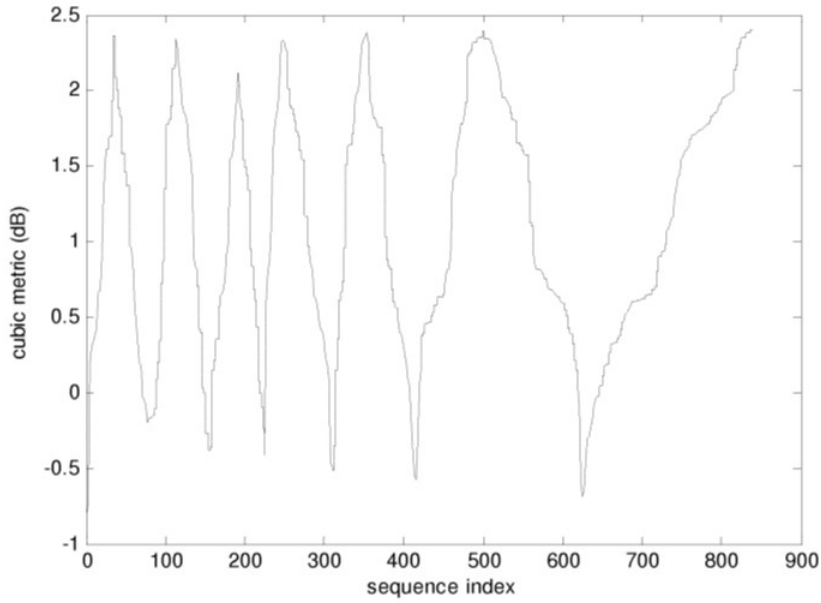


Fig. 4

- 96. The specification then moves on to the “first embodiment”. The narration begins at [0027] which says that according to the first embodiment “sequence allocation is made cyclic”, so that sequence number one is consecutive to sequence 838.
- 97. This is illustrated by Figure 5, which uses the first ordering scheme:

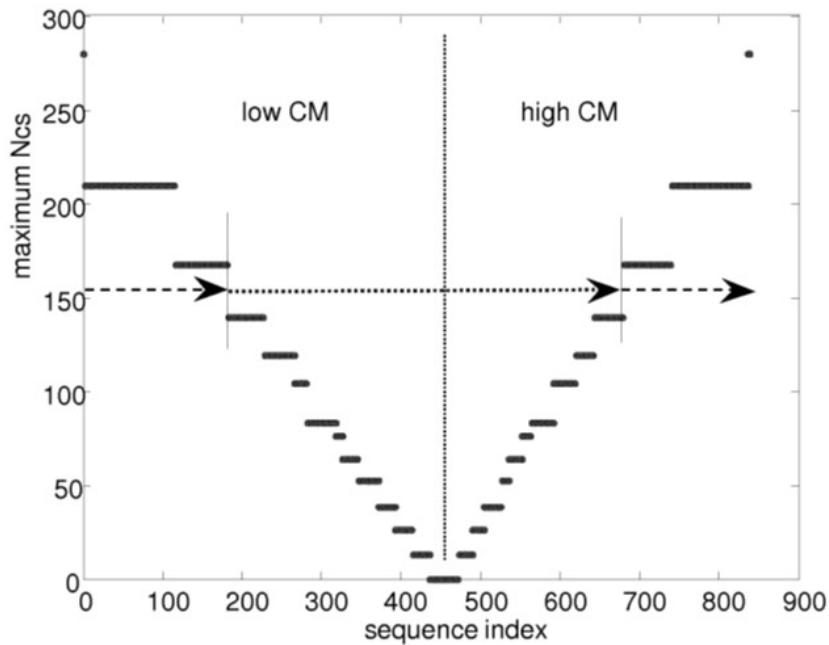


Fig. 5

98. The high mobility cells are at the left and right ends of the figure. The specification explains that their being discontinuous is undesirable and explains that using cyclic allocation joins them up. So it is possible to assemble a group of 64 sequences using the extreme right hand side followed by the extreme left hand side (see [0031]).
99. It is also explained that the same approach can be used for the Fig 2 second ordering scheme.
100. The “second embodiment” follows, with its description starting at [0042].
101. [0042] explains that the second embodiment will have sequence ordering schemes which combine the first and third ordering schemes, or the second and third ordering schemes. So, first of all high and low CM sets are formed according to figure 1 or figure 2. Then the third ordering scheme is applied to both sets, or just to the high CM set, with subsets being formed according to Max Ncs, and sequences then sorted by CM within each subset. This is shown in Figure 7 (Figure 1 combined with Figure 3):

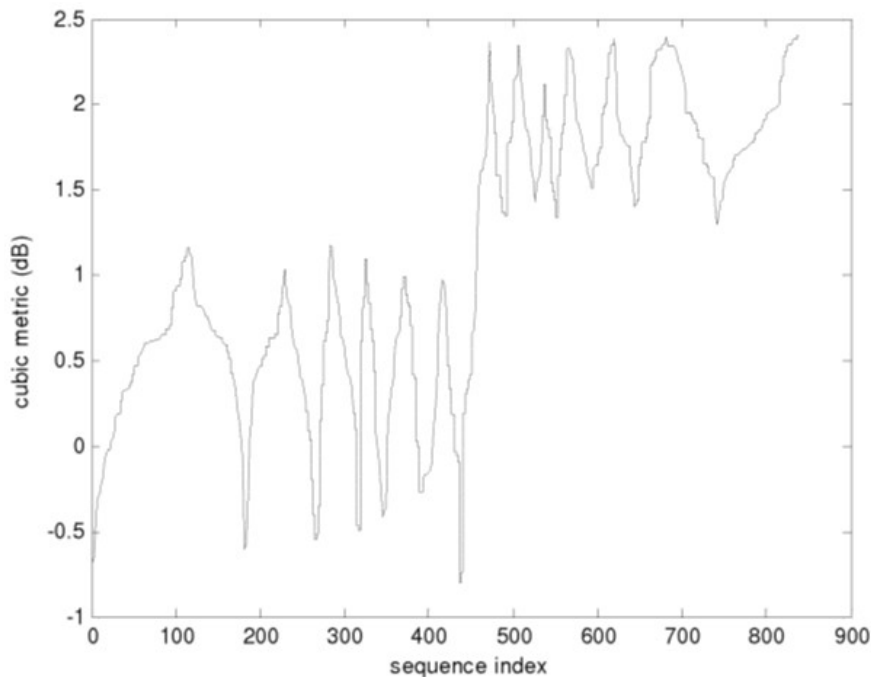


Fig. 7

102. It will be important when dealing with added matter to note that there is no explicit reference in the context of the second embodiment to cyclic allocation.

Claim 1

103. Claim 1 of the Patent is (with the integers labelled in the form referred to in the papers, originally divided up by Prof Purat):

	A device comprising:
1[a]	a searching unit configured to search a set of specific sequences, comprising a set of root sequences and cyclic shifts thereof,
1[b]	wherein the searching unit is configured to start from a root sequence index indicating a root sequence of ordered root sequences, include available cyclic shifts of the root sequence, and continue with a next root sequence if necessary for filling the set,
1[c]	wherein the searching unit is further configured to interpret the ordered root sequences in a cyclic manner, and
1[d]	wherein the ordered root sequences are obtained by ordering sequences of a predetermined length and number in accordance with cubic metric of each of the sequences and a size of a high mobility cell each of the sequences supports, wherein the ordering comprises:
1[e]	- dividing the sequences into a first set with cubic metric values below a predetermined threshold and a second set with cubic metric values above the threshold,
1[f]	- forming two or more subsets of the sequences in the first set and two or more subsets of the sequences in the second set according to the supported cell sizes,
1[g]	wherein the subsets are arranged such that supported cell sizes of the sequences increase between subsets of the first set and decrease between subsets of the second set or vice versa, and
1[h]	- ordering the sequences in each subset according to their cubic metric values, wherein the sequences of adjacent subsets are ordered with alternating decreasing and increasing cubic metric values.

104. I have indented 1[e] to 1[h] as in the granted claim in the Patent itself. It should also be noted that 1[f] and 1[g] are a single sub-feature in the Patent version so 1[g] has no leading hyphen.
105. This is a claim to a searching unit configured to search a set of specific sequences in a particular way. It searches by root sequence and cyclic shifts until it fills a set. It interprets the ordered root sequences in a cyclic manner. The ordering is done by the steps in features [e] to [h], combining ordering schemes as was taught in [0042] in the second embodiment.

ANTICIPATION BY WOO

106. Oppo argued that the Patent is anticipated by Woo. All the claims in issue stand or fall together; I only need to decide on claim 1 and there is no dependent claim to consider.

Legal principles

107. Woo is a published European Patent Application. It is a novelty-only citation under s. 2(3) of the Patents Act 1977 (the EPC has an equivalent provision in Art 54(3), and the purpose of the provisions is to prevent double patenting). S. 2(3) provides:

(3) The state of the art in the case of an invention to which an application for a patent or a patent relates shall be taken also to comprise matter contained in an application for another patent which was published on or after the priority date of that invention, if the following conditions are satisfied, that is to say—

(a) that matter was contained in the application for that other patent both as filed and as published; and

(b) the priority date of that matter is earlier than that of the invention.

108. Thus under s. 2(3)(b) Woo can only be relied on in relation to matter that it contains and has an earlier priority date than that of the Patent (which is the Patent's date of filing).

109. Woo has multiple priority claims; the one of relevance to this trial was referred to before me as PD8, a US provisional application filed in Korean on behalf of LGE.

Basic test

110. There was no dispute as to the basic legal standard applicable to a disclosure said to be an anticipation: there have to be clear and unmistakable directions (*General Tire and Rubber Co v Firestone Tyre and Rubber Co Ltd* [1972] R.P.C. 457, approved by the House of Lords in *Synthon v SKB* [2005] UKHL 59). There also has to be enablement, but Nokia did not say that if there was a sufficiently clear disclosure in Woo then it was nonetheless not enabled. I use “ambiguous” and “ambiguity” below in some instances to mean a failure to meet this standard.

111. Oppo also cited what Lord Hoffmann said in *Synthon* [22] in relation to the fact that the test is an objective one and it is not necessary that the author of the prior art knew that he or she was “planting the flag”. I accept this, of course, but did not see the relevance to the present case, which is not run as one of inevitable result, and Oppo did not really develop it.

Further points on unambiguous/unmistakeable

112. I also accept Oppo's submission that a prior art document may, to the relevant standard, disclose two (or more) discrete things and if one of them anticipates then that is enough, even if the other does not. Nokia did not really dispute it. There has to be disclosure of the two discrete possibilities, though: a generic disclosure which merely embraced both is not good enough.
113. Nokia also did not dispute Oppo's submission that the mere fact that there is an argument over the meaning of a disclosure does not mean that it is unclear or ambiguous. I agree with this.
114. Relatedly, Oppo submitted that "[t]he court has to resolve the meaning of the paragraph" (paragraph [0055] of Woo). I do not entirely accept this. As I have said, I do agree that the existence of an argument over meaning does not mean that there is a lack of clarity or ambiguity. I would also agree that the Court should not be quick to find something ambiguous; a patent disclosure is intended by the author to be meaningful and the Court should try diligently to identify the meaning. But the very fact that that the test is one of unmistakable/unambiguous disclosure necessarily implies that the Court can find that a disclosure is too unclear to amount to an anticipation.

Role of expert evidence

115. There was extensive expert evidence about Woo's teaching. In my view it was admissible where it elucidated the technical considerations relevant to understanding the document and inadmissible where it descended into mere analysis of words. Attributing meaning (or lack of it) once the technical context has been explained is the Court's function.
116. It was also admissible for the experts to put forward possible ways to work Woo that would (as they saw it) satisfy the teaching in a sensible way consistent with the parties' contentions on claim interpretation. This was particularly done by Prof Purat in answer to Dr Cooper's evidence that Nokia's interpretation of the key passage in Woo would not make technical sense.
117. Subject to the point that the mere existence of an argument does not imply ambiguity, I also think some forensic weight can be attached to the fact that both experts have genuinely struggled to understand a teaching.

Actual events, later documents

118. Nokia relied on actual events in RAN1 to try to promote its position on the meaning of the relevant parts of Woo. The basic point was (Nokia said) that at the point in time when PD8 was filed, LGE had only got as far as the idea in the LGE Tdoc prior art, which is not said to anticipate, and that it only included the idea of the Patent, requiring further sequencing steps, in a later Woo priority filing after Nokia's idea was adopted at RAN1. Nokia made no attempt to justify this in law. It is irrelevant prejudice.

119. By very much the same token, it is not legitimate to try to understand Woo by reference to the Patent. Of course, the parties know the target presented by claim 1 of the Patent, but the reader of Woo would not and could not. The reader of Woo would just try to understand its teaching with an open mind. Hindsight can creep in if the analysis is “does Woo mean X?”, where X is something designed to fall inside claim 1, rather than “what does Woo mean?”.

Significance of parts of Woo not having priority

120. Nokia raised a potentially significant nuance. It pointed out that only matter in Woo which can claim the priority date of PD8 is relevant to anticipation, and that accordingly much of Woo itself cannot be relied on by Oppo. Oppo accepted that. However, there is material in Woo, *not* present in PD8, which Nokia says informs the interpretation of the parts of Woo which Oppo *can* rely on, in a way favourable to Nokia. In particular, there is a section later in Woo than the parts on which Oppo relies, having no equivalent in PD8, which clearly does disclose the full sequence of steps of claim 1 of the Patent. Nokia says that that later section may be used to interpret the parts on which Oppo relies, and points away from the earlier parts disclosing the same thing as the later.
121. Neither side pointed me to any authority or commentary which bears on this. It feels intuitively rather odd that a document, in this case PD8, whose contents would (Oppo says) anticipate when written if they were published, and whose matter then becomes part of the state of the art through s. 2(3), could fail to anticipate because of some further text added only later in a published version, after the priority date of the patent in question, which changes the context and therefore the meaning of the original.
122. However, on reflection and after hearing oral submissions, I think Nokia is right. The way that s. 2(3) works is to make some of the matter in the relevant patent application (Woo) prior art; PD8 is not prior art. The limitation is that matter in the relevant patent application can only be relied on if it has an earlier priority date; that is where PD8 comes in. So one identifies matter in Woo and then asks if it has priority from PD8. Matter for these purposes means information and one determines the information in Woo by interpreting it. There is nothing in s. 2(3) that says that only part of Woo must be read for the purpose of interpreting it, and to not read all of it might give its individual parts a meaning which was not (objectively) intended. What if a part of Woo that did not have priority *expressly* said that the part that Oppo relied on did not cover what Oppo said? There could be no valid reason to ignore it.
123. I also think, although I was not addressed on it, that this conclusion is at least consistent with avoiding double patenting.
124. Oppo also said that there was no authority on the point, but did not provide any principled reasons why Nokia was wrong. It said that if the relevant parts of Woo did come in, they helped Oppo, and I deal with that in context below, and reject it.

125. I make it clear, however, that my decision on this nuance is not necessary to my overall conclusion that there is no anticipation by Woo. I would have reached the same result if it were not permissible to look at the later part of Woo.

Disclosure of Woo

126. Woo concerns a method of generating random access preambles in a wireless system (see [0001]). It gives the 3GPP context at [0002]ff. The general goal is given at [0010]-[0011]:

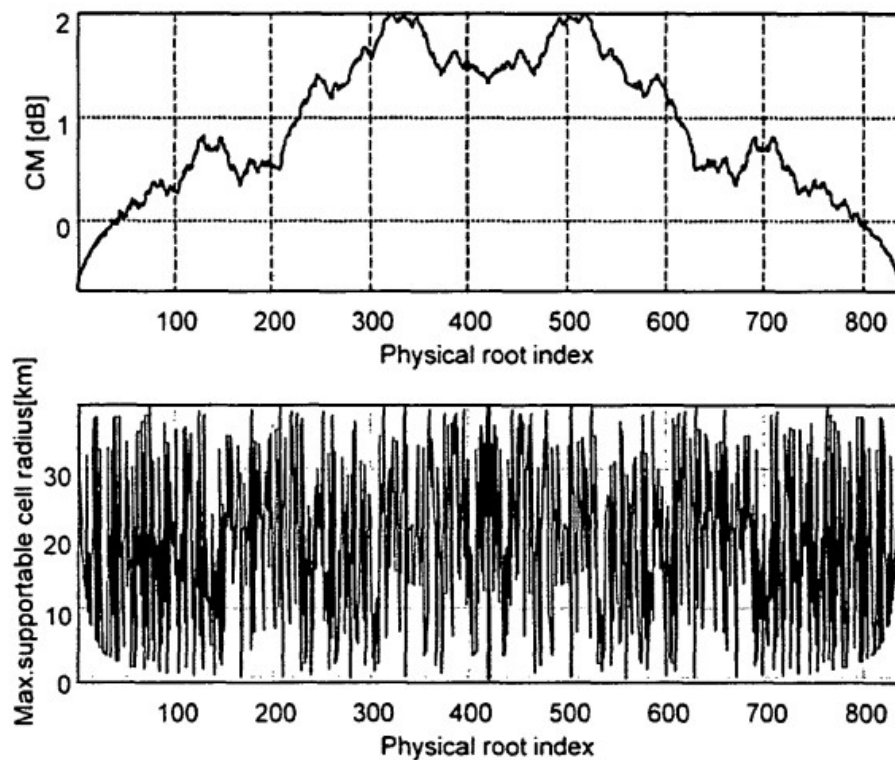
[0010] In order to enhance performance of data detection in a receiver and increase capability, correlation or CM (Cubic Metric) characteristics of the sequences should be guaranteed to a degree. This means that the sequences belonging to the sequence sets used for the random access procedure should have correlation or CM characteristics guaranteed by more than a certain level. In particular, a sequence used for a high speed environment in which the user equipment is moved by a speed of 30km/h or faster and a sequence used for a low speed environment need to be separately used in order to guarantee sequence characteristics in consideration of Doppler effect.

[0011] A method is sought for guaranteeing the characteristics of sequences used for transmission of the uplink control information with smaller amount of signaling overhead.

127. An outline of how this is achieved is given in the Summary section at [0012] – [0019]. This talks in very general terms, and there is no dispute that the examples in Woo all order sequences by CM and Max Ncs.

128. The bulk of the argument arose in relation to the Exemplary Embodiments and the teaching around them. They begin at [0021].

129. Figure 4, at [0042] shows how CM and Max Ncs vary if the natural ordering of root sequences is used:



130. In Figure 5 the ordering is still by CM but the physical roots are paired; nothing turned on this. Figure 6 shows ordering by cell size.
131. As one would expect, when ordering is by CM or cell size then the Max Ncs is essentially random.
132. [0046]-[0047] give examples of ordering based on Max Ncs. Figure 7 shows an ordering using a formula given in [0047] and produces an “M” shaped graph, Figure 8 has pairing rather like in Figure 5, and Figure 9 uses Max Ncs (so is a straight line).
133. Whichever ordering is used in Figures 7-9, the other characteristic shown, CM, becomes very random. Woo points out this shortcoming in [0049].
134. Woo then goes on to propose schemes in which CM and Max Ncs are both used. There is a new section heading just after [0049] and before [0050] which is “<Example of ordering according to CM characteristics and maximum supportable cell radius characteristics>”.
135. Paragraphs [0050] to [0055] are at the start of the section and it is their meaning that is crucial to the Woo anticipation attack:

<Example of ordering according to CM characteristics and maximum supportable cell radius characteristics>

[0050] The ordering according to the CM characteristics and the ordering according to the maximum supportable cell radius characteristics may have the opposite characteristics. A method for achieving both gains of the CM characteristics and the maximum supportable cell radius characteristics will now be described.

[0051] The method of ordering by combining various characteristics follows the following procedures.

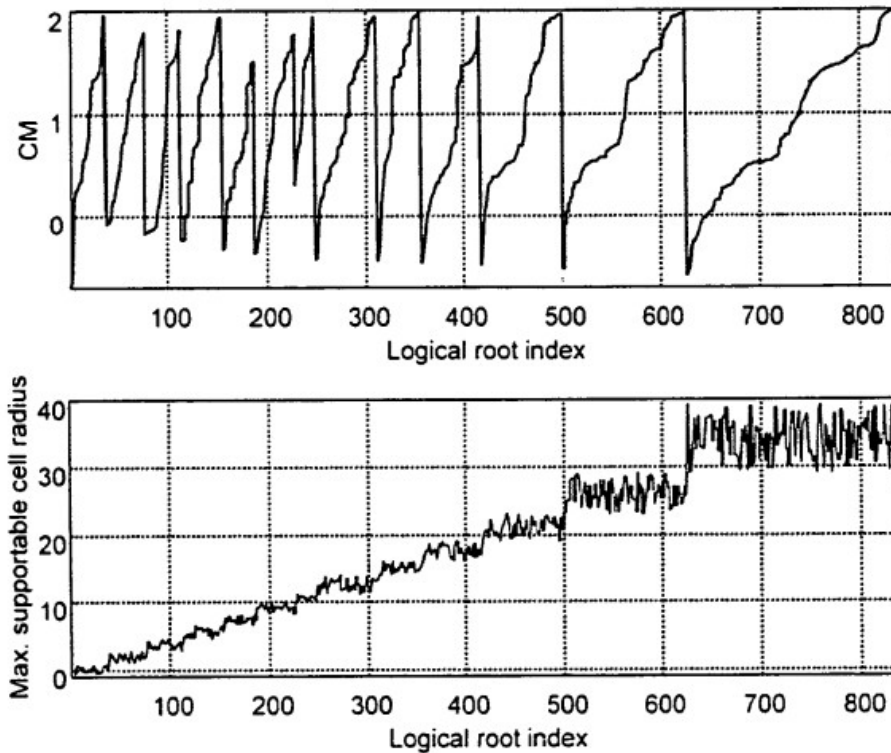
[0052] Step 1. The entire indexes are ordered according to specific (particular) characteristics.

[0053] Step 2. The entire indexes are divided into sections (or groups) based on relevant values (grouping).

[0054] Step 3. The indexes of the sections are ordered according to respective different characteristics in each section (or group).

[0055] Step 4. The steps 2 and 3 are repeated. In this case, in dividing the indexes into sections, a subsequent section may be associated with a preceding section, or the subsequent section may not have any relation with the preceding section and a new rule may be applied to the subsequent section.

136. The greatest focus of the argument was on Step 4 at [0055]. Steps 1 to 3 involve ordering the sequences by one “specific” characteristic, dividing them into sections, and then ordering those sections by “respective different characteristics”. Step 4 follows this. Oppo says that [0055] means, or at least includes as a possibility, redoing steps 2 and 3 with a different characteristic than was used the first time. Nokia disputes this.
137. Although [0050] – [0055] are written generically in terms of “characteristics”, the reader would know that it meant one of two characteristics: CM or Max Ncs.
138. Woo then gives some examples.
139. From [0056] to [0065] an example is given in which the sequences are grouped by Max Ncs then ordered by CM. The overall result can be seen in Figure 11:

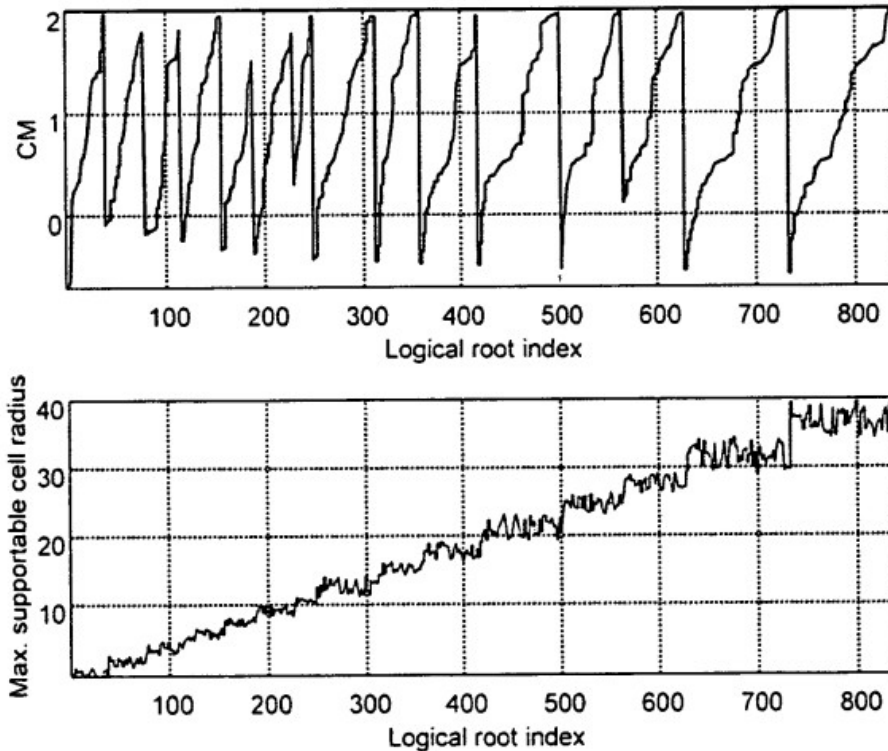


140. This uses the first three steps.
141. Figure 12 then illustrates the same approach but with each sequence paired with its complex conjugate. This is similar to the Figure 11 result, as Woo points out at [0070].
142. Then a further Figure, Figure 13, is introduced at [0071]. This was also a focus of argument and so I quote [0071] and [0072] in full:

[0071] FIG. 13 is a graph showing CM characteristics and maximum supportable cell radius characteristics according to logical root indexes according to another exemplary embodiment of the present invention. Namely, FIG. 13 shows ordering based on the plurality of characteristics and pair allocation.

[0072] Referring to FIG. 13, the sections divided in FIG. 12 can be more minutely divided. For example, the sections of the configuration numbers 11 and 12 in Table 3 can be halved to use a wider maximum cell radius.

143. And Figure 13 is as follows:



144. The difference, compared with Figure 12, is that the two right-hand groups defined by Max Ncs, at logical sequences 500-625 and 626-738 have been split in two, so in the upper part of Figure 13 the corresponding CM “peaks” have been split in two. There are therefore 15 peaks in Figure 13 and only 13 in Figure 12 (Table 3 defined the possible groups in terms of Max Ncs values but I do not think anything turns on that).

145. [0074] explains that this allows a bigger maximum cell radius:

[0074] The maximum cell radius can be increased from 29.14km to 34.15km so as to be used by applying Table 7. Here, particular sections are halved and re-ordered, but it is merely an example. That is, the size of particular sections can be divided in various manners. For example, in order to support a particular maximum cell radius, sections may be divided based on the particular maximum cell radius. Alternatively, sections may be divided such that the number of indexes used in a particular section is doubled. Sections having a small number of indexes can be grouped into one section, to which the second ordering may be applied. In addition, a section having a large number of indexes can be divided into two (or more) sections, to which the second ordering may be applied.

146. At [0075]-[0077] an example is given in which the initial ordering is by CM, followed by division into groups by CM, and ordering of the groups by Max Ncs. This also uses the first three steps.

147. Woo then provides some general guidance at [0096]-[0097]:

[0096] In all the exemplary embodiments as described above, when indexes are ordered based on certain characteristics, the order of values having the same characteristics does not affect the order of ordering. Also, the order of pair indexes does not affect the order of ordering. In the ordering (mapping) method according to all the exemplary embodiments, as the indexes increase, they are ordered in an ascending order that the CM or the maximum supportable cell size increases, but it is merely an example. That is, as the indexes increase, they may be ordered in the ascending order that the CM or the maximum supportable cell size is increased or in a descending order that the CM or the maximum supportable cell size is decreased in each group. In addition, the indexes may be ordered in the shape of a mountaintop (^) or in the shape of a mountain valley (v). And, the directionality of the CM or the maximum supportable cell size can be determined to be different in each group.

[0097] FIG. 25 is a graph showing CM characteristics and maximum supportable cell radius characteristics according to logical root indexes according to another exemplary embodiment of the present invention. As the logical indexes increase, they may be ordered in the ascending order that the maximum supportable cell size increases and in the descending order that the CM decreases. FIG. 26 is a graph showing the CM characteristics and the maximum supportable cell radius characteristics according to logical root indexes according to another exemplary embodiment of the present invention. Respective CM groups have been grouped based on the cyclic shift parameter Ncs. As the logical indexes increase, they are ordered in the ascending order that the maximum supportable cell radius size increases, in the descending order that the odd number groups of the CM decrease, and in the ascending order that the even number groups of the CM increase.

148. This can be understood by Figures 25 and 26:

Fig 25:

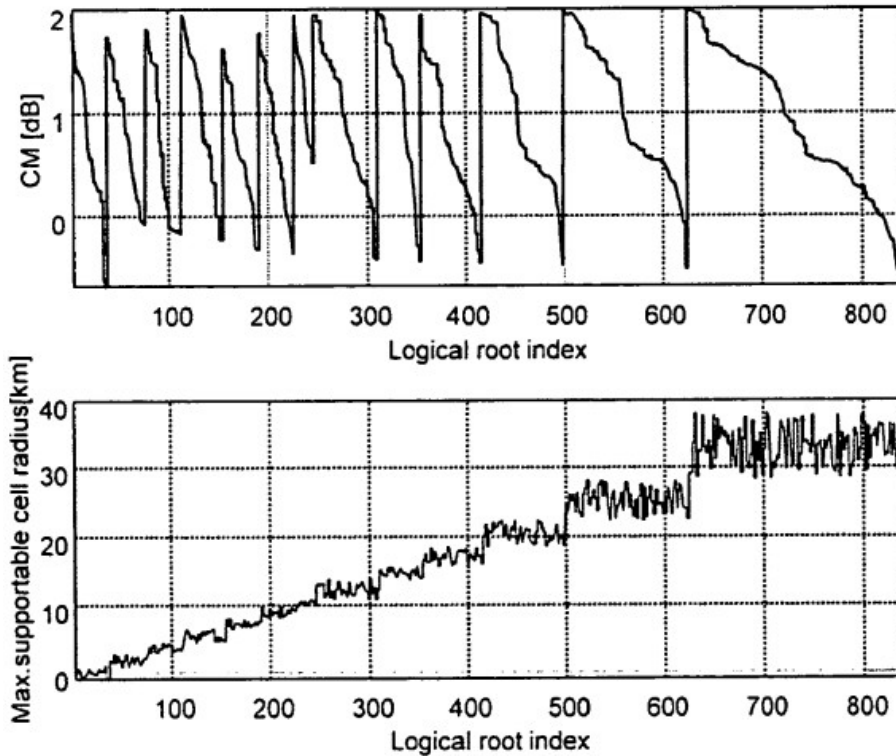
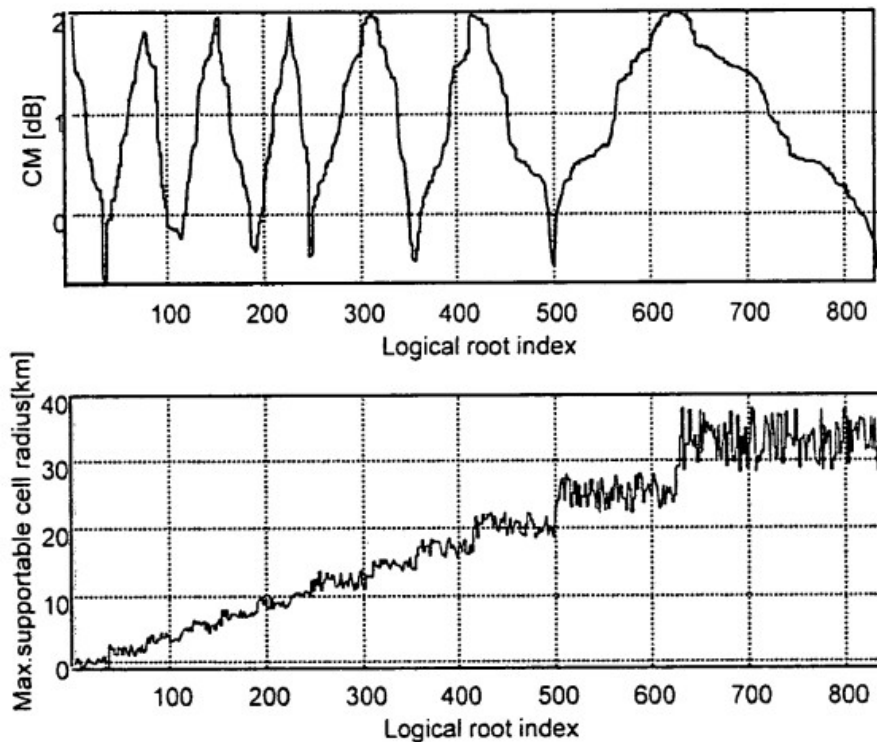


Fig 26:



149. The guidance at [0096]-[0097] is significant because Oppo needs to be able to combine it with the teaching at [0050]-[0055] to get all the features of claim 1, in particular feature 1[g].
150. Cyclic indexing is taught at [0099].
151. The part of Woo that I have referred to above which does not have priority from PD8 but on which Nokia relies is at [0100]-[0102] under the heading “<Embodiment of hybrid ordering>”.

The parties’ arguments

152. The parties’ arguments were very long and detailed. In my view they went well beyond the analysis that the ordinary skilled person would undertake. I also thought that both sides, but especially Oppo, picked the meaning that would suit their case in this litigation and then went looking for ways to shape Woo’s disclosure toward it. I would also say that Oppo’s arguments focused unduly on attacking what Nokia said that Woo meant, without taking on board that Nokia does not have to say that Woo is perfectly clear. On the contrary, Nokia says that Woo is unclear, so it would not be surprising if there were problems with seeking to explain it. Nokia’s interpretation does not have to resolve all the problems with Woo for Oppo to fail.
153. I will aim to summarise the main points taken by the parties. It is impractical to list every nuance.
154. Oppo argued that:

- i)** The key passage for analysis is step 4 at [0055]. I agree with this.
- ii)** [0055] discloses two options, one of which is that, when steps 2 and 3 are repeated, the grouping can be formed based upon the other characteristic than that used to form groups in original step 2. I.e. if the first time around was done by CM, the second may be Max Ncs, and vice versa.
- iii)** The other option would be that the second iteration of step 2 would be done with the same characteristic.
- iv)** Nokia was saying that the option at iii) was the only thing disclosed in Woo. I agree with this characterisation of Nokia's position.
- v)** [0096]-[0097] is generally applicable to the teaching. This is a subsidiary point. The parties did not elaborate it much.
- vi)** There were three points in favour of Oppo's position:
 - a)** First, the grouping in step 2 is required to be by "relevant values"; that must mean values by which the groups can meaningfully be formed. So when step 4 says that step 2 should be repeated it is natural that the groups should be formed by the characteristic according to which they have just been ordered in step 3. By contrast, Nokia's approach, Oppo said, would really mean going back to step 1 and doing the same thing all over again.
 - b)** Second, the language of the second sentence of step 4 makes it clear that in forming the groups in repeating step 2, the new groups may be associated with the preceding ones (using the same characteristic) but also can have no relation to them and a new rule can apply (different characteristic).
 - c)** Oppo's interpretation of step 4 provides for a technically meaningful ordering but Nokia's has "little technical significance".
- vii)** Nokia's case had the following defects:
 - a)** It involved reading step 4 as limited to the preferred embodiments.
 - b)** It really required redoing steps 1-3 and not steps 2-3 as taught. This is the flip side of part of Oppo's first point.
 - c)** Misreading "preceding section" and "subsequent section".
 - d)** It involved reading into Woo the idea at step 4 of assessing steps 1-3 and then deciding whether to adjust group sizes or direction of ordering. Oppo said this was not taught and would not occur to the skilled person.
 - e)** Wrongly suggesting that [0055] was unclear. This is obviously somewhat conclusory and what was really meant was that the

presence of an argument did not imply lack of clarity. I have already accepted this.

- f)** Nokia said that Figure 13 was a continuation of Figure 12 with redefinition of the group sizes, but it is not, it is a separate embodiment which starts step 1 afresh.
- viii)** On the significance of paragraphs [0100]-[0101], there was no authority in favour of their being legally relevant, but if they were it would favour Oppo because they disclose “hybrid” ordering and so would be understood to fall within the grouping of examples that started at [0050].

155. Nokia argued:

- i)** The natural meaning of [0055] was that whatever characteristics are used in original steps 2 and 3 would be used when those steps were repeated.
- ii)** However, even with that understanding, step 4 is unclear.
- iii)** There is no example of step 4 being done in the way that Oppo relies on.
- iv)** In most of the relevant examples only steps 1-3 are done. When something beyond steps 1-3 is done (Figure 13) it fits with Nokia’s reading and not with Oppo’s.
- v)** Figure 13 is a refinement of figure 12, continuing on from it.
- vi)** That even if the teaching at [0050]-[0055] *encompassed* the detailed sequence of steps in claim 1[e]-[h] of the Patent as a possibility, the sequence is not *disclosed*.
- vii)** [0096] was unclear as well and not generally applicable. But in any event it supported Nokia’s interpretation on the main point because it suggested refining the result of an initial step 3.
- viii)** The application of step 4 on Nokia’s interpretation put forward by Prof Purat was technically meaningful.
- ix)** The point about [0100]-[0101].

Analysis

156. I have used the parties’ submissions listed above to organise my analysis under a number of headings. I have not tried to organise my reasons by addressing their points, responses and rejoinders one by one as they did.

Wording of [0055]

157. In my view [0055] is just very unclearly worded, when assessed from the point of view of having taken on board the technical context (as to which there is little dispute other than the semantic one about the relationship of Figures 12 and 13) so as to be in the position of the skilled person. The problems of clarity arise

from the undefined and unclear expressions “subsequent section”, “preceding sections”, “associated”, “not have any relation” and “new rule”. They are difficult individually and worse when put together.

158. As I have said above, the court should try to give meaning to patent disclosures, and the use of unclear wording is not the end of the inquiry. The skilled person would not read [0055] in isolation and in particular they would know that it was followed by some concrete examples. The skilled person would understand that they were going to be illustrative of the general teaching without exhausting it. The skilled person would think they were going to see step 4 at some stage.

The Figures

159. The skilled person would see that in most instances in the following section there is nothing that could correspond to step 4. This would be a puzzle because step 4 is not presented as being an optional add-on.
160. The skilled person would see that the only instance in which something on top of steps 1-3 was possibly done was Figure 13.
161. Oppo says that Figure 13 is a completely fresh example involving starting with a clean sheet at step 1. I do not agree with that. Oppo’s position was highly semantic, relying on Figure 13 being described as “another exemplary embodiment” as indicating that it was entirely self-contained. I think the skilled person would attach a lot more weight to the fact that [0072] makes a connection back to Figure 12.
162. In addition, such an understanding would give the skilled person *something* that might correspond to step 4 – getting to Figure 12, then redoing it using the same characteristic, using the ordering already done for step 1 (see below) but with different sized sections. I think this can be fitted with [0055] adequately, although by no means perfectly, with later “subsequent” sections being subjected to a “new rule” in terms of section size, compared with earlier “preceding ones”. I acknowledge that “be associated” and “no relation” fit less well, but neither party was really able to cope with them.
163. If Oppo were right and Figure 13 is completely stand-alone then not only would there not be any worked example of that which Oppo says is comprehended within step 4, there would be no worked example of step 4 at all. That is very unlikely.

“Subsequent section” and “preceding section”

164. Oppo says that these expressions imply a comparison between how sections of sequences are treated at one step (by CM or Max Ncs) and how they are treated at another step. Nokia says it refers to sections within a single step, with “subsequent” and “preceding” being assessed by reference to the logical sequence number.
165. Reading the sentence as a whole I think that Oppo’s reading is highly artificial and unpersuasive. I do not think it would occur to the skilled person at all,

unless they were led to it by knowing Oppo's contention, which is not legitimate. It is much more natural to read it in the sense that there is division into sections by working through the sequences in order. By reference to that order and within the ordering, one section will come after another.

Step 1 repeated?

166. Oppo said that if Nokia was right (and the same characteristic was re-used) then it would be necessary to redo step 1 as well as steps 2-3.
167. I do not accept that. Prof Purat explained, and anyway I think it is apparent, that if you order all the sequences by one characteristic at step 1, which is necessary in order to divide them at step 2, then you can keep the result (which is just a list of numbers) e.g. by storing it in memory and reusing it later. So in a meaningful way it is possible to repeat steps 2 and 3 only when repeating with the same characteristic.

Technically meaningful result

168. Prof Purat put together a number of examples which he said were technically sensible implementations of how he saw step 4 working. Oppo attacked these in cross-examination with some success, but in at least one instance (Purat 3 page 11) the experts agreed that a 4-stage process according to Nokia's interpretation of Woo step 4 and consistent with its examples gave a technical benefit.
169. Therefore, Oppo cannot argue that Nokia's approach lacks any technical sense.

Two meanings or one for [0055]?

170. As I have said, Nokia's position is that step 4 is about repeating steps 2 and 3 with the same characteristic. Oppo says that it includes that possibility but also includes the possibility of repeating the steps with the other characteristic.
171. I do not think Oppo's approach is a reasonable one. There is nothing in [0055] to indicate that step 4 embraces these two very different possibilities. I agree that the steps are phrased somewhat permissively because there is a choice as to which characteristic to use first, but that is quite different from step 4 covering two different overall approaches.
172. I note that in his written evidence Dr Cooper initially seemed to say that repeating steps 2 and 3 with the other characteristic was the only thing disclosed (in large part because he said that using the same characteristic did not make technical sense), but later modified (or at least clarified) this in his fourth report to accept that when repeating steps 2 and 3 it was possible to use the same characteristic as before, or a different one. So he said that *both* Nokia's *and* Oppo's readings were clearly disclosed by [0055] (as part of the clarification he said that different characteristics would produce a "more" technically meaningful effect and that reinforces my conclusion above that Oppo is unable to argue that Nokia's approach lacks any technical sense).

173. Although caution is appropriate in determining whether an expert is confining himself to his proper role, and although this evidence was in part inadmissible comments on interpreting words, I think that Dr Cooper's shifting ground was revealing of the severe difficulties Oppo had in trying to accommodate the fact that Nokia's reading is a plausible one (which I find that it is, although not perfect) *and* that its (Oppo's) reading is clearly and unambiguously comprised in [0055].

The expert evidence generally

174. As I have said, the parties' cases were directed far too much to trying to take their interpretations of [0055] as starting points and finding ways to mould the disclosure of Woo around them. This involved hindsight and was much more apparent on Oppo's part. The expert evidence had the same problem, and again significantly more on Dr Cooper's part than Prof Purat's.

175. Leaving that aside, and more generally, it was clear that the experts struggled severely with understanding Woo, and Dr Cooper said he had spent considerable time trying to understand it. I am not surprised, but that does not gel at all well with the document being clear and unambiguous, and I did not think either expert's difficulties with the document were in any way synthetic. I think they found it hard because the document is very unclear.

[0096] and [0097]

176. I agree with Nokia that these paragraphs are not clear, including in relation to which embodiments already shown are referred to in the first sentence as "described above". They also give a large number of options.

[0100]-[0101]

177. I agree with Nokia that if reference to these paragraphs were permitted, it would support Nokia's case. There is a very striking difference in wording between these paragraphs and [0050]-[0055] and if the skilled person turned their mind to whether [0055] discloses or permits redoing steps 2 to 3 with different characteristics (which I do not think they would without prompting), their conclusion would be that when the author of the application wanted to describe such a thing, he or she did so with the language of [0100]-[0101], which is also in a different section of the disclosure.

178. Oppo argued that if [0100]-[0101] were relevant then they assisted it because the heading above [0100] is "<Embodiment of hybrid ordering>" and the skilled person would therefore conclude that what is shown was a specific instance of the 4-step ordering.

179. There is nothing in that. The section containing [0100]-[0101] is a new and distinct one separated from [0050]-[0055] by many pages and by a section of general teaching. It is true that "hybrid" is used repeatedly in Woo including within the section initiated by [0050]-[0055] but it just means that both CM and Max Ncs are used. It cannot be concluded from that that [0100]-[0101] is a subspecies of [0050]-[0055], it just means that they have in common the use of

both characteristics. In addition, [0100]-[0101] does not have a description which readily fits into a 4-step analysis, although (again I think with hindsight) it is possible to rejig it to be expressed that way.

180. So if [0100]-[0101] are admissible then I think they help Nokia but they are a small part of the picture and would not be conclusive either way, i.e. whether Nokia or Oppo was right about what can be got from them.

Covered v disclosed

181. The ambiguity in and around [0055] that I have held to exist is fatal to Oppo's case, but even if it were not, that does not mean Oppo would succeed. It would still be necessary for Oppo to show that within what would still be quite a broad teaching it was clearly disclosed to use CM first, then Max Ncs, and then to repeat steps 2 and 3 with the characteristics reversed, and then to combine that with the appropriate option from [0096]-[0097]. That is not disclosed in my view, it is merely a possibility within a wide envelope of choices which are not individually spelt out.

Conclusion

182. The attack of anticipation by Woo fails.

OBVIOUSNESS OVER ZTE WITH LGE

183. There are two general matters to mention before I come to the law and prior art.

Nature of the attack

184. As Counsel for Oppo acknowledged, the obviousness attack in this case is an unconventional one. It is worth setting out its shape. In some important ways, it has alternative limbs. The essential elements of the attack are as follows:
- i)** The attack starts with ZTE. The law permits a party attacking a patent to choose its starting point, and deems the skilled person to read the prior art with interest. So this is a legitimate starting point.
 - ii)** Then, Oppo says, the skilled person would realise that ZTE has problems with it. This is disputed. It depends in part on the state of the CGK.
 - iii)** There is also an issue over whether, if there were such problems the skilled person (a) would realise them from ZTE itself, or (b) would need to have read LGE to appreciate them. The latter would obviously be a harder case for Oppo, but it runs both in the alternative.
 - iv)** Next, Oppo says that appreciating the problems would lead the skilled person to look for a solution in other Tdocs submitted to RAN1. The skilled person would look for other Tdocs that were hybrid solutions and that would point towards LGE. Oppo also says that the skilled person would find their way to LGE simply because they would have read it for the relevant RAN1 proceedings.

- v) Nokia objects at this point that the skilled person would, if they realised the problems, try to find a solution by improving ZTE according to its own teaching, without looking to other sources. Oppo disagrees and anyway says that it is just another obvious option, not undermining the obviousness of going to LGE.
 - vi) Oppo finally says that, the skilled person having identified LGE by one of the above means, it would be obvious to combine it with ZTE in a way which would fall within claim 1.
 - vii) Somewhat separately, or at least in parallel, Oppo says that the skilled person would use cyclic interpretation of the ZC sequence numbers based on the CGK (neither ZTE nor LTE proposes it).
185. The arguments and evidence on these topics overlapped in a number of respects. I have organised my analysis using them as a structure but the position has to be considered as a whole and I have aimed to do so. I note that in its written opening Oppo said that it was also running an obviousness case starting with LGE and leading to ZTE. It said that the attack was very similar to that starting from ZTE. LGE as a starting point was not pursued in Oppo's closing but in any event it could be no stronger than the attack from ZTE.

Obviousness – the law

186. The basic approach is as set out in the decision of the Supreme Court in *Actavis v ICOS* [2019] UKSC at [52] – [73], with its endorsement at [62] of the statement of Kitchin J, as he then was, in *Generics v Lundbeck* [2007] EWHC 1040 (Pat) at [72].
187. I have also borne in mind the principle from *Brugger v Medicaid* [1996] RPC 635, which I have discussed in a number of recent cases, that an obvious course is not made less so by the mere fact of other obvious options.
188. I also think this is a case where the dangers of step-wise analysis (*Technograph v Mills & Rockley* [1972] RPC 346) are acute.

Mosaicing

189. Oppo referred to *Technograph* at 355 for the proposition that for obviousness it is permissible to make a mosaic, but only if it is one which “can be put together by an unimaginative man with no inventive capacity”.
190. It also referred to *Pfizer's Patent* [2001] FSR 16 at [65]-[66] to show that while an obvious mosaic can arise from a cross-reference in one of the documents to the other, that is not the only way. I agree with this, but it does not undermine the principle that the mosaic must be an obvious one to make, which was common ground before me.
191. For its part, Nokia relied on *Technip France's Patent* [2004] RPC 46, at [7]-[8]. There, Jacob LJ expressed the principle in terms of the skilled person being forgetful so as not to carry the contents of one piece of art into the next, but that

was just his way of looking at the same point and I do not think he was stating any other principle than that a mosaic has to be obvious to assemble.

No a priori expectation when reading the prior art

192. The skilled person is deemed in law to read each prior art citation with interest, but that does not mean that they approach any particular citation with the expectation in advance that it will contain something useful. See e.g. Laddie J in *Inhale Therapeutic Systems v Quadrant Healthcare* [2002] RPC 21 at [47]. I bear that in mind when it comes to combining ZTE with LGE; even if the skilled person found their way from the former to the latter by obvious reasoning they would not without more assume that the latter was going to solve the problems of the former.

Pozzoli

193. I have identified the skilled person and the CGK above so to that extent I have followed the first two steps of the *Pozzoli* analysis.
194. Oppo did not present its argument explicitly in terms of *Pozzoli* steps 3 and 4, either by reference to inventive concept or claim features. I think this was probably symptomatic of the unusual nature of the obviousness case. As I see it the relevant differences between ZTE and claim 1 are the use of cyclic interpretation (feature 1[c]) and the sequence of ordering steps as 1[e] to [h]. As to the latter, Oppo says that the sequence results from the obvious concatenation of LGE after ZTE. I do not think there would be anything to be gained by trying to split down which sub-feature comes into play at each step of Oppo's argument.

ZTE

195. There is little if any dispute about what ZTE discloses.
196. At the start of section 1, Introduction, it reiterates that agreement had been reached on the signalling of one index number and one cyclic shift.
197. Then, it says that two ordering methods had so far been identified, one based on CM and one based on Max Ncs. It references a TI Tdoc for the first and a Panasonic/NTT DoCoMo Tdoc for the second. LGE is not referenced.
198. It identifies the pros and cons of the two methods. By using the CM approach, ZC sequences with similar CM properties can be used in a cell and ones with low CMs can be used in larger cells. The disadvantage, the authors say, is ZC fragmentation, which it says is illustrated in Panasonic.
199. The fragmentation problem arises because if you order by CM then in a high mobility cell you have the issue that sequences with poor Max Ncs cannot be used. This can be seen visually in figures 1 and 2 of the cited Panasonic Tdoc:

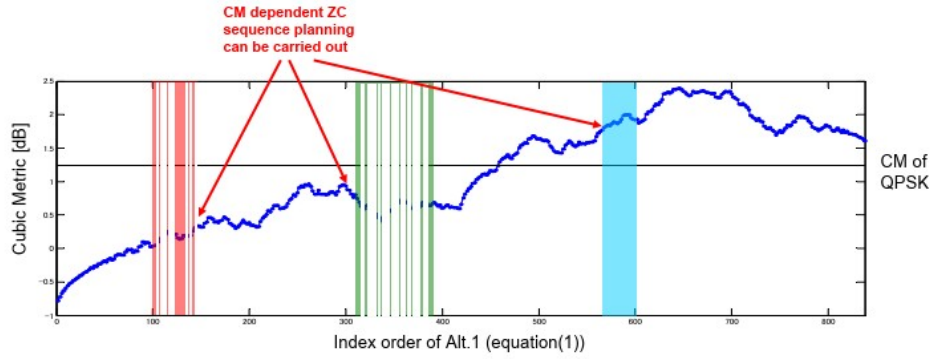


Figure 1 Pre-defined sequence index order and CM values (Alt.1, $K=839$).

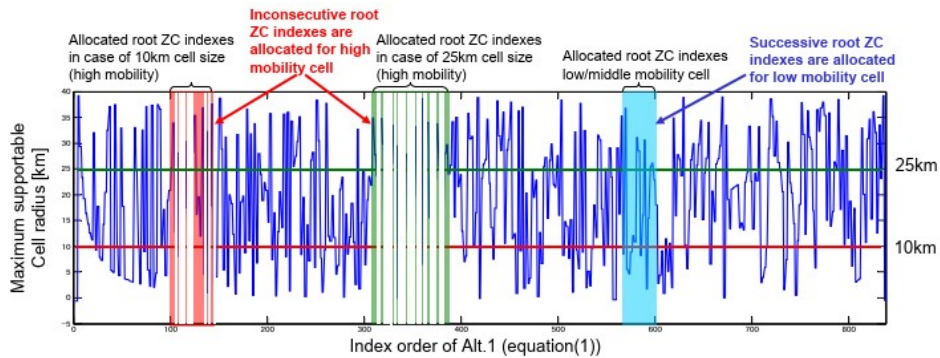


Figure 2 Pre-defined sequence index order r and the maximum supportable cell radius for high mobility configuration (Alt.1, $K=839$).

200. In figure 1 the CMs vary smoothly from sequence to sequence, but figure 2 shows that starting within a run of sequences many have to be rejected in high mobility cells (closely bunched red and green clusters of vertical stripes) because the Max Ncs is unacceptable. This is not a problem in the low/middle mobility cells. The gappy red and green stripes leave unused, “fragmented” sequences.
201. The Max Ncs approach is said to avoid fragmentation but means that “we can not perform sequences planning according their CM properties”. The skilled person would understand that this meant that if you ordered and grouped by Max Ncs your sequences within groups would vary undesirably in CM.
202. ZTE then makes its proposal, along with an explanation:

The group-based method mainly includes four steps,

- sorting the ZC sequences according to their CM values,
- dividing the ordered ZC sequences into several groups,
- sorting the ZC sequences in each group according to their maximum supportable cell radii (See appendix A for the reordering method based on maximum supportable cell radius),
- establishing the mapping relationship between signalled index and ZC sequence index,

Here we propose to divide all the ZC sequences into 2 groups according to the CM value of QPSK (1.2 dB). As a result, the CM values of the ZC sequences in the first group are less than 1.2 dB and those in the second group are larger than 1.2 dB. Then ZC sequences are sorted according to their maximum supportable radii with descending order in the first group and ascending order in the second group. This ordering method in each group makes crossing group ZC sequence allocation possible. The re-ordering result is shown in Fig 1 and mapping relation between signalled index and ZC sequence index is presented in Appendix B.

203. This quite clearly calls out the significance of the CM of QPSK in sequence ordering and is the reason why I said above that that CGK issue was of limited practical importance.

204. There is then a useful figure:

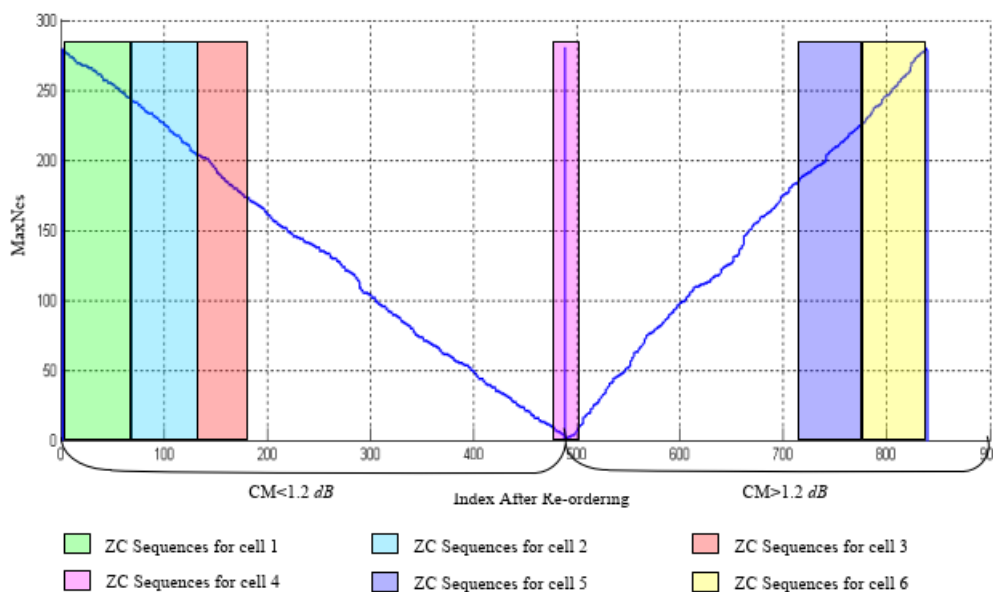


Fig 1 Group-based Re-ordering Method

205. And this helps understand the teaching that follows about the advantages of the idea:

The group-based method we present has the following advantages,

- CM planning can be performed
 - ◇ ZC sequences with small CM values to large cells (such as cell 1, 2, 3, in Fig 1) to obtain better detection performance and
 - ◇ ZC sequences with large CM values to small cells (such as cell 5, 6 in Fig 1).
- No ZC sequence fragments will be generated during the process of successive increase of signalled index.
- If needed we can also allocate the ZC sequences crossing two groups to the low mobility small size cell such as cell 4 in the Fig 1.
- The algorithm for generating preamble sequences is still available without increasing additional complexity of sequence allocation and indication.
- Finally from the reordering result in appendix B, we can see that ZC sequence can also be allocated in pair when more than one ZC sequence is needed in a certain cell, which allows efficient matched filter implementation as mentioned in [5].

206. Conclusions follow in section 3:

3 Conclusions

In this proposal we presented a group-based reordering method of ZC sequence. We believe that for the ZC sequence allocation both CM property and maximum supportable cell radius should be considered in high mobility cell and only CM property should be considered in low mobility cell, so when there are high mobility cells in the cluster group-based method is a good choice, which allows us to allocate ZC sequences according to their CM properties and will not generate fragments. Meanwhile the algorithm for generating preamble sequences is still available for group-based method and no complexity is increased.

What the skilled person would take from ZTE

207. As I elaborate further below, the experts generally agreed that ZTE was a workable scheme that appears to resolve the problems that it identifies.
208. There is no cyclic interpretation, no “roll-over” in ZTE. In the particular situation shown in the figure, it would not be possible, upon reaching sequence 837 (right hand edge of the yellow), to start again at 0, because 0 is already allocated to cell 1 (green, left hand side). Dr Cooper said that there might not be a conflict because cell 1 might be physically very distant in some parts of the network, but that is not pointed out by ZTE and the visual impression is that “roll-over” would not work. It is true, as Oppo pointed out, that cell 4 bridges the low-CM/high-CM boundary and that is referred to in the third bullet point of the advantages, but that does not involve rolling over the ZC sequence number from 837 to 0. Cell 4 occupies a continuous run of ZC sequences. I conclude that cyclic interpretation is not obvious from ZTE.

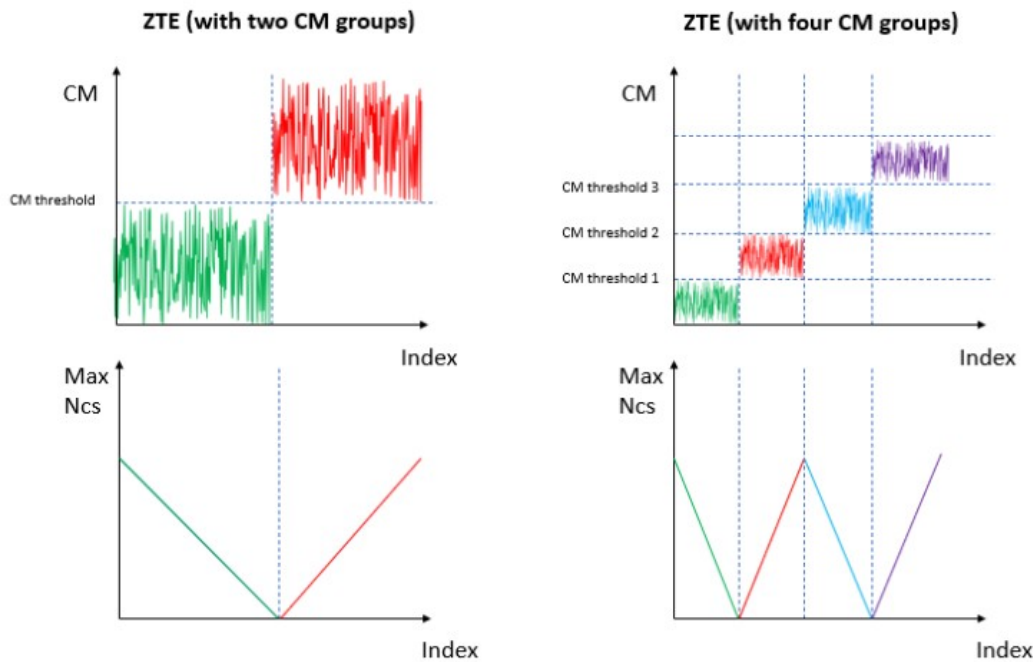
Problems with ZTE?

209. The problem with ZTE on which Oppo relies is that ordering by Max Ncs means that adjacent sequences can have very different CMs.
210. This, Oppo said, was out of keeping with the CGK that it was desirable to have contiguous runs of sequences in which both Max Ncs and CM are as similar as possible.

211. I have held above that that was not CGK.
212. Oppo's fallback was that it would be obvious in the context of ZTE. It said that Prof Purat had said it was "routine stuff". I do not agree. To a question that used the phrase "routine stuff", Prof Purat gave an answer that began with the word "yes", but he was not agreeing to the proposition that spotting the problem relied on by Oppo was routine (see T2/183). He was just saying that if the skilled person drew a particular figure then it was easy to see that the CM did indeed change between adjacent sequences. His position (bridging T2/182-183) was that the skilled person would think that the sequences had usefully been arranged so that low CM sequences could be used in larger cells, and that drawing "such a figure" was not an "immediate next step".
213. As for Dr Cooper, in cross-examination (T4/479-481-483) he:
- i) Accepted that ZTE did not itself say there were ordering problems, and taught that it had solved the problem that it identified.
 - ii) Accepted that the skilled person would expect the proposal to work, and would see it as "coherent" and "technically sensible".
 - iii) Said that the skilled person would have to have read other RAN1 submissions to appreciate that there was a problem with ZTE of the kind relied on by Oppo.
214. On the basis of this evidence I find that the skilled person would not, without invention, think of the problem on which Oppo relies.
215. As to the last point I have mentioned in relation to Dr Cooper's evidence (that the problem would not be spotted without reading other RAN1 submissions), Oppo submitted that the skilled person would in fact have read all the other proposals, so there was no circularity. I would not think about it in terms of circularity or otherwise myself, but I do think that the need for Oppo to resort to this argument lays bare that it really must be its case that all the RAN1 Tdocs were CGK, a proposition which I have rejected and which Oppo at other points in its argument expressly disclaimed.

Solution within ZTE

216. Prof Purat in his second report said that if the skilled person thought that the rapid change in CM values was seen as a problem, the skilled person would try to address it by using more groups, instead of just two. He illustrated the idea as follows and said that it was consistent with ZTE's teaching:



217. As I have said below when commenting on the level of detail of the cross-examination, this evidence was not challenged. It was not put to Dr Cooper either, although he commented on it in his third report. In any event, I find it easy to understand what the point being made was, and able to assess that indeed it is a minor tweak to ZTE which the skilled person might well derive from ZTE itself and which would be well directed to the problem relied on by Oppo. Oppo's response, as I have mentioned already, was that while it might be an obvious way to go, another one would be to look to other RAN1 submissions. There can of course be more than one obvious route for the skilled person and this sort of argument is never entirely binary, but I think it is a significant mark against Oppo's case.

Journey from ZTE to LGE

218. If, contrary to my conclusion, the skilled person had identified a problem of the kind on which Oppo relies without invention, the next question is whether they would then by obvious means find their way to LGE.
219. There is something of a conundrum in even asking this question given that Dr Cooper had said that the problem with ZTE relied on by Oppo would not be spotted without the skilled person's having read other RAN1 submissions, including LGE, but I will nevertheless attempt to answer it, and will do so on the assumption that the skilled person had not in fact read LGE at this stage of the analysis but had spotted a problem with ZTE.
220. It is accepted that there is no express cross-reference to guide the skilled person in making the step to LGE, so the most usual, conventional basis for mosaicking is not available to Oppo.

221. Oppo contends that the skilled person would as a matter of fact read all of the most current RAN1 submissions on the topic. This amounts to saying that they were all CGK and I have rejected that.
222. In my view, in the artificial scenario that I am considering the skilled person would not have any positive reason to think that there was any likelihood that there was a solution to the postulated problem with ZTE to be found in other RAN1 submissions. That does not mean that it was impossible that there might be, but the exercise of going looking would be an entirely uncertain one.
223. Also, the skilled person would appreciate that they would be looking for a solution to a problem in a novel proposal (ZTE) by sifting what were likely to be other novel proposals. This would further reduce their expectation of a good result.
224. I do accept that the skilled person, if they started down this route, would have a relatively modest number of Tdocs to read. That is certainly a factor, but it cannot on its own mandate that it was obvious to go to LGE.
225. I also accept that once the skilled person had studied all the Tdocs they would appreciate that ZTE and LGE were both “hybrid” proposals. I accept that the skilled person would think that looking at a Tdoc which was of a totally different kind to ZTE was even less likely to bear fruit, but it is a *non-sequitur* to say that just because they were of a broadly similar kind it would be obvious to connect the one to the other. This segues into the analysis of how the skilled person would react if they did get to the stage of considering the two documents together, and I address that below, but I find that they would not by obvious means progress from ZTE to LGE and come to consider them together.

LGE

226. Again, there was not much disagreement about what LGE discloses.
227. The Introduction says much the same as the Introduction of ZTE, in the sense that it identifies the use of a logical index and a cyclic shift, says that ordering (mapping) needs studying and cites TI and Panasonic. ZTE is not cited.
228. In section 2, LGE says that both CM and Max Ncs ordering have “desirable properties” so it would be “natural” to combine them. It illustrates by figure 1 that they cannot “coexist in a simple manner”, and makes its own proposal as follows:

To exploit both benefits, simple hybrid index ordering can be introduced. For example, one rule can be applied to the whole physical index and the other rule may be adopted for the segmented intermediate logical index. Considering cell planning complexity is low with cell-size based sorting, the physical to logical index mapping can be derived as follows:

1. Physical index sorting according to supportable cell-size for the case of high mobility cells
2. Sorted indices are segmented according to N_{CS} configuration
3. For each segmented index range, apply CM ordering

229. And illustrates it in figure 2:

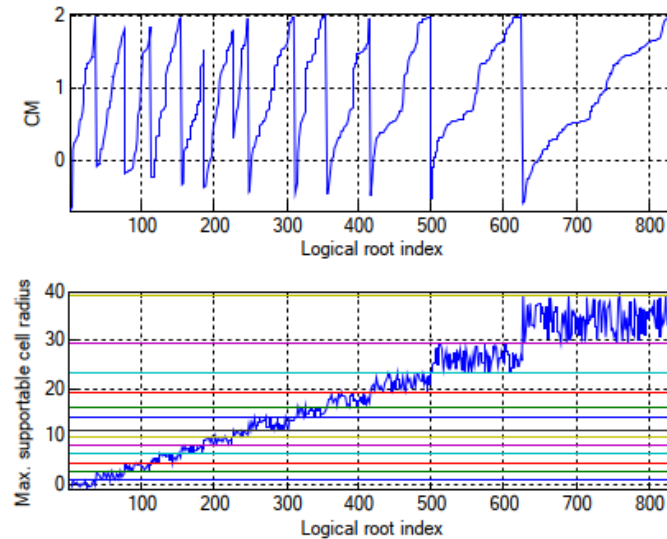


Figure 2. Hybrid ordering properties

230. This means that the CMs of neighbouring sequences will be similar; the experts agreed about that. There are exceptions to that, though, because at the end of each Max Ncs-ordered group there is a sharp drop in the CM.

Problems with LGE?

231. Dr Cooper identified three problems with LGE:

- i) The large drops in CM at group boundaries to which I have just referred.
- ii) A discontinuity in Max Ncs values at the highest values if more indexes are needed to fill the set of 64 (this relates to the cyclic interpretation point).
- iii) Although the CM ordering groups sequences so that their successive CM values are close to each other, they may straddle the QPSK CM threshold, which would mean they were not equally suitable for large cells.

Combining ZTE and LGE

232. The last stage in the argument is that the skilled person would combine ZTE and LGE by doing them in sequence. The question is: was that obvious?

233. Even assuming everything down to this point in Oppo's favour, I hold that this last step was not obvious. My reasons are as follows.

- i) Neither ZTE nor LGE presents itself as a modular component for combination with another scheme. Each is presented as a self-contained scheme.
- ii) The skilled person would see each of ZTE and LGE as a trade-off. Neither would be seen as a perfect solution (on Oppo's own case) but that does not mean that the skilled person would have an expectation that something a lot better could be achieved by combining them.

- iii) Each of ZTE and LGE is a two-stage hybrid approach. Indeed, it might be said that ZTE and LGE are the same overall approach but taking their criteria in a different order.
- iv) Combining them would lead to an approach with more stages but there was no precedent for that.
- v) Regardless of how the skilled person found LGE from ZTE, each would be unfamiliar to them. The skilled person would not feel on solid ground cutting and pasting them in the way that Oppo asserts.

234. Oppo's main argument in favour of the obviousness of combining the documents was based on the cross-examination of Prof Purat. In its written closing submissions it said that Prof Purat "accepted that LGE provides the skilled person with an obvious solution to the problem of randomness of the sequences in both ZTE's CM groups, particularly the high CM group". It quoted extensively from Prof Purat's oral evidence. I reproduce the two main quotes below, with Oppo's emphasis retained:

T2/201-204:

- 16 Q. The skilled person who looks at LG, having previously looked
17 at ZTE, would notice a few things. The first thing is that
18 they have taken the step that ZTE did not do in that they have
19 grouped by Ncs value and the cell-size ordering?
20 A. Correct.
21 Q. Doing that has allowed them to order by cubic metric?
22 A. That is correct.
23 Q. Now, the skilled person coming to LG, with its randomness of
24 the sequences in both the cubic metric groups, but
25 particularly in the high cubic metric group, they would see
2 that the LG approach, the grouping by Ncs and ordering within
3 the Ncs groups, was a solution to that problem, would they
4 not?
5 A. Yes. It is used within these Ncs (unclear) or groups. It
6 uses a more smoother (unclear) curve.
7 Q. So it would deal with that issue, and it would mean that once
8 you have taken the inevitable step of having to group by Ncs
9 value, that allows you to order by cubic metric, and you can
10 make sure you get rid of the issue that ZTE had, that they had
11 variation one sequence to the next?
12 A. Yes. I do not think this is obvious but as a consequence it
13 is correct.
14 Q. Sure, but given that, because of the signalling method ----
15 A. Yes.
16 Q. ---- multiple sequences were going to have to use the same Ncs
17 value, grouping by Ncs is pretty much inevitable, is it not?
18 A. It is not grouping really. I mean, of the consequence of the
19 quantisation of the Ncs values, there will be a group, but
20 this is not what you would see from ZTE.
21 Q. Sure, not from ZTE. But when you look at LG, you see that the

- 22 first step in the LG method is physical sorting according to
23 supportable cell size?
24 A. Right.
25 Q. Which is the last step of ZTE?
2 A. Right.
3 Q. So the second and third steps in LG, of sorting the indexes
4 according to Ncs configurations and then applying cubic metric
5 ordering within those groups, they are pure additions to what
6 is taught in ZTE, are they not?
7 A. Yes, they are. You have to use these additional steps.
8 Q. So they do not take away any of the benefits of ZTE?
9 A. (Pause) I am just thinking, sorry. (Pause) Yes, I think that
10 is correct.
11 Q. And what it does do, if you were to take ZTE and then adopt
12 LG's approach of segmenting according to Ncs, and then
13 ordering by cubic metric within those groups, it deals with
14 the issue that the skilled person would have perceived of the
15 variation from one sequence to the next in cubic metric?
16 A. That is the technical consequence of this, yes.
17 **Q. And what I want to suggest to you is the skilled person,**
18 **coming to LG from ZTE, and aware of that issue with ZTE, they**
19 **would see that LG provided the solution to that?**
20 **A. (Pause) That is also correct, yes.**
21 **Q. So doing that, having those two additional steps to where you**
22 **got to in ZTE, allows you to keep the benefits from ZTE of the**
23 **grouping above and below the cubic metric of QPSK, but get rid**
24 **of ZTE's problem of the big differences between cubic metric**
25 **one sequence to the next?**
2 **A. That is right, yes.**

T2/204-205:

- 15 Q. So in contrast to ZTE, where you had the V-shape, whereby if
16 you got to the end of your indexes and you had a few sequences
17 that you could not get 64 preambles out of you could wrap
18 round to the beginning, the skilled person would see you could
19 not do that in LG?
20 A. Yes, he would not have in mind anyway this wrap around, but
21 yes. But if you have ----
22 Q. If you had understood that from ZTE -- take it on this
23 assumption -- if the skilled person had understood that there
24 was a benefit in the V-shape in ZTE, in terms of being able to
25 go back to the beginning again, he would see that that was a
2 downside of LG, would he not?
3 A. If they compare the max supportable cell size ordering in LG
4 with the one in ZTE, yes, they would see there is now a
5 difference.
6 **Q. So if they were coming to LG from ZTE, they would see that as**
7 **another reason why you would want to start with the ZTE**
8 **approach of dividing and ordering by cell size, as they have**

9 done, and then add to it the LG approach of grouping by Ncs
10 and applying cubic metric ordering?
11 A. So you start at ZTE. You have now in mind that you should
12 wrap around at the end. You would see that is a benefit of
13 ZTE versus LG. Yes, that is right.

235. I make several observations about this evidence:

- i) It is classic stepwise questioning of the *Technograph* kind. The witness was taken through multiple small steps but not tackled on the overall obviousness.
- ii) Prof Purat did not in fact accept that all the steps in the analysis were obvious. This is most clearly seen when he said “I do not think this is obvious but as a consequence it is correct”. Having heard the evidence, I think he meant the same thing in the answer that contained two pauses to the question about not taking away the benefits of ZTE, and in the answer “That is the technical consequence of this, yes”.
- iii) It did not really tackle whether it was obvious to add LGE on to ZTE. It was about what the skilled person would think the effect of doing so would be if that were done. The questioning did tackle whether LGE had the same problem as ZTE, and Prof Purat accepted that it did not, but that is subtly yet importantly different.

236. So I reject Oppo’s contention that Prof Purat accepted its case.

237. The evidence that I have just referred to is somewhat wrapped up with the cyclic interpretation point.

238. I have held that cyclic interpretation is not readily apparent on the face of ZTE or obvious from it. As I understood Oppo’s argument, it was that having seen cyclic interpretation in ZTE, the skilled person would want to carry it forward into LGE and would be incentivised to do so by appreciation of the second of the three problems with LGE referred to above. I do not think it was really argued that if ZTE did not provide the idea, LGE would.

239. So the cyclic interpretation point muddies things still further for Oppo’s case. Even if it had not done, I would have rejected the obviousness attack for the other reasons given above.

The cross-examination

240. Neither side cross-examined on every sub-point. I suspect this was because of the complexity of the argument. It is fair to say that Counsel for Oppo cross-examined in more detail than did Counsel for Nokia. Nokia relies more heavily on the arguments that Dr Cooper used hindsight and on undermining getting from ZTE to LGE. These are relatively high-level points, so it devoted less time to the details of the two citations.

241. This situation led to arguments by each side that the other had not challenged various things. The dynamic I have described meant that Oppo made more such

arguments, but Nokia made them on aspects of the obviousness attack that were significant, most notably in relation to Oppo not challenging Prof Purat on how the skilled person would improve ZTE, something he had covered in his written evidence (to be fair, those paragraphs of Prof Purat's report were not put to Dr Cooper specifically – see above).

242. There is no obligation to challenge every word of an expert's evidence, and given that there is not endless time in trials a judgment has to be made by Counsel about how granular to make matters. What is important is that the main points are put and that the expert has a fair chance to comment. It is relevant to consider the opportunity to comment in oral evidence or in written reply evidence (see *Edwards Lifesciences v Boston Scientific* [2018] EWCA Civ 673 at [65]-[68]). I am satisfied that both sides put their overall case fairly as to its main points (if more briefly in Nokia's case) and that the experts had an adequate chance to comment. On those (fairly minor) points where there was no specific challenge in oral evidence, such as the suggested improvement to ZTE put forward by Prof Purat, I have had more than adequate help from the experts on the technology to understand and assess them.

Secondary evidence

243. Nokia sought to strengthen its position on obviousness by reliance on secondary evidence. The main points of its case in this respect were that when RAN1 meeting #50 finished on 24 August 2007, the issue of ordering ZC sequences for the RACH preambles was unresolved, but RAN1 delegates had been made specifically aware of ZTE and LGE, as I have identified above. The issue was to be considered again at RAN1 meeting #50bis on 8-12 October. In the intervening period, 9 relevant Tdocs were put in, by a variety of participants, but, Nokia points out, only Nokia itself proposed the solution of the Patent (in Tdoc R1-074340, 2 October 2007).
244. Nokia also contends that a consensus coalesced around a different proposal from its own, and that there were a variety of further proposals after the priority date that did not get to the solution of the Patent.
245. This is an unusual situation for the deployment of secondary evidence. Important points in Nokia's favour are that:
- i) In contrast to many cases where secondary evidence is deployed, it can very confidently be said that the prior art was known to relevant people, and relatedly that they were furnished with ZTE and LGE in a single collection of documents.
 - ii) Again unusually, one can have a high degree of confidence that the real-life people who saw the prior art were at least as skilled as the ordinary skilled person.
246. Nokia also argued that there is a high degree of assurance that the relevant people, the RAN1 delegates, were striving for the best and, if necessary, innovative solutions. This is more complex. The companies who sent delegates to RAN1 were not just interested in good solutions because they also wanted to

have their own proposals adopted and to get patent protection for them. There was, both experts agreed, sometimes some horse-trading between companies based on each having something adopted, and with a reduced regard for technical merit.

247. I think the horse-trading point was overdone by Oppo, but is a factor. My conclusion is that while it happened somewhat, it was a much more minor factor than a communal effort geared to finding the best solution. The participants knew that getting the overall best solution was in all their interests generally, so that a strong standard would emerge which would be widely adopted and lead to strong equipment sales at the end of the day.
248. More significantly, while there was a strong drive to get to the best solution, another real-world factor was that that took time. Once a participant had put a proposal forward it would tend to believe in it, and advocate for it for some time, including after an initial rejection. So there was a degree of inertia. And there clearly was a lot of time spent in communication between the delegations trying to find a consensus.
249. Also important was the sheer shortness of time between the prior art's becoming available and the date of the Patent, when coupled with the fact that the RAN1 participants were clearly very busy. It must be borne in mind that while an idea could clearly be conceived in a short time (as Nokia's work shows) that does not mean that it always would be, or that resources were given to it. A number of ideas were generated that were not the same as the Patent's invention, but with more time and resources then more ideas would have been developed. One has to recall that the skilled person thinks of *all* the obvious developments of the prior art.
250. Overall, while Nokia has some unusual positives to its position which I have listed above, the confounding factors are such that I do not give weight to the secondary evidence. This does not harm Nokia's case, it just means that it does not add to it. I must reach my conclusion on the primary evidence, and for the reasons given above, that conclusion is that the obviousness attack fails.

ADDED MATTER

251. Two allegations of added matter were pleaded but only one was pursued at trial. It was as follows:
5. The matter disclosed in EP 103 as granted extends beyond that disclosed in the EP 103 Application and in EP 103's parent application as filed (namely EP 2 045 939 A1) (the "Parent Application").

PARTICULARS

- (a) The Parent Application disclosed two separate embodiments. The first relates to a cyclic sequence allocation and the second relates to a sequence ordering scheme.

- (b) The combination of two of the features of claim 1 and claim 8 of EP 103 (cyclic interpretation and alternating ordering of adjacent subsets by CM value) is not disclosed directly in either the EP 103 Application or the Parent Application. If the feature "alternating ordering of adjacent subsets by CM value" is disclosed at all, the two features are disclosed exclusively as separate embodiments.
- (c) The subject matter of claim 1 and claim 8 of EP 103 combines these features and thus goes beyond the content of the EP 103 Application and beyond the content of the Parent Application.

252. The conditional "If the feature 'alternating ordering of adjacent subsets by CM value' is disclosed at all" can be ignored as it is a reference back to the added matter allegation that was not pursued. So the complaint is against the combination of cyclic allocation and the sequence ordering scheme.

The law

253. The law on added matter is well known and was not in dispute. A strict comparison must be made and if the amended patent discloses new matter relevant to the invention that was not clearly and unambiguously disclosed before, the amendment is not allowable; see *European Central Bank v Document Security Systems* [2007] EWHC 600 at [97]ff, cited with approval in *Vector v Glatt* [2007] EWCA Civ 805. A species of this general rule arises when there is intermediate generalisation by taking a feature from a specific embodiment and introducing it into a claim when there is no indication that it was generally applicable. See *Nokia v ICom* [2012] EWCA Civ 567.
254. The legally relevant comparison is with the application as filed but for present purposes one can look at the granted Patent and that is what both parties did. I asked for an agreed comparison of the paragraphs of the application and the Patent to satisfy myself that this was appropriate, and I agree that it was.

Analysis

255. In support of the plea identified above, Oppo argued that cyclic allocation is only to be found in the First Embodiment, and that the ordering scheme of claim 1 as granted (reflected in claim features [e] to [h]) is only to be found in the Second Embodiment. It says there is no disclosure to combine them, let alone to the required clear and unambiguous standard.
256. Oppo pointed in particular to [0028] which discloses cyclic allocation using the first ordering scheme of Figure 1 (narrated at [0020]ff), and to [0029] which says that cyclic allocation is also useful in the context of the scheme shown in Figure 2 (narrated at [0022]ff). It argues that the Second Embodiment picks up the third ordering scheme (referred to at [0026] by reference to Figure 3) and says (at [0042]) that it can be combined with the first or second scheme, but makes no reference to cyclic allocation.
257. Nokia responded that:

- i)** There is a clear disclosure that both cyclic interpretation and the 3-step ordering scheme of claim 1 are advantageous and are both referred to as “embodiments of the invention”.
- ii)** Cyclic interpretation is advantageous regardless of the ordering scheme, as well as bringing advantages when used with certain ordering schemes.
- iii)** There is no ordering scheme other than the 3-step ordering scheme that is described as an embodiment of the invention. This was not gone into or relied on much at all and I am doubtful if it is correct given the way that the Figures are described at [0019] and I give it no weight either way.
- iv)** One of the benefits of the first and second ordering schemes is that they allow cyclic allocation because root sequences with the highest sequence numbers and root sequences with the lowest index numbers have the same Max Ncs values.
- v)** The second embodiment preserves the property of the second or first ordering scheme; this is because although the third ordering scheme changes the ordering of sequences within the subsets, it does not change the ordering of the subsets themselves. So the root sequences with the highest sequence number still have the same Max Ncs values as the root sequences with the lowest.
- vi)** A related benefit is that cyclic allocation makes it possible to create an additional set of 64 sequences including sequences from the top and bottom of the range.
- vii)** It is expressly stated (at [0043]) that “[t]he second embodiment combines benefits of the first and third ordering schemes” (both sides slightly misquoted this in their closings, but it did not matter), and that would include the benefit of permitting cyclic allocation.
- viii)** The second embodiment results in an arrangement according to the first or second ordering scheme.

258. As I have said, I do not attach weight to point iii) and nor do I think there is anything much useful from a technical point of view in point i), which seemed very semantic. But I accept the other points, and I do so mindful that the standard to be applied is clear and unambiguous disclosure, not obviousness.

259. It is a little bit fiddly to someone lacking the CGK technical understanding to follow why cyclic allocation is useful and why the third ordering scheme maintains the ability to use it, but I was firmly persuaded that the technical points at ii), iv) and v) would be clearly understood by the skilled person. Dr Cooper accepted point ii) and Prof Purat’s evidence was not really challenged. I think point vi) is clearly disclosed in [0031] and to the extent the witnesses disagreed about that I prefer Nokia’s argument and disagree with Dr Cooper. As I say, I am not applying an obvious standard but am drawing on the experts for basic technical appreciation.

260. Against this background I conclude that there is a clear disclosure of using cyclic allocation with the 3-step ordering scheme. The skilled person would unambiguously derive as much from the teaching of the document as a whole, but most specifically and most concretely from the teaching at [0043] that the second embodiment combines benefits of the first and third ordering schemes, which would be understood to the necessary standard to include cyclic allocation. This is the conclusion reached by the District Court of the Hague and the OD. Oppo's arguments to the contrary were artificial and depended on divorcing the text of the document from the skilled person's technical understanding.

EXCLUDED SUBJECT MATTER

261. Oppo contended that all the claims of the Patent are invalid on the ground of excluded subject matter under s. 1(2)(c) of the Patents Act 1977 (EPC Article 52).

The law

262. S. 1(2) is as follows:

(2) It is hereby declared that the following (among other things) are not inventions for the purposes of this Act, that is to say, anything which consists of—

(a) a discovery, scientific theory or mathematical method;

(b) a literary, dramatic, musical or artistic work or any other aesthetic creation whatsoever;

(c) a scheme, rule or method for performing a mental act, playing a game or doing business, or a program for a computer;

(d) the presentation of information;

but the foregoing provision shall prevent anything from being treated as an invention for the purposes of this Act only to the extent that a patent or application for a patent relates to that thing as such.

263. The case law is very important in this area, and has a complicated history.

264. In *Aerotel v Telco* [2006] EWCA Civ 1371, the Court of Appeal set out a four-stage test at [40]:

(1) properly construe the claim;

(2) identify the actual contribution;

(3) ask whether it falls solely within the excluded subject matter;

(4) check whether the actual or alleged contribution is actually technical in nature

265. Both sides before me also referred to the explanation of the test given by Jacob LJ at [42]-[47]:

[42] No-one could quarrel with the first step—construction. You first have to decide what the monopoly is before going on [to] the question of whether it is excluded. Any test must involve this first step.

[43] The second step—identify the contribution—is said to be more problematical. How do you assess the contribution? Mr Birss submits the test is workable—it is an exercise in judgment probably involving the problem said to be solved, how the invention works, what its advantages are. What has the inventor really added to human knowledge perhaps best sums up the exercise. The formulation involves looking at substance not form—which is surely what the legislator intended.

[44] Mr Birss added the words "or alleged contribution" in his formulation of the second step. That will do at the application stage—where the Office must generally perforce accept what the inventor says is his contribution. It cannot actually be conclusive, however. If an inventor claims a computer when programmed with his new program, it will not assist him if he alleges wrongly that he has invented the computer itself, even if he specifies all the detailed elements of a computer in his claim. In the end the test must be what contribution has actually been made, not what the inventor says he has made.

[45] The third step—is the contribution solely of excluded matter?—is merely an expression of the "as such" qualification of Art.52(3). During the course of argument Mr Birss accepted a re-formulation of the third step: Ask whether the contribution thus identified consists of excluded subject matter as such? We think either formulation will do—they mean the same thing.

[46] The fourth step—check whether the contribution is "technical"—may not be necessary because the third step should have covered that. It is a necessary check however if one is to follow *Merrill Lynch* as we must.

[47] As we have said this test is a re-formulation of the approach adopted by this court in *Fujitsu* : it asks the same questions but in a different order. *Fujitsu* asks first whether there is a technical contribution (which involves two questions: what is the contribution? is it technical?) and then added the rider that a contribution which consists solely of excluded matter will not count as a technical contribution.

266. Subsequently, however, the EPO considered *Aerotel* with some disfavour. The sequence of events, and consequent additional analysis, can be understood from the judgment of Kitchin LJ (as he then was) in *HTC v Apple* [2013] EWCA Civ 451 at [34]-[51] from which I think it right to quote fairly extensively:

34. Upon this appeal we are concerned once again with the exclusion of computer programs contained in art.52(2)(c), subject to the qualification in art.52(3) that it applies only to the extent to which the patent relates to such subject matter as such.

35. In *Aerotel Ltd v Telco Holdings Ltd; Macrossan's Patent Application* [2006] EWCA Civ 1371, [2007] R.P.C. 7, this court reviewed various decisions of the EPO Boards of Appeal and earlier decisions in this jurisdiction. It was conscious of the need to place great weight on the decisions of the Boards of Appeal but given what it described as the state of conflict between them, it explained it would be premature to do so, noting that the matter might have to be reconsidered if and when the Enlarged Board ruled on the issue. In the meantime this court was bound by its own precedents and, in particular, the decisions in *Merrill Lynch's Application* [1989] R.P.C. 561 (CA), *Gale's Application* [1991] R.P.C. 305 (CA) and *Fujitsu Ltd's Application* [1997] R.P.C. 608 (CA) to consider whether the invention made a technical contribution to the known art, with the rider that novel or inventive purely excluded subject matter does not count as a technical contribution.

36. The court also explained that the following four stage approach is consistent with its earlier decisions and the statutory test and provides a convenient way of addressing the exclusion:

- (i) properly construe the claim;
- (ii) identify the actual contribution;
- (iii) ask whether it falls solely within the excluded subject matter;
- (iv) check whether the actual or alleged contribution is actually technical in nature.

37. The first step poses no difficulty for it simply involves a conventional exercise of interpretation. The second step is, the court noted, more problematical. How is the contribution to be assessed? In this regard, the court recorded with apparent approval the submission made by Mr Birss (as he then was) on behalf of the Comptroller that the exercise involves looking at substance not form and assessing what the inventor has added to human knowledge. The court continued at [44]:

“Mr Birss added the words “or alleged contribution” in his formulation of the second step. That will do at the application stage – where the Office must generally perforce accept what the inventor says is his contribution. It cannot actually be conclusive, however. If an inventor claims a computer when programmed with his new program, it will not assist him if he alleges wrongly that he has invented the computer itself, even if he specifies all the detailed elements of a computer in his claim. In the end the test must be what contribution has actually been made, not what the inventor says he has made.”

38. The third step involves asking whether the contribution thus identified consists of excluded subject matter as such. The final step is then a check, which may not be necessary, and involves assessing whether the contribution is technical.

39. Some two years later this court again considered the exclusion in *Symbian v Comptroller-General of Patents* [2008] EWCA Civ 1066, [2009] R.P.C. 1. In the meantime, the Boards of Appeal had themselves considered *Aerotel* in decision T 0154/04 *Duns Licensing Associates* [2007] E.P.O.R. 38, describing it as “not consistent with a good-faith interpretation” of the EPC and, indeed, as “irreconcilable” with it. The Board in *Duns* explained that any reference to the prior art in considering art. 52 would lead to “insurmountable difficulties”, it being a concept “finely tuned” by a combination of arts. 54–56. It proceeded to endorse what this court had described as the “any hardware” approach, that is to say taking into account all the features of the claimed invention in considering art. 52 but only taking into account technical features in assessing inventive step; or, in other words, holding that the innovation must be on the technical side and not in a non-patentable field. A number of other decisions of the Boards of Appeal subsequent to *Aerotel* took broadly the same approach.

40. Despite the rather trenchant terms used by the Board in *Duns*, the court in *Symbian* explained that the approaches in *Aerotel* and *Duns* and in the great majority of other cases were, on analysis, capable of reconciliation. As Lord Neuberger of Abbotsbury said of the third step:

“So far as we can see, there is no reason, at least in principle, why that test should not amount to the same as that identified in *Duns*, namely whether the contribution cannot be characterised as ‘technical’.”

41. I respectfully agree in terms of result for it seems to me that whichever route is followed, one ought to end up at the same destination. On the *Aerotel* approach a claimed invention whose only contribution is not technical or lies in an excluded field falls to be rejected under art.52 under steps (iii) and (iv), whereas on the *Duns* approach such an invention falls to be rejected under art. 56 because such a contribution must be cut out of the assessment of inventive step.

42. Nevertheless, conscious of the need for consistency, the court in *Symbian* considered whether it could be satisfied that the Boards of Appeal had formed a settled view on the point which differed from the conclusion expressed in its own previous decision in *Aerotel* and, if so, whether it should now follow that approach. It decided that it should not do so for various reasons. First, there had been no decision of the Enlarged Board; second, the approaches taken by the Boards in the various decisions since *Aerotel* were not identical; third, on least on one of those approaches, it seemed the computer program exclusion may have lost all its meaning; fourth, extra-curial remarks of Mellulis J. of the Bundesgerichtshof suggested that the English courts were not alone in

their concerns about the approach of the Boards; and finally, if this court was seen to depart too readily from its previous approach it would risk throwing the law into disarray.

43. A few days after this court had given its decision in *Symbian*, in a referral under art.112(1)(b), the President of the EPO asked the Enlarged Board to consider a set of questions relating to the patentability of computer programs to which she considered the Boards of Appeal had given different decisions. In its decision *G3/08 Programs for Computers* [2010] E.P.O.R. 36 (12 May 2010), the Enlarged Board ruled the reference was inadmissible on the basis that the notion of different decisions in art.112(1)(b) had to be understood restrictively in the sense of conflicting decisions, and legal development could not on its own form the basis for a referral. It considered the decisions identified by the President were not conflicting although, in one case, they did reveal a legitimate development of the case law.

44. In these circumstances neither Apple nor the Comptroller suggested it would be appropriate for this court to abandon the approach explained by this court in *Aerotel*. In my judgment they were right not to do so. For the reasons given in *Symbian*, I believe we must continue to consider whether the invention made a technical contribution to the known art, with the rider that novel or inventive purely excluded subject matter does not count as a technical contribution. Further, in addressing that issue I believe it remains appropriate (though not strictly necessary) to follow the four stage structured approach adopted in *Aerotel*.

45. How then is it to be determined whether an invention has made a technical contribution to the art? A number of points emerge from the decision in *Symbian* and the earlier authorities to which it refers. First, it is not possible to define a clear rule to determine whether or not a program is excluded, and each case must be determined on its own facts bearing in mind the guidance given by the Court of Appeal in *Merrill Lynch and Gale* and by the Boards of Appeal in Case *T 0208/84, Vicom Systems Inc/Computer-related invention* [1987] OJ EPO 14, [1987] 2 E.P.O.R. 74; Case *T 06/83, IBM Corporation/Data processing network* [1990] OJ EPO 5, [1990] E.P.O.R. 91 and Case *T 115/85, IBM Corporation/Computer-related invention* [1990] E.P.O.R. 107.

46. Second, the fact that improvements are made to the software programmed into the computer rather than hardware forming part of the computer does not make a difference. As I have said, the analysis must be carried out as a matter of substance not form.

47. Third, the exclusions operate cumulatively. So, for example, the invention in *Gale* related to a new way of calculating a square root of a number with the aid of a computer and Mr Gale sought to claim it as a ROM in which his program was stored. This was not permissible. The incorporation of the program in a ROM did not alter its nature: it was still a computer program (excluded matter) incorporating a mathematical method (also excluded matter). So also the invention in *Macrossan*

related to a way of making company formation documents and Mr Macrossan sought to claim it as a method using a data processing system. This was not permissible either: it was a computer program (excluded matter) for carrying out a method for doing business (also excluded matter).

48. Fourth, it follows that it is helpful to ask: what does the invention contribute to the art as a matter of practical reality over and above the fact that it relates to a program for a computer? If the only contribution lies in excluded matter then it is not patentable.

49. Fifth, and conversely, it is also helpful to consider whether the invention may be regarded as solving a problem which is essentially technical, and that is so whether that problem lies inside or outside the computer. An invention which solves a technical problem within the computer will have a relevant technical effect in that it will make the computer, as a computer, an improved device, for example by increasing its speed. An invention which solves a technical problem outside the computer will also have a relevant technical effect, for example by controlling an improved technical process. In either case it will not be excluded by art.52 as relating to a computer program as such.

50. In *AT &T Knowledge Ventures LP's Patent Application* [2009] EWHC 343 (Pat), [2009] F.S.R. 19 Lewison J. (as he then was) reviewed many of the decisions referred to in *Aerotel* and *Symbian* and derived from them the following set of what he described as useful signposts:

- (i) whether the claimed technical effect has a technical effect on a process which is carried on outside the computer;
- (ii) whether the claimed technical effect operates at the level of the architecture of the computer; that is to say whether the effect is produced irrespective of the data being processed or the applications being run;
- (iii) whether the claimed technical effect results in the computer being made to operate in a new way;
- (iv) whether there is an increase in the speed or reliability of the computer;
- (v) whether the perceived problem is overcome by the claimed invention as opposed to being merely circumvented.

51. I respectfully agree these are useful signposts, forming as they do part of the essential reasoning in many of the decisions to which we must look for guidance. But that does not mean to say they will be determinative in every case. I have also had the benefit of reading in draft Lewison L.J.'s judgment in this case. I respectfully agree with that too, including his observation that, in the light of Mann J.'s judgment in *Gemstar-TV Guide International Inc v Virgin Media Ltd* [2009] EWHC 3068 (Ch), [2010] R.P.C. 10, he would adopt as his fourth signpost the

less restrictive question whether a program makes a computer a better computer in the sense of running more efficiently and effectively as a computer. Indeed, this is, to my mind, another illustration of the still broader question whether the invention solves a technical problem within the computer.

267. Thus on the basis of authority binding on me, the *Aerotel* test remains the right one, albeit that *HTC* (at [44]) says that it is not always mandatory.
268. Since *HTC* there has been a decision of the Enlarged Board of Appeal in *G1/19* (*Patentability of computer implemented simulations*). Nokia made submissions about it but did not, to my mind, really say that there was anything that required modification of the *Aerotel* test. In any event in my view a material change to that test could only be made by the Court of Appeal given its decision in *HTC*. I think it would be legitimate for me to refer to the EBA's decision if there were some new aspect of the law at a level of detail not covered by *Aerotel* in which I needed to fill in a gap, but Nokia did not submit that there was.
269. Oppo made its submissions by reference to *Aerotel*, subject to three points. I will deal with the first of them separately below because it was substantive. The second point was that the exclusions operate cumulatively (*HTC* at [47]); I accept this as a statement of the law and bear it in mind but it had little if any significance to Oppo's arguments as matters turned out. The third point was that it is useful to distinguish between those problems and effects which are "internal" to a computer and those which are external (*HTC* at [49]). I accept this too, and bear it in mind. The problems and effects relied on by Nokia seem to me to be external and I refer to this in more detail below.
270. A further point which emerges clearly from *HTC* is that the inquiry is one of substance and not of form (e.g. at [46]).

Oppo's first point – novelty only prior art

271. A point arises in the present case because Oppo's argument on excluded subject matter would, or at least could, be stronger if it could use *Woo* to define the actual contribution of the Patent (at *Aerotel* question (2)). The reason is that *Woo* discloses cyclic allocation whereas *ZTE* and *LGE* do not.
272. However, *Woo* is a novelty-only citation. Can that be used to decide the actual contribution? Oppo argued that it is legitimate. It referred me to the judgment of Floyd J (as he then was) in *HTC v Apple* [2012] EWHC 1789 (Pat) (his decision was reversed by the Court of Appeal in the judgment discussed above, but this aspect was not challenged on appeal):

15. In *Gemstar TV Guide International v Virgin Media Ltd* [2009] EWHC 3068 (Ch) at [37], Mann J left open the question of the appropriate "baseline" for the purposes of determining the contribution: was it any cited prior art, or only common general knowledge? Although I did not hear full argument on this point, it seems to me that the baseline is defined by any item of prior art admissible for a novelty attack. As the quotation from *Aerotel* makes clear, the contribution which the English

jurisprudence requires the court to consider is the actual addition to human knowledge, not the “alleged” contribution which one would discern from a reading of the patent specification. If it were the latter, then I can conceive of an argument along the lines that the skilled person would assess the alleged contribution in the light of his own common general knowledge. Once one is assessing a real contribution, however, it would seem odd not to take account of the whole, real state of the art (that is to say ignoring the deemed state of the art for novelty purposes under section 2(2) of the Act). The exercise of determining the contribution should in principle be the same as that involved in determining the difference between the prior art and the inventive concept for the purposes of obviousness. To ignore, as Apple invited me to do, the state of the art which does not form part of the common general knowledge seems to me to be entirely artificial, not least because the concept of common general knowledge is not a concept which appears in the Act or the EPC. Such a distinction would mean that an invention which was not novel nevertheless made a contribution to human knowledge, because the novelty destroying document was not part of the common general knowledge. I do not think that is what the cases, or the EPC, intended.

[Emphasis from Oppo’s submissions]

273. Oppo very fairly points out that while Floyd J said that the relevant baseline was not limited to the CGK (which I think is clearly correct given the Court of Appeal’s decision and also *Aerotel* itself) and included “*any item of prior art admissible for a novelty attack*”, he went on to refer to the “*real state of the art*” not including novelty-only citations (I think from the context it is clear that he meant s. 2(3) not s. 2(2)). This qualification was *obiter* and Oppo says it was incorrect. I agree that it was *obiter* and that is no doubt why Floyd J did not go into the reasoning any more fully.
274. This is not a straightforward point.
275. In favour of Floyd J’s approach there has been a tendency in this area of the law to look at the subject matter exclusions as being related to inventive step, stripping out the wrong kinds of contribution before seeing whether what is left is inventive.
276. On the other hand, one can imagine situations where it would seem necessary to take account of novelty-only art in connection with Art 52 to get to the correct result. To take an example that came up in argument before me, what if a piece of novelty-only art disclosed all the claimed features of a patent claim except for a claim feature that the product be painted blue (an aesthetic choice clearly excluded by Art 52(2)(b))? Surely the claim could not be valid, but why not? The example is probably not a realistic one because such a claim feature would not be allowed through examination, but it makes the point: what if novelty lies purely in excluded matter?
277. I asked Counsel for Nokia by what means the conclusion of lack of novelty could be reached if not by the line of reasoning that Art 52 rules out of

consideration non-technical features when novelty-only art is concerned. Nokia did not identify any other means and neither side identified any other case law of assistance, whether domestic or EPO.

278. I therefore rather tentatively conclude that novelty-only prior art must be capable of being taken into account in this way, at least in such relatively simple cases (I recognise that on one level I may be said to be in disagreement with Floyd J in *HTC* which has naturally given me reason to pause, but it does not seem that the point was argued before him in any detail). If that is applied to Woo then cyclic allocation has to be ruled out of the contribution. In the event, that does not affect the result.

T489/14

279. In this TBA case, which followed G1/19, the Board held that a simulation (of a crowd) and a design process based on it (for a better building) were excluded matter. Oppo relied on this. I do not think the case decided anything new and it certainly does not justify modifying the *Aerotel* approach. This is an area of patent law where it is especially dangerous to compare facts rather than work from identified principles, but in any event I do not think there is any relevant factual analogy.

Analysis

280. There is no dispute of construction relevant to *Aerotel* step (1).
281. As to *Aerotel* step (2) the actual contribution over the ZTE plus LGE combination is in the *particular* ordering scheme using CM and Max Ncs. I accept Oppo's submission that the prior art disclosed the basic ideas of sequencing and of using CM and Max Ncs, including using them together.
282. Given my conclusions on the CGK and on obviousness, there was also a contribution compared with ZTE plus LGE in deploying cyclic allocation.
283. If it is legitimate to use novelty-only art, as I have concluded, then the contribution over Woo is again the particular ordering scheme (Woo as I have construed it is basically LGE).
284. At *Aerotel* step (3) I must ask if this contribution was technical. I think it clearly was. On the evidence, it was clear that the specific ordering scheme:
- i)** Provides the opportunity for a UE manufacturer to tune the power amplifier so as to save battery power.
 - ii)** Keeps down the system information needed to signal preambles and so avoid a reduction in system capacity.
 - iii)** Reduces the complexity of implementing the searching unit (albeit only to a minor degree).
 - iv)** Provides an overall benefit to network throughput and data rates experienced by a UE.

285. Prof Purat also said that cyclic allocation gave a benefit in terms of avoiding the need for smaller cells. If cyclic allocation is to be excluded from the analysis either because of Woo or because I am wrong in my analysis of CGK/obviousness to that extent (but with the ordering scheme still being inventive) then this benefit cannot be relied on. But as is apparent, most of the matters relied on by Nokia are not to do with cyclic allocation.
286. Oppo had three answers to this.
287. One was that the real contribution of the Patent is in network planning which is merely a mental act, performed in reality by a computer, which is a “cognitive exercise” or mental act, and gives rise only to a sequence of numbers, not a real-world effect. I reject this; the Patent would make network planning easier, but that is not all that it does. It enables the real world effects referred to above. It was at this stage of the argument that Oppo deployed T489/14 but I reject any relevance of it for reasons given above. So far as one should delve into the facts (which I do not think one should) there was no equivalent in T489/14 of the real world effects of reduced power usage, better data rates etc., as identified above.
288. The second was that factors other than the ordering scheme would affect what preamble(s) was/were sent and therefore (as I understood the argument) whether the benefits referred to above would be achieved. This could be said in almost any case; the Patent allows a benefit to be achieved but whether it is will depend on sensible application of its teaching.
289. The third was that the Patent does not provide the mobile with new preambles it could not have transmitted before. At the level of an individual mobile transmitting an individual preamble this is perhaps true but it again ignores the benefits of the ordering scheme and is one of form not substance.
290. I therefore answer Aerotel step (3) in Nokia’s favour.
291. Aerotel step (4) is just a cross-check on step (3) and does not add anything in the present case. The attack therefore fails.

CONCLUSIONS

292. My conclusions are:
- i)** The Patent is valid.
 - ii)** The Patent is admitted to be essential and so claim 1 is infringed by 4G and 5G functionality in the Oppo phones.
293. I will hear Counsel as to the form of Order if it cannot be agreed. I direct that time for seeking permission to appeal shall not run until after the hearing on the form of Order (or the making of such Order if it is agreed). I draw attention to paragraph 19.1 of the Patents Court Guide, which says that a hearing on the form of Order should take place within 28 days of hand down. In the present case, 28 days from hand down will be 13 February 2023 but given the unusually

long time from provision of the draft to hand down (owing to the Christmas break) I would hope the hearing can be earlier than that.