APPLICATION OF THE PRINCIPLES OF PERMUTATION AND COMBINATION (IN MATHEMATICS) IN TELECOMMUNICATIONS

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ABSTRACT

The principles/theories of permutation and combination in mathematics are stated: These principles/theories are applied in the allocation of telephone numbers from country code to actual telephone/fax numbers for home or businesses. The results obtained are compared to the present world population. How this result could improve the present world telecommunications system is demonstrated.

Keywords: permutation; combination; mathematics; telecommunications; telephone; fax; world population.

1. INTRODUCTION

The principle of permutation, in mathematics, is about arranging a group of numbers or objects in a specific order while that of combination is about arranging a group of numbers or objects in no specific order[1]It will be intriguing to realize how these two principles could be applied in real life. This paper narrates and illustrates how these two principles could be applied in telecommunications; in the alloçation of telephone numbers to subscribers around the world, with ease.

Every person living on earth, in developed, underdeveloped and undeveloped countries deserves to have a telephone because of its necessity. One would then ask: Is it possible to assign telephone numbers to every person living on earth? The answer to this question is "Yes." How can this be proved?

This paper proves and illustrates that concept using the principles of permutation and combination in mathematics.

2. The Telephone Numbering System

The allocation of telephone numbers primarily starts with the International Telecommunications Union (ITU).[2] The ITU determines and assigns telephone country codes to all countries in the world. Since this

task is regulated and controlled, the allocation of those numbers must be in specific order. Usually, these numbers range from 1 to 3 digits.

Next to country codes are city codes. City codes are usually assigned by the Ministry of Telecommunications of each country. Usually, these range from 1 to 3 digits as well. Next, in the series of numbers, is usually the telephone numbers themselves; a set of numbers that can go up to 7 digits. Hence, generally a telephone number system appears as follows.

$$\underbrace{XXX}_{\text{Country Code}} \quad \underbrace{XXX}_{\text{City/Area Code}} \quad \underbrace{XXX\ XXX}_{\text{Phone Number}} \text{ ---- (1)}$$

3. Application of the Principles of Permutation and Combination

(a) The Allocation Of Country Telephone Codes

The allocation of country telephone code must be in specific order. As already mentioned, the ITU controls this function. The emphasis on this arrangement/allocation is in the word "order." For this reason, this implies the principle of permutation in mathematics. The allocation can be efficiently carried out by posing the following mathematical question: In how many ways can 3 digits be arranged from a group of 10, in particular orders? Answer to this question is provided by the principle of permutation in mathematics. It should be understood that one is free to choose the 3 digits from the decimal numbering system (0……...9), in particular orders. Hence, the answer to that question is $10P_3$, which is:

$$10P_3 = \frac{10!}{(10-3)!} = \frac{10!}{7!} = \quad (1)$$

$$10 \times 9 \times 8 = 720 \text{---------- (2)}$$

This means that there are 720 ways to arrange 3 digits from a group of 10 digits, in particular orders. What does this imply in allocation of telephone codes for countries in the world? There are 273 countries in the world today.[3] Using the result from equation (2), this means that all the 273 countries in the world could easily be assigned telephone codes. Comparing the number of countries in the world to the result obtained from equation (2), it can easily be seen that this freedom of choice is more than twice possible and available. That takes care of the first segment in equation (1).

(b) The Allocation Of City/Area Codes

Telephone city/area codes of all countries in the world are usually assigned by the country's Ministry of Telecommunications. Usually, these digits are 3, selected from the decimal number system, 0….9. Grouping of these 3 digits must also be in a particular order. What this implies is that the grouping could be

efficiently implemented using the principle of permutation in mathematics, similar to that of allocation of country codes. That means arranging digits in groups of 3 selected from the decimal digit system, (0….9), in orders. This is represented mathematically as $10P_3$.

$$10P_3 = \frac{10!}{(10-3)!} = 10 \times 9 \times 8 = 720 \text{ ---} \quad (3)$$

What this implies is that 720 combinations could be obtained for 3 digits arrangements from 10 digits (0….9). In a country like the United States of America (USA) which has 50 states, this principle would allow up to 720 combinations for area codes.

(c) The Allocation Of Phone Numbers

The principle for efficient allocation of phone numbers is technically different from those of country and city/area codes. This usually constitutes 7 digits and is the actual telephone numbers which provide telecommunications services for homes and businesses. This principle is equally applicable to all types of communication lines. To have a wider latitude of numbers, the 7 digits could be broken into 2 segments, of 3 and 4 digits, as follows:

X X X X X X X ----------(4)

The arrangement here follows no particular order. Hence the principle of "combination" in mathematics applies. By this application the number of arrangements for the first 3 digits, combined from a group of 10 digits (0…..9), are obtained from the following expression.

$$10C_3 = \frac{10}{(3!)(10-3)!} = \frac{10}{3!x7!} = \frac{10x9x8}{3x2} = 120 \text{---- } (5)$$

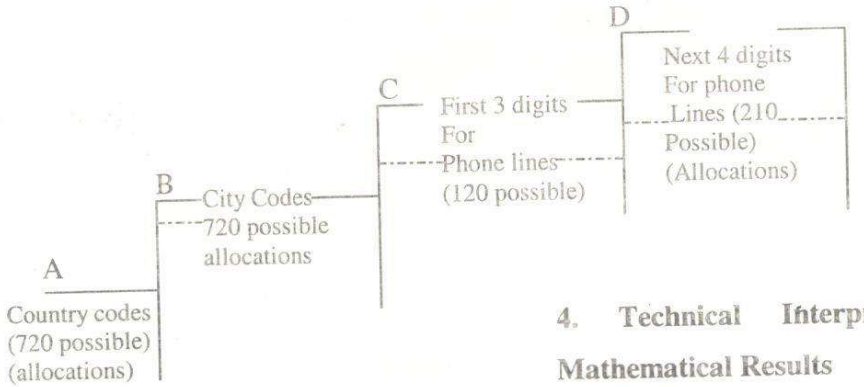
From the result in equation (5), these would give 120 combinations of 3 digits, chosen from 10 digits (0….9). The last 4 digits would similarly be arranged using the same principle of "Combination." This would be as follows

$$10C_4 = \frac{10!}{(4!)(10-4)!} = \frac{10!}{4!x6!}$$

$$= \frac{10x9x8x7}{4x3x2} = 210 \text{ ----------(6)}$$

There would hence be 210 arrangements of 4 digits, chosen from 1

Figure. 1: An Illustration Of Telephone Allocation Numbers From Country Codes To Actual Telephone Numbers



0 digits, 0…..9.

The explanation of the illustration in figure 1 is that each number allocation at point A will have 720 possible combinations at point B. Each allocation at point B will have 720 possible combinations at point C. Each allocation at point C will have 120 possible combinations at point D, while each allocation at point D would finally have 210 possible combinations.

These allocations and possible combinations of numbers would give 720 x 720 x 120 x 210 = 13,063,680,000..(7)

This very principle of allocation of communication lines covers all types of telephones (including cellular telephones), fax and beeper lines all over the world.

4. Technical Interpretations of the Mathematical Results

The mathematical results obtained could technically and practically, be implemented as illustrated in the following chart.

5. Discussion

The present world population is 6,400,000,000.[4] The result obtained from the study, equation (7), is more than twice the present world population. What this implies is that it is possible for every person on earth to be assigned both telephone and fax lines with ease, as long as there are voice and data exchange equipment to handle the distribution, coding and de-coding of information. The issue of "congestion of lines," should not come up at all, as long as the equipment are properly sized.

6. Conclusion

This study, with the accompanying result, had been made possible by the unique application

of the principles/theories of permutation and combination in Mathematics. It would prove an efficient way for the International Telecommunications Union (ITU), Ministries of Telecommunications and Telephone Companies, in different countries around the world to adopt, in the process of assigning telephone and fax numbers for homes and businesses. The same principle can be applied for economic and social planning of countries and communities around the world. It would particularly be useful in the allocation of social security and national identification numbers and in income identification/classification schemes. A practical application of mathematical principles has once again been demonstrated.

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