Superluminal Data Transmission supported in Quantum Entanglement

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Abstract

A bit classical technique, supported by quantum entanglement, is presented for superluminal data teleportation, from a transmitter to a receiver, theoretically placed at any distance. This technique is developed by the author of this article and any industrial and commercial application must have his authorization.

1. Introduction

In 1935, the physicists of Semitic origin, the German Albert Einstein, Nobel Prize winner in 1921, the Russian Boris Podolski and the American Nathan Rosen published, in Physical Review, the article “Can the Quantum Mechanics description of physical reality be considered complete? ” in that by means of a mental experiment they produced the Einstein-Podolski-Rosen paradox, or the EPR paradox, about the so-called, in that same year, quantum entanglement between particles that cannot be determined to exist in a single state but in a superposition of states corresponding to a system with a wave function for the entire system, by the Austrian physicist and philosopher Erwin Schrodinger, Nobel Prize winner in 1933, who, through a long correspondence with Einstein, proposed the "Schrodinger's cat" mental experiment that preluded the criticism of quantum physics raised in EPR.

The quantum entanglement that implies the instantaneous interaction between two particles, in addition to its probabilistic nature, violates the principle of locality, introduced by Special Relativity, which defines that any interaction between events can only occur with a speed less than or equal to the speed of the electromagnetic wave in the vacuum and that the particles exist in a single state. “For two unrelated energy particles, when one associated particle is measured together, a corresponding energy change of the other associated particle may occur at any remote physical location” (1).

The explanation given by EPR is that there are no particles in physical reality in superposition of states, which as a result of a measurement collapse into a certain one that instantly fixes the state of the entangled particle, but rather it is due to the existence of hidden variables that are not included by quantum mechanics, making it an incomplete theory and giving rise to a poor definition of particle entanglement, according to the local reality existing in a deterministic way belonging to objective local theories.

In 1964, the Northern Irish mathematical physicist John Bell, in an article "On the EPR paradox", formulated Bell's inequalities theorem which, based on Einstein's theory of the local reality of particles, allowed it to be experimentally tested. The results proved Quantum Mechanics right. Physicists, Nobel laureates 2022, Anton Zeilinger, Austrian, John Clauser, American, and Alan Aspect, French, experimenting with entangled photons, with new methods that improved on Bell, unequivocally established that quantum mechanics is non-local.

In 1969, the author proposed his theory of the superluminity of the graviton, the gravity-transmitting boson according to quantum theory. In this paper, seeking to validate this vision from another perspective, the author proposes a new technology based on quantum entanglement to achieve superluminal data transmission.

In quantum mechanics, particles are described by a wave function $\psi(x)$. And particles exist in a superposition of states. For example, a single photon has a superposition of two states that are incompatible with each other. The photon is assumed to be in both states simultaneously:
$|\psi\rangle = |A\rangle + |B\rangle$ $|\psi\rangle$ is the "state" of the system.

In the entanglement two distant systems are in a correlated superposition state. Thus, we can create an entangled state where:
$|\psi\rangle = |A_1\rangle |A_2\rangle + |B_1\rangle |B_2\rangle$

If we use a single-photon detector to measure which path photon$_1$ is at location 1 and find that it is in path A_1 then photon$_2$ must be in path A_2 and the state instantly “collapses” to $|\psi\rangle = |A_1\rangle |A_2\rangle$. This has instantly physical effects at location 2 (2).

Gisin’s group in Switzerland performed a nonlocal interferometer experiment over a distance of 10 km. They subsequently showed that the collapse of the wave function occurs at least 10,000 faster than the speed of electromagnetic wave in vacuum (2).

“Entangled state theory plays an important role in the transmission of quantum mechanical information”. “In the classical network information communication theory and network communication science, "bit" is usually the most basic definition concept and basic measurement unit to define the amount of information. Quantum bit unit is the unit of measurement for transmitting quantum scientific information. Both quantum symbolic information theory and mathematical quantum information communication theory are based on mathematical qubit". "At first, when a concept of quantum wireless communication was first widely proposed, everyone did not fully agree. It was not until a few years later that people really began to understand the basic concepts of quantum wireless communication. Quantum teleportation, quantum dense communication coding and quantum spatial secret information sharing are the main applications of quantum teleportation". "Research shows that more than 92% of quantum communications at home and abroad take quantum entanglement as the core factor of industry competitiveness. The application of quantum entanglement in quantum communication has been increasing in recent years. In the application of quantum communication, quantum entanglement has the effect of fast transmission, unlimited capacity and absolute security" (1).

Entangled states can be created in many different ways for example:

- Polarization states of photons: $|\psi\rangle = (|x_1\rangle |x_2\rangle + |y_1\rangle |y_2\rangle) / \sqrt{2}$
- Path entanglement of photons.
- Energy-time entanglement (nonlocal interferometer).
- Energy levels of atoms or ions.
- Hyper-entanglement – several degrees of freedom at once.

In a quantum computer, the qubits: photons, atoms, electron spins, superconductors, can be in a superposition state: $|\psi\rangle = |0\rangle + e^{i\varphi}\ |1\rangle$ while in a classical computer the bits can be only in a binary value of 0 or 1.

The power of the quantum computation and also superiority de quantum communication are supported in use of qubits respect to classical computation y communication both based in bits due to that qubits support an arithmetic superior to binary arithmetic used in classical technology. However, the power of the instantaneous action to distance of quantum entanglement is not applicable to communication since it is restringing a maximum speed of electromagnetic wave in vacuum, this is, c.

The quantum entanglement as an instantaneous action at a distance leads to the idea of instant communication between two parties that share an entangled pair. But, according theory special relativity it is showed that such a communication is not possible (3), (4), (5).

Therefore, engineering based on quantum physics applied to computer science has not explored beyond processing using qubits within computer equipment and transporting it through classical wireless and wired channels, restricting communication to the maximum the speed of the electromagnetic wave in a vacuum.

In this work, from our particular vision of superluminality, we present a new technology based on quantum entanglement with the aim of teleporting classical bits superluminally. We do not intervene in computers and their programs (DTE), the main component of a data processing system that may well be entirely classical or quantum computers, but rather the equipment and its communication programs (DCE) that integrate them into Wide Area networks (WAN). Our proposal is to replace the current bit-analog communications technology with bit-entanglement communications technology. We are not proposing to stay in the current classical bit processing technology since it can be with qubits, but to advance using bits in communication with the power of their teleportation through quantum entanglement. Whether it is with bit or qubit computers, our new technology for communication within WAN networks requires, of course, to radically redoing the DCE where there will be no more modems and in the case of qubit computers additional qubits-bits-qubits converters will be required in the DCE. But in all the processing is maintained within the DTE either in classical or quantum technology. We emphasize our new bit-quantum entanglement communication technology only has the DCE as its object, which must be designed accordingly.

2. Fundamentals of bit teleportation

Although it is true that the state that results from quantum collapse in an entanglement system between two particles is probabilistic, it is also true that it is deterministic that said state changes when an update occurs. That is, between quantum entanglement two particles, the resulting state in the second as a consequence of the potential state in which the superposition would collapses will change when a new entanglement is caused between the first particle of the pair and a third.

In this way, we can generate bits from the second particle by detecting, very softly to avoid the wave collapse and the destruction of quantum entanglement, in which lies the great challenge of this new technology but never its unattainability, the change of its state according yes/no, since it will be yes when the first particle is entangled with a third one and it will be no when there was no entanglement.

3. Technology change

A technique for the teleportation of classic bits is designed, changing the currently existing bit-analog technology while preserving the essentials of the field of teleinformatics, which combines information: word-text, voice, image and/or video with its transport, that is, in the communication between computers that is carried out, according to the architectures of distributed networks, with bus, ring, star and indefinite topologies or their combination of star and tree ring topologies, and that according to at present, transport is supported by electric-electromagnetic wave technology (bit-analog technology), which is sought to be replaced by bit-quantum entanglement technology, of course preserving bit technology throughout. The proposed change is from analog to quantum entanglement technology during communication.

Bit technology uses discrete discontinuous signals from two electrical states (on/off, high voltage/low voltage, current/no current etc.) while analog technology uses electromagnetic waves, thus continuous signals through a variable electromagnetic field which combines oscillating electric and magnetic fields that propagate in space. Bit-analog technology requires a converter (modem) between both types of signals.

There are two kinds of networks: local LAN (Local Area NetWork) connections, normally restricted to a building, which carry out transport through electrical signals (bit technology) and remote WAN (Wide Area NetWork) connections, such as Metropolitan Area NetWork, within the area of a city, and the World Area NetWork, with coverage that can become global, which carry out transport through electromagnetic waves (analog technology) that require signal modulators-demodulators (MODEMS), main component of the DCE, which are to change the electrical signal (bit technology) within the local connection to electromagnetic waves (analog technology) within the WAN connection and vice versa (6). Of course, it is the WAN scenario that the change from the current bit-analog to our bit-quantum entanglement communication technology applies.

From the perspective of information, the connection is generally made using packet switching, usually under the models: OSI (Open System Interconnection), which provides the theoretical design of a network, and TCP/IP, which within the theoretical formulation implements operational protocols to obtain the address in which the data is sent (IP) and make its delivery (TCP), specifying the exchange of information between data processing systems and the X.25 recommendation that specifies the characteristics of the connection between a processing system sending data and a receiving data processing system. Packet switching is structured under the first three levels of the OSI model, that is, the physical interconnection, data link control and network control layers and a set of associated standards such as X.3, X.28, X. 29, X.75 etc. Four-layer TCP/IP simplifies the seven OSI layers by combining the presentation and session layers into an application layer and the physical and data link layers into a host layer (6).

A data processing system is the set of one or more computers, with its software made up of the operating system, utilities and application programs for both the system and the users, and its hardware that includes the computers themselves and their peripherals, for short (DTE), and data communication equipment (DCE). In other words, a software-hardware structure with autonomous information processing capacity. Major components of DCEs are modems and routers that carry the digital signal from the modem to various devices in the data processing system (7).

WANs share the transmission of multiple wired or wireless signals simultaneously, that is, from multiple users, using frequency division multiplexing. Bandwidth of up to 600 megabits per second is currently available and modems can be up to 64 kilobits per second.

Data transmission within bit-analog technology occurs under the settings:

• Forward: ISP> analog signal>modem>digital signal>DTE

• Back: DTE>digital signal>modem>analog signal>ISP

ISP is the Internet provider.

4. The change from bit-analog communication technology to bit-quantum entanglement communication technology

Although in the long term it will be sought to fully support WAN, in the short term it is proposed to produce the change from bit-analog communication technology to bit-quantum entanglement communication technology through a remote point-to-point connection between a data processing system sender data and a receiver data processing system, that is, outside the architectures of distributed networks and with a purely experimental and provisional nature.

In the new technology bit-quantum entanglement there are no modems since the digital signal is not changed to analog but the DCE must produce the quantum entanglement in two ways, that is:

• Forward: DTEe>digital signal>DCEe>quantum entanglements>DCEr>digital signal>DTEr

• Back: DTEr>digital signal>DCEr> quantum entanglements>DCEe>digital signal>DTe

DTEe is sending data processing system, DCEe is sending data communication equipment, DTEr is receiving data processing system and DCEr is receiving data communication equipment

Therefore, the experimental point-to-point remote connection will be configured as:

Transmitter exchange-to-receiver data processing system>digital signal>DCE>quantum entanglement of two remote particles>DCE>Receiver exchange-to-transmitter data processing system.

5. Infrastructure requirement for remote communication based on quantum entanglement

• For data transport, a given number of quantum entanglements of two remotely placed particles for the outward and equal number of quantum entanglements of two remotely placed particles for the return. For the group of quantum entanglements proper to the forward path, the second particle will be from the access of the DCE in the receiving system, but for the group of quantum entanglements proper to the return path, the second particle will be from the access of the DCE in the receiving system. It should be noted that both groups of quantum entanglements will be independent of each other.

• For the transport of the metadata that refers to the necessary data of the physical interconnection (first layer of the OSI model), a certain number of quantum entanglements of two remote particles.

6. DCE Logic Design Requirements for Quantum Entanglement

From the current DCE, the router is preserved, but in exchange for the modem, the DCE is required to include, apart from the basics for data communication like CPU, memory RAM, data bus, address bus etc. the following indispensable components of quantum entanglement of particles:

6.1 The DCE will work in two modes

In order to support two-way bit teleportation, that is, round-trip, the DCE must work in two modes, one as a transmitter and the other as a receiver, depending on the round-trip mode of the data processing system to which it is connected.

6.2 Data buffer

- From the data processing system in sending mode, a group of data will be loaded into a buffer (temporary memory in RAM) of the DCE in sending mode, which can come from a selection or all the records of one or more files, one or more databases, or group of data supplied by online data capture terminals and eventually data that may result from logical and/or mathematical operations from the former or from internal functions, for example, from the number generation function random.

- In the buffer, the data from the DCE in sending mode according to the numeric, alphabetic and/or special characters in which they are encoded, will be represented in one of the binary pattern systems as they are electronically stored in bits in the buffer, for example :
  - ASCII (American standard code for information interchange) that provides 128 different binary patterns, using 7 binary digits for each character. Thus, the a is represented by 0001110 and the A by 1010000.
  - EBCDIC (Extended binary coded decimal interchange code), in which 8 binary digits are used for each character. Similarly, as in ASCII 7, they are for the character and the eighth is for parity that stores the result of the function that assigns the binary digit 0 when the sum of the 7 that represent the character gives even and 1 when it is odd and is used to verify its inalterability.
  - BCD (Binary coded decimal) which represents 1 decimal digit by 4 binary digits. Thus, the 3 is stored in binary code as 0011 and the 9 as 1001 (8).

6.3 Initial conditions to be met

- Start signal teleportation of bits through a classical channel.

- In the DCE in sending mode, generation of physical connection data, that is, connector size and electrical control signals such as the addresses that will be teleported to the DCE in receiving mode.

- Synchronization between the DCE of the data processing system in sending mode and the DCE of the data processing system in receiving mode.

- At least a number of entanglements particles between the emitting system and the receiving system equal to the number of bits to be teleported in two ways, that is, in the emitter-receiver direction and vice versa, corresponding to a character, that is, a system of 4 entanglements for BCD, 7 for ASCII and 8 for EBCDIC for the forward path and the same for the return path. But, it can also be a number of quantum entanglements corresponding to the bits necessary for the teleportation of all the component characters of the data of an information unit loaded in the buffer of the sending DCE.

- In the DCE in receiver mode, for each quantum entanglement, detector on the second particle acting very smoothly, to avoid the collapse of the wave and destroy the entanglement. That is, 4 detectors for BCD, 7 for ASCII and 8 for EBCDIC. Or the number of detectors that are required for the entire component bits of the characters of an information unit. Of course, the best character representation pattern is the EBCDIC because it supports integrity verification through the parity bit during the teleportation process.

6.4 Process for each buffer load in the DCE in sender mode

By firmware for each group of data, represented in bits, and loaded into the buffer of the DCE in emitter mode, its superluminal teletransport between this and the DCE in receiver mode, by means of quantum entanglement technology of particles placed at a distance up to about 1,200 kilometers, reached experimentally in China up to now, but thousands of kilometers, theoretically without limit, and in the emitter-receiver or return direction.

a) In general, the following mathematical model would be used, which is taken from (9) and it is formulated in vectors at the Hilbert´ space.

. Photon to be teleported: photon 3 at DCE emitter.

$|\varphi\rangle_3 = \alpha|0\rangle_3 + \beta|1\rangle_3$

Where α y β are complex numbers that satisfy $|\alpha|^2 + |\beta|^2 = 1$, 0 is horizontal polarization and 1 is vertical polarization.

Photon 3 in the DCE emitter will be teleported to the DCE receiver by changing the state of photon 2 which, without breaking the entanglement between photons 1 and 2, will be detected by a very fine change in the energy of photon 2. Therefore, it is requires an ultrasensitive detector in DCE receiver.

- Entanglement at remote distance: photon 1 at DCE emitter and photon 2 at DCE receiver

$|\psi\rangle_{12} = 1/\sqrt{2}\ (|0\rangle_1 |1\rangle_2 + |1\rangle_1 |0\rangle_2)$

The objective is to ensure that photon 2 is in the same state of polarization as photon 3. First, a joint measurement will be made on photons 3 and 1. It will be a Bell-type state measurement, which consists of the projection of the state of the two photons onto four possible entangled states $|\Phi^{\pm}\rangle_{31}$ and $|\Psi^{\pm}\rangle_{31}$ (called Bell states), so there will be one out of four possible outcomes. Due to the entanglement between photons 1 and 2, the state of photon 2 will depend on the result of this measurement.

When performing the Bell measurement, the state $|\varphi\rangle_3$ will be destroyed, and photon 3 will find itself in an entangled state with photon 1 of the four possible states of the Bell basis.

The four Bell states for two particles are:

$|\Phi^{\pm}\rangle_{31} = 1/\sqrt{2}\ \ (|0\rangle_3|0\rangle_1 \pm |1\rangle_3|1\rangle_1)$, $|\Psi^{\pm}\rangle_{31} = 1/\sqrt{2}\ \ (|0\rangle_3|1\rangle_1 \pm |1\rangle_3|0\rangle_1)$

- The state of the system of the 3 photons in terms of the states of the Bell basis are:

$$|\Psi\rangle_{123} = ½\ [|\Phi^{+}\rangle_{31}\ (\alpha|1\rangle_1 - \beta|0\rangle_1) + |\Phi^{-}\rangle_{31}\ (\alpha|1\rangle_1 + \beta|0\rangle_1)$$

$$+ |\Psi^{+}\rangle_{31}\ (-\alpha|0\rangle_1 + \beta|1\rangle_1) - |\Psi^{-}\rangle_{31}\ (\alpha|0\rangle_1 + \beta|1\rangle_1)\ ]$$

By making a joint measurement of photons 3 and 1, they will not only be entangled, but photon 3 will teleport.

b) In particular, the procedure would be done as follows: Suppose, it is a record of a total of 12 decimal digits, that is, 48 bits corresponding to the data involved in preparing the invoice of a subscriber of a certain service. The data would be stored in the DCE buffer in sending mode in BCD and would be composed of:

- Subscriber account number of 6 decimal digits which gives 24 binary digits, that is, 24 bits in 6 groups of 4 bits.

- Code of the concept of collection to be paid by the subscriber of 1 decimal digit, that is, 4 bits in 1 group of 4 bits.

- Collection value of 5 digits, that is, 20 bits in 5 groups of 4 bits.

For each teletransport cycle between the DCE in sending mode and the DCE in receiving mode, synchronized between them, the procedure would be:

- A minimum group of bits would be generated in the buffer in the DCE in receiving mode to receive in teletransport the 4, 7 or 8 bits corresponding to a character according to the BCD, ASCII or EBCDIC coding system in which it is found in the DCE in emitter mode. According to the example, per character, a group of 4 bits would be generated in the DCE in receiver mode, which would take the value of 1 if the detector, in the DCE in receiver mode, for each bit found a change in the value of the second particle when the first particle is entangled, with a third (9) originated by a generator of entangled particles at a very short distance, therefore, first and third particles in the DCE in emitter mode and only if the value of the binary digit to be teleported was 1. From what on the contrary, that is, when the value of the binary digit to be teleported was 0, the entangled particle generator at a very short distance, in the DCE in emitter mode, would not do so and, consequently, the corresponding detector in the DCE in receiver mode it would find no change in the state of the second particle, and thus a bit with the value 0 would be generated in the buffer at the receiving mode DCE.

- This process would be iterative until all the characters are transferred from the DCE in sending mode to the DCE in receiving mode. In the example, the transmission of the data of the registry that intervenes for the preparation of a subscriber's invoice would be done 12 times, if for each time a character was teleported, the registry comprises 12 digits or only once if in each cycle of the sending DCE will teleport all the characters of an information unit, that is, of the total data placed in the buffer of the sending DCE.

- For each cycle of the DCE in emitter mode after the initial one, the first and third particles of the two entangled at a very short distance, placed in the DCE in emitter mode, would disentangled the third, using a detector on it, causing the wave to collapse through full measurement.

The following diagram illustrates the process in basic terms described:

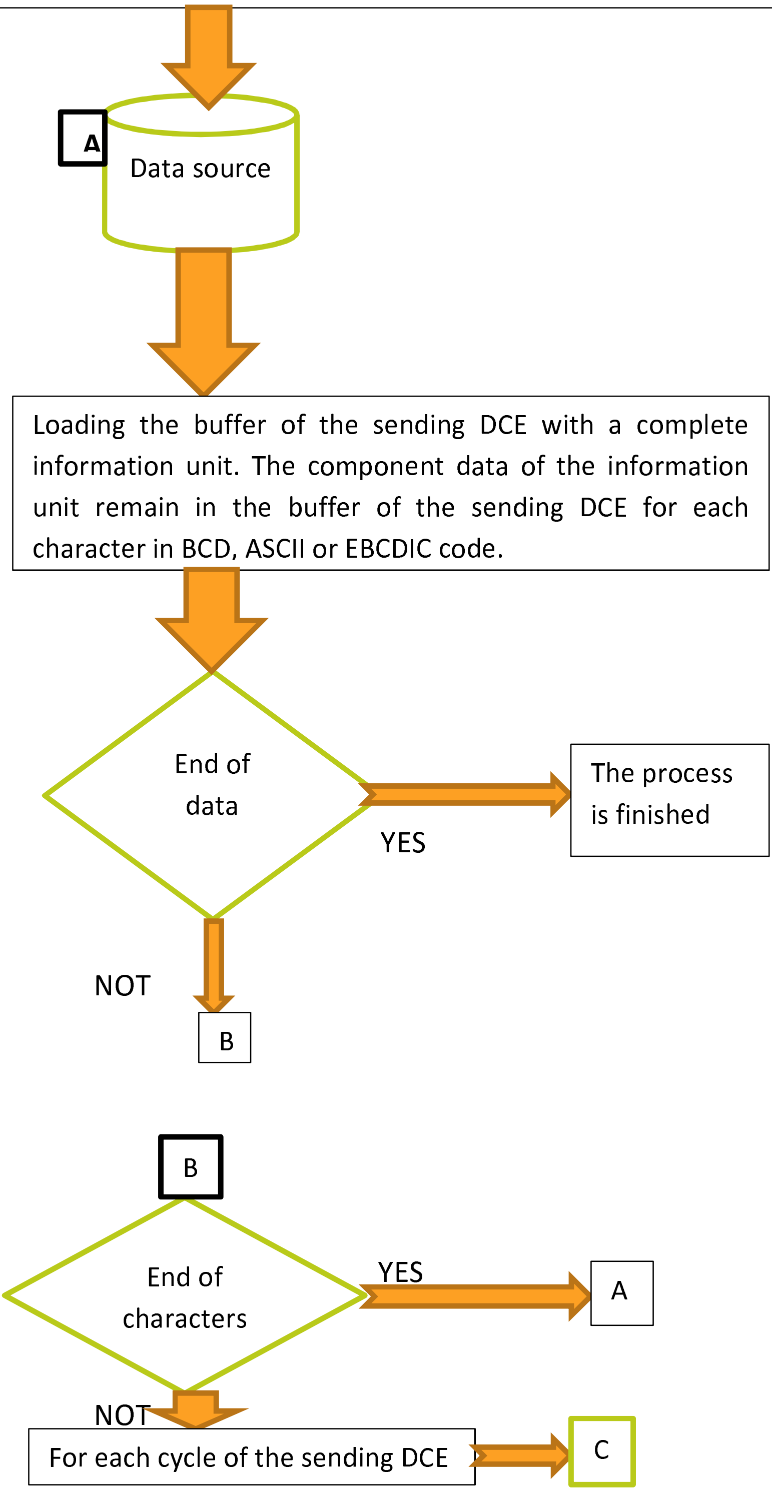
INITIAL CONDITIONS

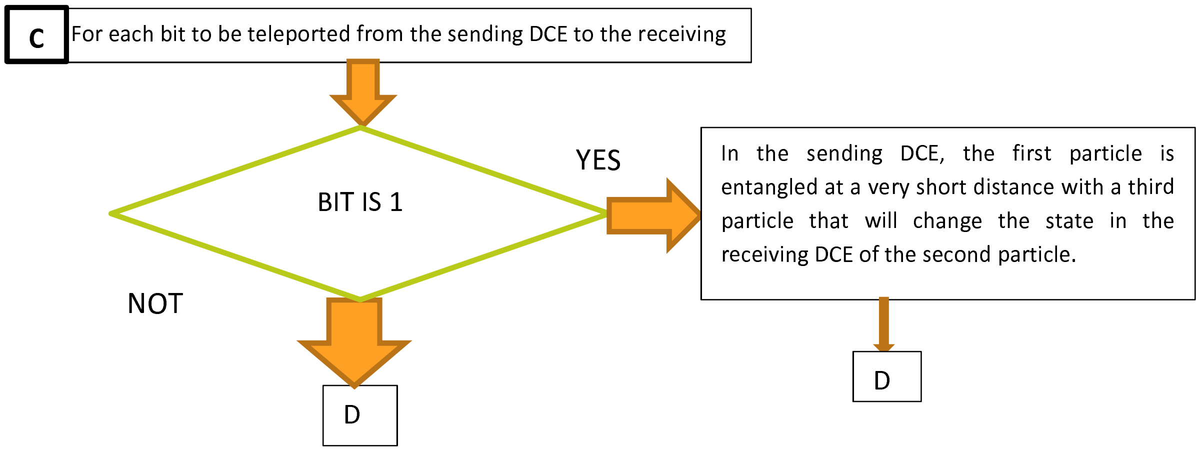
- Start signal teleportation of bits through a classical channel.

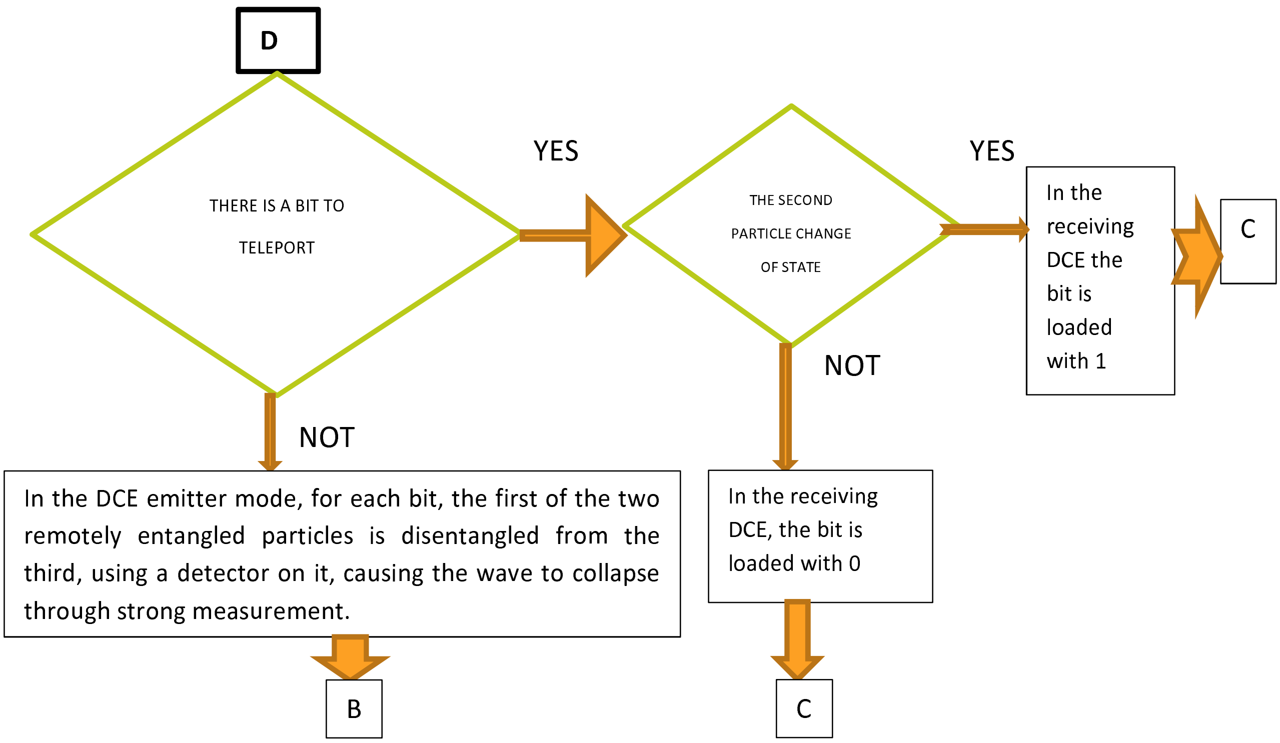
- Pair of synchronized DCE, one in transmitter mode and the other in receiver mode.

- At least a number of entangled particles between the emitter and the receiver equal to the number of bits to teleport a character

- In the DCE in receiver mode, for each quantum entanglement a detector on the second particle is necessary, acting very smoothly, to avoid the collapse of the wave and destroy the entanglement.







7. Problems

“In a quantum microwave communication transmission channel, due to a variety of unavoidable natural environment noises, the microwave quality coefficient of "quantum entangled state" will gradually decrease with the increase of microwave transmission channel distance, that is, with the gradual increase of microwave transmission distance, the mutual entanglement between two neutral particles will gradually degenerate, Therefore, the entanglement coefficient will gradually increase and the mass will decrease”. “No matter what kind of entanglement operation, decoherence is the biggest obstacle of entanglement operation”. Entanglement purification is an effective method to overcome environmental noise and decoherence: it can keep the logarithm of single entanglement high purity (1).

Because the tendency of entangled particles is to disentangle due to their interaction with their environment or when strongly measured, and because the no-cloning theorem states that quantum states cannot be copied, the stability of entanglement over time and long-distance communication are difficult. For these reasons, the particles are encapsulated minimizing their interaction with the environment, when necessary, very fine measurements are made and quantum repeaters are used. In any case, it is evident that we are facing technologies in their beginnings that should evolve a lot.

Particularly in relation to our proposal on the new bit-quantum entanglement communication technology, it is crucial to establish well that the permanence of the entanglement between particles 1 and 2, in the mathematical model presented in literal a) photons 1 and 2, once through measurement detects the state of photon 2 such measurement should be a very fine measurement that will not break the entanglement between particles 1 and 2 since it is essential to keep it to be able to teleport particle 3, photon 3, or not, in a new iteration according the procedure of literal b).

The scientific consensus is that in very weak even in weak measurements interactions with the measured particle is not enough to collapse a wave function while in a strong measurement the quantum entanglement is effectively cancelled. For example, using as source Quora: Namit Anand, starting a Ph.D. in Quantum Information and Computation at the University of Southern California and Sanjay Sood, physicist, Physics Encyclopedist, Microchip Engineer, Author.

Our proposal on the new bit-quantum entanglement communication technology requires excellent encapsulation that protects the particles from their interaction with the environment and ultrasensitive detectors.

8. Conclusions

• Quantum entanglement between particles allows instant teleportation of data violating local reality.

• It is proven that data can be teleported superluminally.

• The technique can be industrially implemented in classical or quantum computer since it changes bit-analog to bit-entanglement communication technology and it conserves at all any computer technology existing.

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