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Submarine Cable and Optical Fiber Communication: Perceived Alternative:

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ABSTRACT

A submarine communication cable is a cable laid on the seabed across land– based stationsto transmit telecommunication signals across the horizon of oceans and seas.It represents an invisible but essential infrastructure that permits all sorts of global communication. Presently, modern optical fiber cables are used to carry out transmission of communication signals in form of digital data like telephone, internet and private datatraffic. This study examines the advancement from the first submarine cables from initial transatlantic copper wire cable to the modern Optic fiber cables. It x-rays themerits and demerits on the use of early copper cables and Optic fiber cables. The misconception of satellite communicationbeing more important than submarine communication is discussed.

Subjects: *copper cable;optic fiber cables; satellite communication; submarine communication, merits of copper; merits of optic fiber cables*

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I. INTRODUCTION

Submarine communication is misconstrued as being less important than the satellite communication in the present dispensation. Meanwhile, about 95% of internationalcommunication trafficsare routedthrough submarinefiber optic cables (Lieonel carter etal, 2009).Since the advent of the first international submarine cable, a copper-based telegraph cable which was laid across the channel between the United Kingdom and France in 1850, the submarine telecommunication industry have transverse between countries and continents. From copper based telegraph, fiber optic cablehas becomethe pivot of the internet, transmitting approximately 99% of all data. There are more than 420 submarine cables in use and this transverse over 700,000 mile around the world. Presently the world demand for interconnectivity between theoffshore and mainland environments are putting pressure on energy and communicationcompanies to improve theirunderwater cables arepipeline networks to create an effective, continuous and reliable relay of communication energy resource (bacci, et.al, 2013).

The submarine communication cables caries the internet, financial transactions, international communications social media, news etc may people do not consider the value of these cables systems but ignoring than in a potential security threat. The laying of their submarine cable must follow some considerable procedures to accommodate other environmental and geographic settings.Due to possible risks, the positioning of the cable laying scenariosconstitutes a multi displinary approach. It must include the evaluation of cable or pipelinetechnicalfeatures like the minimum banding radius (Nonnis etal, 2016) the sea bed nature consisting of thegeomorphological structure of the substrate, the marine biodiversity and preservation. Tourism, fishing and aquaculture, maritime traffic must be considered before laying the submarine cable. Hence the laying routine must consider the hazardous points such as the navigation routes, anchorage area, routentries, and intensively trawled areas.

II. METHODOLOGY.

Systemic and logical analysis of scholarly works and industrial reports were adopted in this work. Analysis of experimental trials by scholars and captains of industries on submarine optical fiber communication formed the basis of the study.

COPPER SUBMARINE CABLES:

The first submarine cable used for telecommunication in the simply copper cables coated with gutta-percha. There was no other protection and invariably it wasn't successful (Richardson 1968). This serves obviously as an experiment and theconsolidated, protected core was later laid which serves as the telegraph cables. Crude means of laying these cables made some attempts to lay this cable across a long distance unsuccessful.The copper cables were sealed in an outer layer of iron and subsequently steel wire. Indian rubber used to wrap it followed by gutta-percha and they surrounded the multi stranded copper wire at the core.This arrangement creates a high dielectric constant and invariably produces a high capacitance of thecable; this was reduced by using polyethylene’s an insulator (Burnett et al, 2014). This copper cables and the insulation are also subject to attack by sea life, the insulator can be affected and the hemp lay within the still wire armoring creates a channel for pests to eat in.Other problem of shark eating up the cable insulators and whale interference with the cable line and entangles its tail on the cable loops.

Copper cable and its attendant insulation has its electrical problems- the band width it problems.There is no inline repeater amplifier in the copper cable prompting the passage of large voltages which is meant to overcome electrical resistance.The distributed capacitance and inductance joined to contort the telegraph pulses in the copper cable line thereby reducing the bandwidth and critically restricting the data rate. There is electric signal retardation passing through insulated copper wire or core laid underground and thesewere attributed to by induction.The copper wire or core performs the function of the capacitor distributed along the cable length working in tandem of the resistance and inductance of the cable,impedes the speed at which a signal travels through the conductor of the cable.

Advantages ofcopper cables used as submarine cable, lies on the cost and weight. With the advent of optic fiber cable, the specific advantage of copper cables above the opticcounterpart is the cost. Copper cables are less expensive than optic fiber cable.The weight of the copper cable is also an advantage inburying the cables, high pressure waterjets from nozzle are used, the water causes the seabedto become fluidized and the cable will sink down in the slurry.Empirical evidence frommanufacturers shows that lighter cables do not sink sufficiently fast and as such donot reach the required laying depth.Laying on the seabed is fast and less expensive but exposes the submarine cables to tidal currents.With the weight of copper cables, it can position easily on the fluidized seabed and can reduce movement displacement by tidal seabed currents (Teh, et.al, 2006).

OPTIC FIBER CABLES:

The advent of optic fiber cable brought a new dimension in the telecommunication industry.It is a core and cladding layer designed for inner total reflection due to the variance in the opticalreflective index between the core and the cladding layer. The optical fiber repeaters works with a solid-state optical amplifier whichexcites a short length of doped fiber which also function as a laser amplifier. The optic fiber system allows wave length-divisionmultiplexing which subsequently increases the capacity of the optical fiber.In submarine cables,optical fiber cables are used for itsclarity, following runs above 120 kilometers between repeaters to reduce the number of amplifiers and the distortion they cause.There is a similarity between copper cable and fiber optics but they differ is thatfiber optics make use of light pulses to transmit information down fiber lines instead of using electronic pulse as seen in copper cables.The three types of fiber optic cable commonly used (single mode, multimode andplastic opticalfiber) function as alight guide, tele guiding thelight introduced at one of the cables to the other end. Thislight source can be LED or laser.

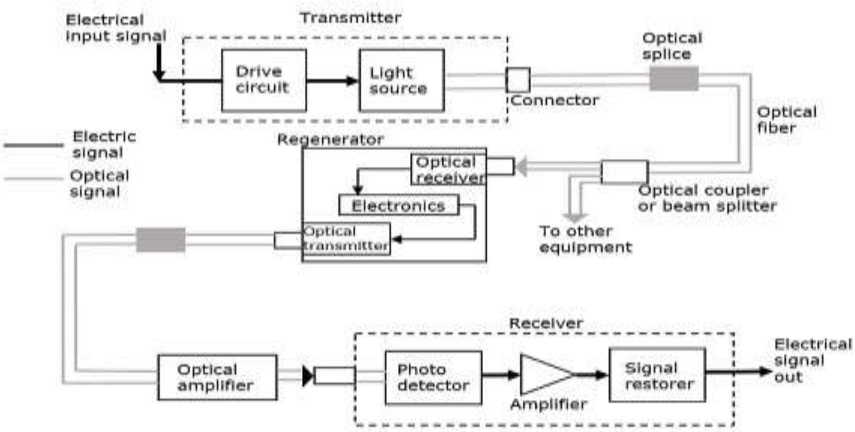

Diagram here

The fiber optics is one of the major building blocks intelecommunication infrastructure. The high bandwidth capabilities and low attenuationattributes makes it very good for gigabit transmission and beyond. The basicprinciple lies in the understanding of the optical parameter which is the refractive index. This is the ratio of the speed of light in a vacuum to that in matter which is the index of refraction of the material.

- n = / frac { c} {v}

c = the speed of higher fiber space = $3x10^8$m/s

$v_=$ thespeedof light in di-electric or non-conducting material.

In optic fiber communication,for a travelling height ray, reflection can only occur when $n_2 < n$.

Optical fiber has a lot of advantages to the earlier used copper cables.

1. Its transmissionbandwidth is higher than copper or metal cables
2. It carrieslarge data transmission
3. The power loss is very low and can be useful in long distance transmission
4. It avails high security andcannot be tapped. This makes it a good submarine communication cables.
5. It remains a better moresecure means of data transmission.
6. There is little or noelectromagnetic interference when using optic fiber cables
7. The cable is not affected in electrical noise.
8. The capacity of the cables is much higher than the copper cables
9. Thecapacity of higher but thesize does not increase as seen in copper cables
10. Optic fiber cables occupy less space and has less weight than the copper cables

Opticfiber cables are di–electric and there is highabsence of spark hazards.Due to feasibility of the fiber optic cable, they are easily bent and are more resistant to corrosions when compared to copper cables.Glass is the raw material for fiber cable and is cheaper than copper cables.

APPLICATION OF OPTIC FIBER CABLE.

Despite its high cost in terms of installation, increasing number of repeaters withincreasing distance and its fragility since it must be enclosed as insulated plasticsheath:optic fiber cable has very useful application in telephone system, sub- marine cable network, CATV system and data link for computer network. It is used in CCTV surveillance cameras. There other industrial uses and in heavy duty construction.

SUBMARINE USE OF OPTICAL FIBER CABLE

Optical fiber has low loss characteristic and this can be used as an edge in submarine optical fiber cable. Up to 50km length of cable can be used without repeaters/(Kojima &Yabutaet.al, 1982)

The level of water can be up to 1500 meter. Astructure oftorgueless armoring cable with a decreased cable elongation under tension can beused to achieve this since breaking elongation is very small.

More than 10 kmfield test can be achieved using this submarine optical fiber.

Optical average loss is small as seen below

Power loss;

The power loss through the transmission line is proportional to thecurrent

$P_{loss} = |^2 R$

The approximation for small voltage andresistance drops.

Looking at the line loss we have

$P=3(|^2 x R)$

When anelectromagneticwave travels down a transmission line andencounters a mismatchedload ordiscontinuity in the line,part of the incident power in reflected back down the line. The return loss is define as

$P_{return} = 10_{Log10}\, p/p_r$

$P_{return} = 20_{Log10}\, 1/_{\square}$

Mismatch power loss;

The mismatch loss is used to describe the loss caused by reflection due to a mismatched line.

Given as:

$P_{mismatch} = 10_{Log10}\, p1/(p_1 - p_r)$

Calculating the efficiency ŋ =

$$\frac{\text{Input} - \text{loss} \times 100\%}{\text{Input power}}$$

$$= \frac{P_s - \text{loss}}{P_s} \times 100\%$$

$= (P_s - \text{loss})$
$(P_s - P_s) \quad 100\%$

$= (1 - \text{loss}) \times 100\%$
P_s

Applying these in the lossencountered inoptic fiber transmissionline shown that low loss and hightransmission capacity can be achieved with large volume of data transmitted.

According to Kojima,etal. (1982), the average loss for high mode fibers was 0.72dB/km, multimode fibers was 0.81Db/km for a 10.2 km long cable operated at 1.3 micron wave length.

The values above shows that low loss and high transmission capacity can be achieved in submarine optical fiber. Thedesign objective of the optic fiber cable will follow the consideration of the tension,fiber breaking elongation bending radiusand water depth expressed as

$$\varepsilon \text{-} \frac{Sph}{\beta e}$$

Where ε = cableelongation, h= water depth, p = tension member density in water, S = coefficient connected with laying and recovery; β = correct coefficient of tensile strength rigidity and ε = young moduleLooking at the equation; the elongation of the cash can be decreased when the tension member is smalland the young module tension member is big. The bending strainεm is given by

$\varepsilon m = b/R$

R is the bending radius whileb is the distance from the neutral axis

The tensile strengthnecessary for the opticfiber cable from recovery frommaximum water depth is - T=SWh.

Where W is the cable weight in water

The elongation characteristic of the opticfiber cable is very important in considering the cable elongation under tension.This is often seen inarmored cable and is very important submarinecommunication cable. The elongation of the cables must be decreased and the elongation that is caused by rewind rotation should be eliminated. To achievethis, torque lessarmoringwill be used. By this, two armoring wire layers will be stranded in reverse direction.

The pitches are closer so that torsontorgues N, (Inner lager) andN_2 (outer layer) will be equal

This is given when elongation values for both N_1 andN_2 areassumed to be the same (Yobutaetal, 1979)

This is given by

$$\frac{P_1/D_1}{P2/d2} - \frac{E_1 D_1 N_1 d^2/_1}{E_2 D_2 n_2 d^2/_2}$$

Where P. the armoring wirestrand, D is thestrandPitchdiameter, N is the number of armoring wires d is the armoring wire diameter,

E is young modulus for the armoring wire.Index 1 &2shows the liner and outer layer.

This configuration of the elongation gives the opticfiber an advantage in submarinelayingdespite the cost.The bandwidth of the opticfiber cable is an addedadvantage for submarine optic cable.There is a sound perspective that optical fiber cable hasincredible capabilities and low attenuation advantage which makes it a better channel for gigabit transmission andbeyond (Massa, 2000).Due to low attenuation and greater signalintegrity of optic fiber cable, it allows longer interval of signal transmission. Its large bandwidth, light weight andsmaller diametermake it an essential toolto transmit information over 100 kmwith no active or passive processing.

ALTERNATIVE TO FIBER OPTICAL CABLE

It is possible to use dense wave divisionmultiplexing (DWDM) which is an open–air transmission technology to increase network capacity in environment where optical fiber–connection areimpractical.This is anopen air optical or fibreless optical transmission. This technology is similar to microwaves data transmissiontechnology but it makes use of light instead of radio waves to transmit voice and data signals.This system uses laser, amplifierandreceivers.Wave length division multiplexing (WDM)technologyis the basis onto which optical fiber network operates. Itemploys more than one light source and detector operating in different wavelengths that simultaneously transmit signals through the same fiber while maintaining the massage integrity of each signal.

WDM use couples to confine the signals on the same fiber. The couplers may bemultiplexerthat input several light source together or de multiplexer–divides onelight source into many according to theconfiguration used at the input and output.Using DWDM technology, a wireless optical network places the wavelengths close to each other enabling larger number of wavelengths hence transmission capacities of the system is increased.The different in DWDM and WDM is the number of channels used. This technology is very interesting in its transmission and operating characteristics but its effectiveness is only for point to pointtransmission since it cannot be used as a network hub.

A ship that entered Kenyan port city of Mombasa wandered into a restricted area and dropped its anchor, and inadvertently severing a major undersea internet and phone link to East Africa (Dillow, 2012). This type of incident happens from time to time but avoiding this situation is still at large since alternative to opticfiber cable is still a mirage.The world that is increasingly wireless is still wired by optic fiber. Isn't there alternative way to connect the globe?Theamazing indispensable nature of optic fiber technology lies on its ability to deliverplausible quantum leaps. The ideato replace these optical fiber cables withany other kind of through–air technology is very tempting but for clarity,durabilityand foreseeablefuture we are tied with fiberoptics.

Recently, the volume of data in communication requires very wide spectrum of frequencies(Sirbu, 2019).To achievewide spectrum of frequencies, we have to get into a very high–frequency electromagnetic wave. Light waves are of vary very high – frequency, but this fades in fog or in rain and therefore will not really be used to a satellite and back.Itcannot even go long distance on the ground.Wecan channel those highlight frequency signals into the optical fiber since the optical fiber isextremely transparent. Signals don't fade over distance and there is no atmospheric interference with the signals, by this the integrity is maintained whether travelling in the room or pacific. This is wherefiber optic creates substantial quantum leaps forward. Withthis, 40 to 100gigabits per second can be achieved. New system of channeling light signals to implementing lenses referredto as time telescopes can manipulate the light impulses and this could potentially keep the optic fiber capacity to grow at a rapid pace for a foreseeable future.

III. CONCLUSION

Analyzing the capabilities of optic fibercable, thelarge bandwidth, large volume of data transmitted and low loss, there is simply no practical viable alternative to the world'scritical submarine optical fiber cable infrastructure.Satellite cannot be an alternation since it will not complete with the required capacity, performance, availability securityand cost point of existing high–speed optical network, overland and submarine.This scenario means that we must continually innovate to increase the information–carrying capacity of these networks of opticalfiber of intercontinental connectivity.

Operating on the basis of DWDM technology, which is a wireless optical network, is very impressive it places the wave length close to transmission capabilities.Unfortunately itstransmission and operating characteristics is for point–to–point transmission, it cannot be used as a network hub.

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