Effect of Rain Fade in Satellite Communication: Making Sense from Knowledge Management Concept

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ABSTRACT :- *This paper considered knowledge management (KM) concept as an effective tool in addressing rain-fade in satellite communication. KMset goals by applying innovative steps of processes towards optimization in communication transmission, with little or no signal loss in reception at the receiving end. One of the problems faced by the satellite communication is rain fade; responsible for distortion phenomenon in signals being propagated at KU band during rain and droplet precipitation. It results in scattering and absorption of downlink signals. The research adopted KM concept for data learning to produce meaningful information for knowledge sharing. While also considering the implication of knowledge sharing in addressing the effect of rain fade such as site diversity and power density in satellite broadcasting.*

KEYWORDS *-Knowledge Management - KM, Rain Fade, Attenuation and KU band*

I. Introduction

Knowledge management is the interaction between people, process and technology, that is, the way knowledge is being applied by people of any race using a proven technology process. Knowledge is an organized data, the process of converting this raw information into knowledge is called knowledge management strategies [1]. Data in its raw state has no meaning until it is processed which now defines knowledge as understanding gained from the interpretation of data [2]. Knowledge management stems from the creation of information by using different information gathering mechanisms such as use of experiments, observations, insights, questionnaires, surveys, interviews, and use of focus groups. The information created are then stored, which could be retrieved, transferred and applied for use at a later date in the future [3]. The application of this stored information is knowledge, knowledge management therefore is the processes involved in gathering, storing, and using this information to achieve good results. The possible contribution of KM can promote efficiency of data transmission as a knowledge evolution.

Satellite communication is the use of satellite stationed in the space to send data or messages from geostationary base stations from one to another. The means of communication between these satellites and the substations is the line-of-sight architecture (LOS). Satellite communication use the very high frequency range of 1-75GHz to transmit and receive signals. The frequency ranges or bands are designated from low to high frequency L, S, C, X, Ku, Ka, and V band. Where L (1-2 GHz), S (2-4 GHz), and C (4-8 GHz) bands are in the lower range and are transmitted with low power, X (8-12 GHz), Ku (12-18 GHz), Ka (26.5-40 GHz), and V (40-75 GHz) bands are in the higher end of this spectrum, they require more power for transmission. Usually, frequencies above 10 GHz, when used in the transmission of signals

get attenuated by rain in a phenomenon known as rain fade [4]. This rain fade occurs when the diameter of the rain cell equals the wave length of the signal, then the signal gets absorbed by the rain. Rain orientation is such that it could be oblate spheroid in shape or simply spherical in shape, these orientations are dependent on the climatic condition associated with the location. At higher frequencies such as the Ku band and above, the signals become more focused therefore having shorter wavelengths, with this knowledge realization, a mitigating technique can be put in place to avoid data loss during transmission.

II. Mitigating Techniques and use of Technology

Some mitigating techniques and the technology include;

Space diversity: sufficiently separated multiple antennas technology are used to implement independent wireless channels. This technique involves installing another (diversity) antenna below the primary antenna at a

given location which allows switching from the primary antenna when fading occurs to the diversity antenna [5].

Time diversity: same information is repeatedly transmitted at sufficiently separate instances of time. Another method that can be used in achieving this is by adding a redundant forward error correction code to the message and spreading it in time by means of bit-interleaving before transmission.

Frequency diversity: same information is repeatedly transmitted at sufficiently separated frequency bands. This is done by using frequency domain separation of propagation factors which is easily achieved because at different frequencies, different types of attenuation occur. The necessary frequency separation is then achieved by filtering.

Power control: Power control is when the transmitting power of the satellite link is varied, that is, either increasing or decreasing the power level, in the presence of path attenuation, to maintain a desired power level at the receiver. This technology comprises of a ground-to-satellite emitter, High-power Amplifier and a control capable of adjusting the operating point of the High-power Amplifier in the presence of fading.

III. Tacit / Explicit Knowledge and Communication System

Knowledge can be considered to be tacit or explicit [6]. Tacit knowledge is the knowledge formed by an individual perspective, examples: ability to recognize a face among crowd, riding a bicycle, and learning to speak a language. Tacit knowledge is soft knowledge which cannot be documented but resides in the mind of the beholder and its use depends on the context to which it is applied. Explicit knowledge on the other hand is the written knowledge, on paper [7]. It is also known as hard knowledge; its range of use is independent on the context. Examples include manuals or instruction books on how to operate a machine. Nonaka and Takeuchi [8] explained the four steps in knowledge transformation as;

Socialization (tacit-tacit): this is knowledge creation through exchange of tacit knowledge by socialization, that is, face-to-face interaction by sharing experiences through verbal communication.

Externalization (tacit-explicit): this is when tacit knowledge is rationalized into models or concepts to offer a valid extract in a visible form which can be documented for record purposes.

Combination (explicit-explicit): this is arranging and sorting of explicit knowledge systems to form a well-organized set of knowledge. Although, no new knowledge is formed but only a refined improvement is made on already available knowledge.

Internalization (explicit-tacit): this results when technical intellect is internalized. That is, gaining experiences through learning, thereby increasing one's own existing tacit knowledge.

According to [6], people's aspect is to come together to create a knowledge sharing environment using the process of managing the knowledge among employees, whereas technology gives the forum to communicate and share the knowledge acquired.

There are great benefits when knowledge management is employed to any technological procedures, amongst which are, identifying weak links and using available knowledge base to rectify such. Providing properly documented expertise knowledge for use when needed (explicit knowledge). It also helps in having proper documentation of a technology process should in case such technology is to be used in the future, in other words knowledge retention. [9]

IV. Mitigating Against Rain Fade Effect on Broadcasting Satellites

Satellites are used for broadcasting services which include radio/television services and mobile broadcasting services. DTH (Direct-to-home), or satellite television, services (such as the DirecTV and DISH Network services in the United States and DSTV in Africa) are received by the consumers in their various homes. Satellites are also used in delivering programs to cell and smart phones and other mobile devices, such as personal digital assistants (PDAs) and laptops.

Due to high and increasing demands on satellite communication over the years, there is need to allocate higher frequencies to this innovation to cater for the increasing demands such as tracking, monitoring, mobile communication, and telephoning. C band (4 GHz/8 GHz) which is the first frequency band is allocated for reception of satellite television programs [10], Ku band (10/14 GHz), the Ka band (20/30 GHz) was brought

about for the need to have more frequency band for growing satellite applications and the V band (40/50 GHz) which is current frequency bands [11].

Staggering benefits of satellite communication makes it impossible to ignore the increasing technology, especially in the area of information technology and its wide contribution in the society. Some of these benefits include, long distance education also known as online education or Tele-Education, broadcastingentertainment - broadcasting of programs via satellite offers a wide varieties of entertainment to viewers [12], telephoning services to underdeveloped areas which lack terrestrial communication services, and a high level of security in the military sector, that is, by providing a wide and secure communications network coverage.

The downside to satellite communication could be expressed in term of signal attenuation. As a result of using higher frequency, the signals become more focused having shorter wavelength thereby getting distorted by atmospheric disturbances, especially signals at 10 GHz and above.

Factors affecting the reception of signals in the KU band include: i. interference - temporary loss of signal ii. low signal strength or coverage iii. signal obstructions iv. weather conditions (rain).

In tropical or rainfall regions various means of rain fading effect are;

Absorption: Absorption occurs when water molecules in a rain droplet absorb parts or all of the signal energy of the passing radio wave. With shorter wavelength, there will be more interaction between the radio wave and water molecules, leading to increased energy losses thus rain fading effect [4].

Reflection: this happens when the signal becomes re-radiated when it encounters a smooth surface medium, in this case rain drop cell.

Refraction: refraction occurs when signal travels through one medium to another especially when both media have different refractive indices. The refractive index of water is dependent on both temperature and frequency.

Scattering: While scattering on the other hand is a physical process caused by either refraction or diffraction of radio wave, in which there is a deviation of the radio wave from the original path as it passes through a medium containing raindrops.

Polarization: directivity of scattering depends on polarization and the size of the rain spheres. There are two types; vertical and horizontal. Vertical polarization results in isotropic scattering (in all directions) while horizontal polarization results in scattering at 90 degrees' angle.

V. Mitigating Rain Fade Effect: Making Sense from KM

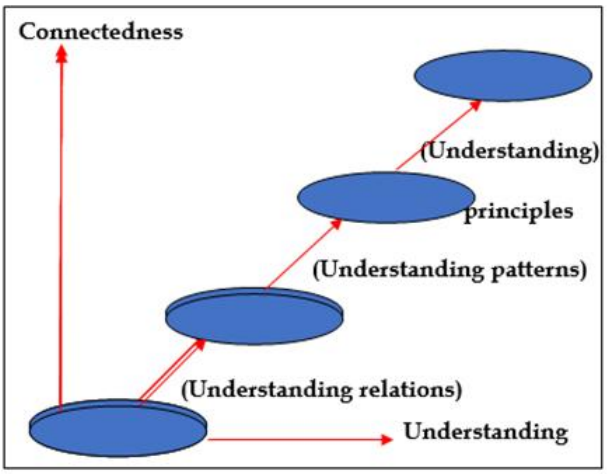

Figure 1: Intellect Transition [10]

Knowledge management application to rain fade can be illustrated using the figure 1 above using the following steps:

Forming communities of practice (COPs): this is the coming together of people with common interest, skills and experience for the purpose of knowledge sharing.

Creation and utilization of knowledge database: forming of data base is the next step in intellect transition. The data to be used are then acquired from various sources and then stored in a databank to be used later.

Incorporation of lessons learnt into strategies: experiences gained from errors in the execution of the project are then put into use on subsequent projects, that is, the lessons learnt are incorporated into later projects for better practices.
Brainstorming sessions: this is process of providing different solutions to a problem in other words, stretching ideas to limits, to produce a shared mentalmodel to be adopted s best practice
Knowledge mapping: providing a network of methodical accessibility of knowledge to employees.
Performing knowledge audit: this is the examination of the available knowledge resources, its flow and use.

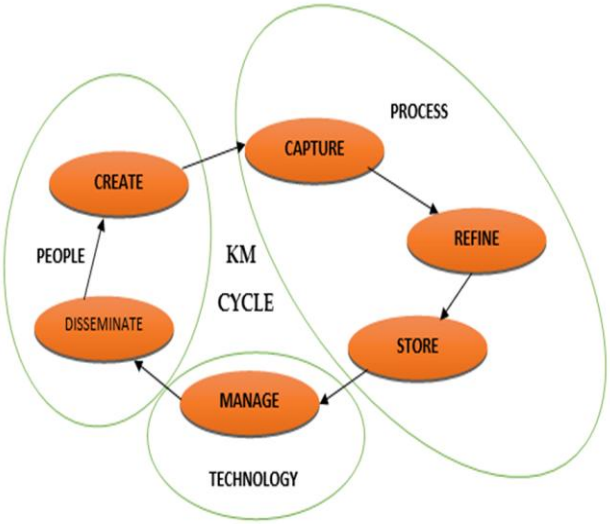

Figure 2: Knowledge Management Cycle

Fig. 2 depicts the process of information collection**.** Data collection is the first step to achieve this goal. Usually consumers and providers of the broadcasting services should be contacted and interviewed to reason out a solution to any problem. This can be done using a number of methods; questionnaire (survey), one on one discussion. Questions could attempt to seek answers to the following conditions, if they occur:

i. How often does this phenomenon occur?

ii. Does it result in a total signal loss?

iii. What dish size is being used?

iv. Was it heavy rain or drizzles when the signal faded?

v. What is the rain cell size during the fading?

vi. How lasting is the fading occurrence?

vii. Would you rather it didn't occur or would you rather wait patiently to rectify itself?

The collection of these data should be carried out by meeting with consumers of this the particular service to ask them the questions that would be needed to proffer solution to this rain fade problem. This stage is also known as requirement gathering, as the answers to the question are gotten by talkingto the experts who gives accurate steps to take in mitigating the rain fade phenomenon

VI. Implementation

Storage: the first stage in this phase is the storage stage or analyzing stage. The given requirements are analyzed to ensure they answer the given problem. This is done by calling on the people with enough experience and knowledge who will then assist in checking and rechecking of the requirements sorted out and

transfer them to the appropriate quarters for further review. These data are stored for future references, they could be saved in an external hard disk or cloud box so as to keep them from being corrupted and tampered with.

Transfer: the process of transfer is to get these data to the coding experts for them to work with. Data can be transferred irrespective of the distance, that is, distance is no barrier for transferring of data from one point to another.

Knowledge application: on application of the solution to the problem that makes it knowledge, that is data collected from the scrap, analyzed to make tangible information and then applied as knowledge to solve the problem.

VII. Conclusion

Knowledge management concept can be applied to every aspect of life to solve practical problems involving people, processes and technology. It ensures continuity of ideas, information and technical know-how, by extracting these ideas in form of data, processing it by turning it to useful information and better technological innovation. As explained in this research work, knowledge management was deplored to study problems of rain fade effect on satellite communication and considered other mitigating factors in the communication industry and other sectors using satellite to propagate signals. Solutions such as site diversity and power could be suggestion to address rain fade against satellite propagated signals.

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