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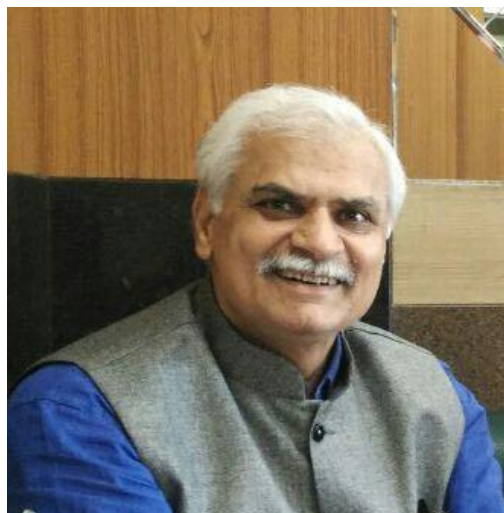
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<u>MESSAGE AND NOTE THROUGH DESK</u>

[A]. Mentor - Prof. (Dr). R.K. Khandal

Prof. Dr. R. K. Khandal

Brief Profile:

a. Prof. Dr. R.K. Khandal Is the President, R&D and Business Development at India Glycols Limited, a well renowned and one of its kind companies in the world manufacturing Surfactants from sugarcane molasses. Former Vice Chancellor, Uttar Pradesh Technical University, Lucknow, a Fellow of the Royal Society of Chemistry, London

b. Unanimously elected President of WAITRO (World Association of Industrial & Tech. Organizations), a UN body, 2010-2012 and 2012-2014

c. Expert member of High-level Committees of Govt. of India:

    i.   Ministry of Science and Technology
    ii.   Ministry of Child and Women Welfare
    iii.   Ministry of Food Processing Industries
    iv.   Recruitment and Appraisal committees of CSIR, DRDO etc.

d. Guided 30 PhD's from 10 Universities. 15 International Patents published 118 research papers in peer reviewed journals, five books and two edited.

e. He has received several awards; prestigious ones include:
    i.   INSME (International award for innovation);
    ii.   R.N. Bangur Memorial award for novel technologies;
    iii.   R.G. Deshpande award for popularizing Radiation processing technology;

    iv.   U.P. Ratna Award, 2014 for Transforming Technical Education in U.P.

    v.   Rajasthan Samman Award, 2015 from Rajasthan Associations;

    vi.   Meri Dilli award, 2010 for improving the living standards of citizens of Delhi

    vii.   Srishti awards for green technologies, waste management etc.

    viii.   Amity Academic Excellence award for pioneering research and academics

    ix.   AMAR UJALA Excellence Award for outstanding contribution to education

    x.   Life time achievement award by World Environment Congress in food preservation, safety, environment protection and renewable energy,

    xi.   Eminent Engineers Award by Institutions of Engineers, India

    xii.   Academic Excellence Award from Engineering Watch, India, in Singapore,

Growth Path:

a. Born on September 6, 1957, he started his career in 1982, as a **lecturer in Indian School of Mines, Dhanbad** at a very young age of less than 25 years.

b. In 1985, joined as a **Group leader in a UNIDO project of Govt. of India.** Post-Doctoral research` ~ 1 year in England and 2 years in France.

c. On return from France in 1991, joined as **Manager, ICI Specialty chemicals**, an MNC and worked for developing Technologies for specialty chemicals.

d. In 1993, joined **India Glycols Limited as General Manager.** Managed team of R&D and Production for 8 years to for new products for growth of the Company.

e. From 2001 to 2012, as the **Director, Shriram Institute, Delhi** established as a leader par excellence. Developed and established a self-sustainability model.

f. **DURING 2012 – 2015, AS THE** VICE CHANCELLOR OF UTTAR PRADESH TECHNICAL UNIVERSITY, **TRANSFORMED THE UNIVERSITY INTO AN INNOVATION UNIVERSITY**.

g. 2015 onwards, Prof. Khandal is, the **President, R&D and Business Development, India Glycols Limited,** a global supplier of Green performance chemicals

h. Prof. Khandal has been associated with leading private universities and institutions as a mentor

Virtues:

Prof. Khandal is a person of eminence with unique expertise and capabilities; a rare profile covering 360̊ research and innovation cycle in career: as an Academician and a Researcher (Govt. and Pvt.). He knows how to convert challenges into opportunities.

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[B]. Patron - in - Chief: – Prof. S.K. Singh

He is serving the nation in the field of science & technology. He has completed his graduation degree in Engineering in Electronics & Communication Engineering, from B.I.T. Sindri, in 1986 and postgraduate in Business Management from X.L.R.I. Jamshedpur, in 2004.

He has 30 years of wide experience in applied Research, Product Development and Program Management besides developing algorithms and their implementation for real-time embedded applications for signal processing in technologies like Software Defined Radio, Digital Subscriber Line, Cable Modem, Meteor Burst Communications and Satellite communications.

Background Highlights:-

- 1986 - 1997, Defence Research & Development Organization (D.R.D.O.) as Scientist

- 1997 - 2006, As Engineering Manager / Program Manager in Multinationals like, Freescale Semiconductor, Ishoni Networks, General Electric Plessey etc.

- 2006 - 2008: Cofounded a Telecom Company Hertz Tele Networks Pvt. Ltd

- 2008 - 2010: Director: Genesis Futuristic Technology Ltd, Noida

- 2010 till date: Founded many organizations till date.

- He had Co-authored a paper on the issue of inter modulation products for D.S.P. based Modulators in 2nd International Symposium on "D.S.P. for Communication Systems" held at Adelaide in 2004. D.S.P. based Modulators: Problems and Solutions.

Message from the Patron - in - Chief's Desk: -

"SANKALAN: - The Journal of Science, Technology & Humanities" (I.S.S.N. Online: - 2455 - 3557) is a Journal started with a goal to publish innovative ideas which proposes value in creating technologies for tomorrow and solving problems of today right from concept to implementation.

This Journal will try to set an example for extending opportunities to scholars of different field to publish their papers with ethics and honesty. I wish a grand success to all the stakeholders of the Journal.

[C]. Executive Editor / Publisher: - Rahul Rai

He is working as Deputy Registrar at B.I.T. Mesra, Ranchi, Jharkhand. His areas of interest are Analytics, Marketing & Entrepreneurship. He is M.B.A with Distinction Marks from B.I.T.S., Pilani, Rajasthan and B.Tech with Distinction in IT and Management. He has 06 years of industrial experience in Analytics and Research industry.

Background Highlights: -

- Worked as Academic Associate in Department of Management, B.I.T.S., Pilani, Rajasthan
- Qualified All India Level: - U.G.C. National Eligibility Test – Junior Research Fellowship (U.G.C. – N.E.T – J.R.F.) in Management in the year 2013
- Diverse Experience in various domain like Banking, Retail, Media & Marketing
- Awarded Many Prizes and appreciations in the career in several fields till date
- Organized & Participated in several seminars and events till date

Note from the Publisher / Executive Editor's Desk: -

Wishing you all a great year ahead!!!

Firstly, I will pay my gratitude to Almighty, my parents and all well-wishers with whose blessings and support we are able to start this journal "**SANKALAN:-The Journal of Science, Technology and Humanities",** (I.S.S.N. Online: - 2455 - 3557) We have started this journal publication for publishing new findings on Science, Technology and Humanities.

I hope this initiative will bring great value for academicians, researchers, students and all those who are involved in Research & Development work. We do have a highly reputed pool of advisory board members from well renowned universities, who help us in keeping high benchmark for quality and originality of our publications. Hence, I am confident that our mission to be the leading Research Journal in field of science, technology and humanities will very soon become true.

I hope very soon Buxar- Land of Rishi Vishwamitra; will soon become educational hub of Bihar.

[D]. <u>Editor - in - Chief: - Rishabh Rai</u>

He is the Editor in Chief of this Journal and working as a P.G.T. Physics and Mathematics in Carmel School, Churamanpur, Buxar, Bihar. His areas of interest are the domains of Electronics and Communication Engineering and Physics, Chemistry & Mathematics. He is M.Tech in V.L.S.I. Design specialization with Distinction Marks & B.Tech in Electronics & Telecommunication Engineering with Honours. Further, he is B.Ed. in Science stream with first class.

<u>Background Highlights: -</u>

- Awarded as the Best Innovative teacher of the year award by ISRO & NASA Delegates in the international level conference at Chandigarh, India on 29.09.2019
- Appreciated by the Govt. of India, Govt. of Bihar & Govt. of Jharkhand for the quality publication of the Journal – Sankalan: - The Journal of Science, Technology & Humanities (e - ISSN - 2455-3557), in the year 2016, 2017 & 2018d
- Appreciated by Kyutec University, Japan and Amazon, an online shopping company for the outstanding publication of the book "Be the change for best always and make difference"
- Earned the respective academic degrees in the career till date i.e. (Class X^{th} to M.Tech.) with Distinction / Honours in aggregate
- Published 20 Technical / Research / Review / Study Papers in several National / International Conferences and Journals till date
- Authored many books, chapters in various publications till date
- Awarded Honorarium & Appreciated for the Paper Publication by A.K.G.E.C. International Journal of Technology in 2016
- Academic Excellence Award, for the academic performance in M.Tech. – (2013 – 2015)
- Academic Excellence Award, for the aggregate performance in B.Tech (2009 - 2013)
- I.E.E.E. National Merit Award – 2013, for the best Paper Presentation in National Conference - E.T.E.A.T – 2013
- Project Selection in the Sixth Science Conclave – 2013, at I.I.I.T Allahabad
- Amul Vidya Bhushan Award – 2009, for the academic excellence & performance in A.I.S.S.C.E. – 2009
- Awarded many awards (Winner), recognitions, appreciations at International, National, State, District, College & School Level in various academics and cultural (Solo Singing, Writing Books, Journals etc.) events till date

<u>Note from the Editor - in - Chief's Desk: -</u>

Firstly, I am thankful to god and grateful to my venerated parents, and all those whose blessings and constant encouragement have helped me to complete this work, i.e. compilation and finalizing of the current issue of the Journal, "**SANKALAN:-The Journal of Science, Technology and Humanities**", (I.S.S.N. Online: - 2455 - 3557). The papers must not be published, copied in parts or whole or accepted for publication anywhere else. For more information and ideas, one must visit the **"Quality & Plagiarism Check"** for such issues, as given in the website www.sankalan.org .

The entire article will must be double blind peer reviewed by our Advisory Board and will be thoroughly checked on the Plagiarism Software if selected, may be published by completing the copyright policies with the Journal. Lastly, I want to thank all the concerned authorities who are directly or indirectly related to our Journal, and must expect that their co-ordination and support are always valuable and required for us forever.

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OBJECTIVES:

❖ To develop and promote academic research activities on various contemporary techno-engineering issues and trends in management and humanities.

❖ To provide a platform to discuss the problems related to the technical as well as the managerial and research issues.

The most valuable and suggestive comments of all the readers are always awaited and welcomed in order to achieve the ultimate goal. We are looking forward for your contributions. All communications must be made only in electronic form e-mailed to:

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CONTACT:-

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CRISP VERSION OF THE SPECIAL ISSUE OF THE JOURNAL

STUDY ON SEVERAL SURFACE CELLULAR SPACE BAND

B Krishna Pal, Academician

Abstract—In this paper a review on the different types of the land mobile satellite channel is presented. We look at the various physical characteristics that influence communications in the land mobile satellite channel and then the different types of models derived for the land mobile satellite channel are discussed.

Index Terms— Communication channel modeling, Fading channels, Land mobile satellite channels, Satellite Communications

I.   INTRODUCTION

Satellite communication has found its place in practice and is implemented in numerous applications. Some of the more common implementations are Global Positioning Systems, satellite television and marine communications. The research field has attracted much attention due to the practical implementations for satellite communication. LMS communications forms an integral part of the satellite communications field and is therefore also an active research field. The LMS channel is a complex communications channel with many factors influencing the channel. We will now briefly look at the physical properties of the LMS channel and examine the impact the various factors have on a signal as it propagates from a transmitter to a receiver. The land mobile satellite channel can be partitioned into ionospheric effects, tropospheric effects and local effects:

Ionospheric effects involve the interaction between layers of charged particles around the Earth and the radio waves. It includes ionospheric refraction, Faraday rotation, group delay, dispersion and ionospheric scintillation.

Tropospheric effects involve the interaction between the lower layer of the Earth's atmosphere (including the air and hydrometeors such as rain) and the radio waves. It includes attenuation, rain attenuation, gaseous absorption, tropospheric refraction, tropospheric scintillation, depolarization and sky noise. Cross-polar discrimination, as defined in [ITU-R618-8], is negligible below 4GHz.

Local effects involve radio wave interaction with the features in the vicinity of the mobile terminal. The terrain, vegetation, buildings, other structures, and vehicles can all interact with the radio wave by the mechanisms of reflection, diffraction, transmission and scattering. The direct component, r1 or line of sight path (LOS) is subjected to all the ionospheric and tropospheric components listed above, in addition to free space loss (FSL), given by

$$FSL = 20 \log [4\pi d/ \lambda] \text{ dB}$$

Where, d is the distance between the satellite and mobile and λ is the wavelength.

At L and S bands, Faraday rotation in the ionosphere is significant, increasing with lower frequencies. For this reason, circularly polarized antennas are often used. When the LOS path is obstructed by trees, buildings, hills or other obstacles, large scale fading or shadowing occurs, and causes severe signal attenuation, which must be accounted for in the link budget.

The specular component r2 reaches the mobile by reflection from the ground. Its strength depends on the constitutive parameters and roughness of the ground. Since this ray normally arrives with a negative elevation, it is not always received by a directional terminal antenna [1]. The diffuse components (r3 and r4) account for the small scale fading in the received signal, which occurs due to the vector addition of reflections, diffractions and

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scattering from local objects. All the channel effects are multiplicative; however additive white Gaussian noise (AWGN) is also present in the system. For the majority of LMS channel models only free-space losses, shadowing and multi-path effects are taken into account, as these effects have the biggest impact on the received signal.

Communication channel modeling is a powerful tool to facilitate the design of communication systems. These models make it possible to simulate a communication system to observe the impact of physical characteristics on the channel. In this paper we will take a look at a few models available in the literature. In order to examine these models, we will group them into four groups and examine each of these groups. The four groups are:

• Analytical models

• Empirical models

• Statistical models

• Hybrid models

II. ANALYTICAL MODELS

According to [2], Ossana was the first to propose an analytical model for radio propagation. Shortly after Ossana's model, Gilbert [3] proposed and compared three analytical models and then Clarke [4] created his model based on one of Gilbert's models. A review of analytical models for terrestrial radio propagation are given in [2] for the interested reader. Dottling [5] proposed a ray-tracing based model for the LMS channel. The aim of this model was to create a model that would be able to model all the various aspects that impact the LMS channel and also be versatile enough to cover the whole frequency range of LMS communication. The resulting model consists of the following five main components:

• Orbit generator: Predicts the position of the satellite.

• Surroundings generator: A detailed description of the receiver's surroundings.

• 2D ray tracing model: A two-dimensional prediction of the propagation path.

• 3D scattering model: A detailed model to describe scattering over the geographical area.

• Stochastic model: This model modifies the ray tracing results to compensate for non-deterministic effects.

This model addresses numerous complex characteristics of the LMS channel and makes use of detailed representations of the real world in an effort to describe the LMS channel. A further extension to this model is presented in [6], where the ray-tracing model is extended to a 3D ray-tracing model. According to [6] the 3D ray-tracing model improves the model notably.

Another ray-tracing based model, proposed by Sofos [7], was created with the aim to be simple and computationally efficient. The model consists of 18 rays to model the propagation of the signal. In this section a discussion of the analytical models for the LMS channel were given. From this it can be seen that the advantage of analytical models is that they can describe a channel accurately and are also adaptable to different environments due to the underlying physical properties taken into account when deriving an analytical model. The disadvantages are that analytical models can be computationally intensive due to the complexity of the model. Another disadvantage is that the LMS channel's properties are not always known and must be approximated. These approximations can lead to inaccuracies in analytical models.

III. EMPIRICAL MODELS

Empirical models are models that are derived by studying measurements made in an LMS communication system. A model is then created by fitting a certain curve or curves to the measured data. This method has been used for

terrestrial radio propagation models such as the Okumura model and the Hata model.

We will now briefly look at some empirical models by classifying them into two groups and discussing each group.

- Vegetative attenuation models

- Link budget calculation models

A. VEGETATIVE ATTENUATION MODELS

Vegetative attenuation models only calculate the losses a of radio signal when propagating through tree cover and is therefore not a complete LMS channel model on their own, but is often incorporated into an LMS channel model for rural and suburban environments. A few important models derived for vegetative attenuation are:

- Modified Exponential Decay model [8]

- International Radio Consultative Committee (CCIR) model [9]

- Barts-Stutzman model [10]

- Goldhirsh and Vogel model [11]

B. LINK-BUDGET CALCULATION MODELS

Link-budget calculation models were developed to facilitate the design of communication systems by helping the designer to get an approximation of the losses a communication system will experience. A few link-budget models are:

- CCIR model

- Empirical Roadside Shadowing Model

- Modified Empirical Roadside Shadowing Model

- Combined Empirical Fading Model

- Urban Environment Model for High Elevation Angles

Empirical models have the advantage that they are computationally simple and can produce reasonably good approximations very quickly. The main disadvantage for empirical models is that they are not related to the physical characteristics of the channel and therefore does not handle changes to the environment well.

IV. STATISTICAL MODELS

Statistical models for terrestrial propagation have been derived as early as the 1960's with Clarke's model [4] and are therefore a well-defined method that has been studied in depth for a long time. An important contribution to statistical modelling for communication systems is Suzuki

[15] with his mixed distribution model and the Gilbert- Elliot [16] multistate model. The first statistical model for the LMS channel was developed by Loo [17] in 1985. Statistical models can be grouped into two groups are as follows –

A. FADING DISTRIBUTIONS

These types of models are derived for non-selective fading in LMS channels. Loo's model was the first model specifically for the LMS channel, but Suzuki's model was

the first model of this type and was derived for terrestrial propagation. A few of these models are as follows-

- Loo's model

- Rice-Lognormal models

- Hwang model

- Cavdar's model

B. STATE-ORIENTATED MODELING

Gilbert's model [16] was the first multi-state model for a communications channel and the multi-state models derived for the LMS channel are based on Gilbert's model. For these models Markov chains are used to choose between different states of the channel. For the LMS channel these states are usually connected to different fading distributions such lognormal, Rician, Rayleigh or even a mixture distribution as discussed in the previous section. Various multi-state models for the LMS channel are as follows-

1.   TWO-STATE MODEL

Lutz [18] derived a two-state Markov chain for the LMS channel from the Gilbert-Elliot model. Similar to Gilbert's model, Lutz's model had a "good" and a "bad" state. His two states were defined as a state where the LOS component is unobstructed and no shadowing is present and a state where severe shadowing is present. For the "good" state the received signal envelope is Rician distribution and for the "bad" state the envelope is modeled as a Rayleigh distribution. The model is seen as the base for state-orientated models for the LMS channel.

2.   THREE-STATE MODELS

Fontan [19], Karasawa [20] and Gillespie [21] derived three state Markov models for the LMS channel. For all three models the three states are defined as:

- LoS component is present ("good state")

- moderate fading ("intermediate state")

- severe fading conditions, no LOS component ("bad state")

The models differ on how each state influences the received signal. Fontan described all three states with Loo's model [24], while Karasawa described the "good" state with a Ricean distribution, the "intermediate" state with Loo's model and the "bad "state with a Rayleigh distribution.

3.   M-STATE MODELS

In this section we look at multi-state models with more than three states. Wakana [22], Dongya [23] and Ming [24] proposed five, six and five-state Markov chains respectively. Their models are all based on the Gilbert- Elliot model with two main states namely "good" or "bad". They then created sub-states for each of the main states to create higher resolution models. All three of them used Rayleigh distribution for their fading ("bad") states and Ricean statistics for their non-fading ("good") states. The difference in their models comes in with the number of sub-states selected for each main state and in the transition matrices for their models.

4.   MULTI-LEVEL MULTI-STATE MODELS

Multi-level multi-state Markov chain models are essentially made-up of separate Markov chains and the results of each of the chains are combined. Such a model is proposed by [25]. The model proposed here has two levels; a shadowing and a fading level. Each of these two levels are extendable to as many states as desired. The shadowing Markov chain uses lognormal distributions, while the fading chain uses Rayleigh distributions. The different states in each level use different parameters for their distributions to represent variations in fading and shadowing. Each of the two levels returns a value generated by their respective Markov chains and these two values are multiplied to generate an attenuation value for the signal strength.

V.   HYBRID MODELS

A.   ROADSIDE VEGETATION ATTENUATION MODEL

This model was proposed by Sofos [26] to simulate the attenuation due to trees in rural areas. The model was derived from measurements made at relatively low elevation angles (10°- 40°). The model is a combination of an empirical model and a statistical model.

B.   HIGH RESOLUTION SATELLITE-TO-INDOOR CHANNEL MODEL

The model discussed [27] is a high-resolution model with a deterministic part and a statistical part and is therefore a highly detailed and complex model. The deterministic model consists of five main components: scenario description, ray tracing and polarization tracking, electromagnetic modeling, generation of results and model validation and fine-tuning. The idea of the model is to perform each of the above steps for a scenario and then validate and fine-tune the results to fit the measured results. This process is then repeated for a wide range of scenarios, so that parameters can be determined and extracted and be used for statistical models. Statistical models are easier to use, if the parameters of the model are correctly identified.

C.   A DETERMINISTIC-STATISTICAL MODEL

This model, proposed by Li [28], combines statistical modeling and deterministic ray-tracing to model the LMS channel. The ray-tracing part of the model is done by making use of the Ergospace ray-tracing package. The model is defined by handling shadowing and fast-fading separately. For the shadowing part of the model two possible cases exist: the LoS case and the non-LoS case. For the LoS case the attenuation is modeled by the normal free-space attenuation equation and for the non-LoS case the shadowing is determined by ray-tracing. For the fast- fading part of the model both LoS and non- LoS is modeled by using Nakagami statistical distributions. The parameters for the Nakagami distributions are determined by making use of ray-tracing. This is another model that demonstrates the use of a combination of modeling techniques in an effort to accurately model the LMS channel.

VI.   CONCLUSION

From this paper we see that a great variety of methods have been presented to model the LMS channel. It is important to see that different models are developed for different applications. Some models were derived for specific operating frequencies or for specific elevation angles, while other models were developed for versatility. In some cases, a model was derived to be as accurate as possible, while other models were designed to be easy to use. The usefulness of statistical models often depends on the measured data available. We conclude that the application determines the choice and effectiveness of a model. In our future work we will select a channel model that will be used to model a satellite modem communication system. The knowledge gathered from this review will assist us in the process of selecting an appropriate model that will best fit our application.

VII.   REFERENCES

[1]   M. Karaliopoulos and F.-N. Pavlidou, "Modelling the land mobile satellite channel: a review," Electronics Communication Engineering Journal, vol. 11, no. 5, pp. 235 –248, oct 1999.

[2]   J. Parsons and A. Turkmani, "Characterization of mobile radio signals: model description," Communications, Speech and Vision, IEE Proceedings I, vol. 138, no. 6, pp. 549 –556, Dec. 1991.

[3]   E. Gilbert, "Energy reception for mobile radio," Bell Systems Technical Journal, vol. 44, pp. 1779–1803, 1965.

[4]   Clarke, "A statistical theory of mobile-radio reception," Bell System Technical Journal, vol. 47, pp. 957–1000, July 1968.

[5]   M. Dottling, H. Ernst, and W. Weisbeck, "A new wideband model for the land mobile satellite propagation channel," in Universal Personal Communications, 1998. ICUPC'98. IEEE 1998 International Conference on, vol. 1, oct 1998, pp. 647 – 651 vol.1.

[6]   M. Dottling, A. Jahn, and W. Weisbeck, "A comparison and verification of 2d and 3d ray tracing propagation. models for land mobile satellite communications," in Antennas and Propagation Society International Symposium, 2000. IEEE, vol. 1,2000, pp. 434 –437 vol.1.

[7] T. Sofos, I. Kotsiopoulos, and P. Constantinou, "A deterministic raytracing-based model for land mobile satellite channel in urban environment," in Vehicular Technology Conference, 1998. VTC 98. 48th IEEE, vol. 1, may 1998, pp. 658 –660 vol.1.

[8] M. Weiss Berger, "An initial critical summary of models for predicting the attenuation of radio waves by foliage," Electromagnetic Compatibility Centre, Annapolis, Md, USA, Tech. Rep., 1981.

[9]   "Influence of terrain irregularities and vegetation on tropospheric propagation," CCIR, Tech. Rep. 236-6, 1986.

[10]   R. Barts and W. Stutzman, "Modeling and simulation of mobile satellite propagation," Antennas and Propagation, IEEE Transactions on, vol. 40, no. 4, pp. 375 –382, apr 1992.

[11]   W. Vogel a d J. Goldhirsh, "Earth-satellite tree attenuation at 20 ghz: foliage effects," Electronics Letters, vol. 29, no. 18, pp. 1640 – 1641, sept. 1993.

[12]   W. Vogel and J. Goldhirsh, "Mobile satellite system propagation measurements at l-band using marecs-b2," Antennas and Propagation, IEEE Transactions on, vol. 38, no. 2, pp. 259 –264, feb 1990.

[13] S. Sforza, M. Buonomo and A. Martini, "Esa research activities in the field of channel modeling and simulation for land mobile satellite systems," in COST227, 1993.

[14]   A. Kanatas and P. Constantinou, "City center high- elevation angle propagation measurements at l band for land mobile satellite systems," Vehicular Technology, IEEE Transactions on, vol. 47, no. 3, pp. 1002 –1011, aug 1998.

[15]   H. Suzuki, "A statistical model for urban radio propagation," Communications, IEEE Transactions on, vol. 25, no. 7, pp. 673 – 680, jul 1977.

[16]   E. Elliot, "Estimates of error rates for codes on burst- noise channels" Bell Systems Technical Journal, vol. 42, pp. 1977–1997, September 1963.

[17]   C. Loo, "A statistical model for a land mobile satellite link," Vehicular Technology, IEEE Transactions on, vol. 34, no. 3, pp. 122 – 127, aug 1985.

[18]   E. Lutz, D. Cygan, M. Dippold, F. Dolainsky, and W. Papke, "The land mobile satellite communication channel-recording, statistics, and channel model," Vehicular Technology, IEEE Transactions on, vol. 40, no. 2, pp. 375 –386, may 1991.

[19]   F. Fontan, M. Vazquez-Castro, C. Cabado, J. Garcia, and E. Kubista, "Statistical modeling of the lms channel," Vehicular Technology, IEEE Transactions on, vol. 50, no. 6, pp. 1549 –1567, nov 2001.

[20] Y. Karasawa, K. Minamisono and T.Matsudo, "A propagation channel model for personal mobile satellite services," 1994.

[21] T. Gillespie and C. Robertson, "An improved Markova model for the urban sotm channel," in Military Communications Conference, 2008. MILCOM 2008.

IEEE, nov. 2008, pp. 1 –8.

[22] H. Wakana, "Propagation model for simulating shadowing and multipath fading in land-mobile satellite

channel," Electronics Letters, vol. 33, no. 23, pp. 1925

–1926, nov 1997.

[23]   S. Dongya, R. Jian, Y. Yihuai, Q. Yong, C. Hongliang, and F. Shigang, "The six-state markov model for land mobile satellite channels," in Microwave, Antenna, Propagation and EMC Technologies for Wireless Communications, 2005. MAPE 2005. IEEE International

Symposium on, vol. 2 aug 2005, pp. 1619 – 1622 Vol. 2.

[24]   H. Ming, S. Dongya, C. Yanni, X. Jie, Y. Dong, C. Jie, and L. Anxian, "A new five-state markov model for land mobile satellite channels," in Antennas, Propagation and EM Theory, 2008. ISAPE 2008. 8th International Symposium on, nov. 2008, pp. 1512 – 1515.

[25]   H. Lin and M. Tseng, "Two-level, multistate markov model for satellite propagation channels," Microwaves, Antennas and Propagation, IEE Proceedings -, vol. 151, no. 3, pp. 241 – 248, june 2004.

[26]   T. Sofos and P. Constantinou, "Propagation model for vegetation effects in terrestrial and satellite mobile systems," Antennas and Propagation, IEEE Transactions on, vol. 52, no. 7, pp. 1917 – 1920, july 2004.

[27]   F. Perez-Fontan, B. Sanmartin, A. Steingass, A. Lehner, J. Selva, E. Kubista, and B. Arbesser- Rastburg, "A high resolution model for the satellite-to- indoor channel," in Position Location and Navigation Symposium, 2004. PLANS 2004, april 2004, pp. 674 – 683.

[28]   X. Li, R. Vauzelle, Y. Pousset, F. Martinez, and P. Combeau, "A hybrid method for modeling satellite communication in urban environment," in Wireless Technology Conference, 2009. EuWIT 2009. European, sept. 2009, pp. 172 –175.

A NEW ERA IN WIRELESS TECHNOLOGY

Priyanka Kumari, Academician

Abstract—**The development of the broadband wireless access technologies in recent years was the result of growing demand for mobile internet and wireless multimedia applications. Through a common wide area radio access technology and flexible network architecture WiMAX and LTE has enabled convergence of mobile and fixed broadband network. The IEEE 802.16 working group has been developing a new amendment of IEEE 802.16 standard (i.e. IEEE 802.16m) as an advanced air interface to meet the requirements of International Telecommunication Union- Radio communications Sector (ITU-R)/IMT advance for 4G. 4G (LTE) mobile technology promises full mobility with higher data rates, low latency and greater spectral efficiency. The purpose of this paper is to provide an over view of different aspects of 4G which includes its features, its proposed architecture, key technology enablers and challenges faced.**

Index Terms — OFDMA: Orthogonal Frequency Division Multiplexing Access, MIMO: Multi Input Multi Output, LTE: Long Term Evolution, Wi-MAX: Worldwide Interoperability for Microwave Access, QoS: Quality of Service.

I. INTRODUCTION

Many were ignorant of what 1G, 2G or 3G stood for and all of a sudden a hike was found out amongst laymen so as to be knowledgeable about it. Still a number of people are unaware of 1G or 2G when the world has moved on to 4G. The telecommunication service in World had a great leap within a last few year. 6 billion people own mobile phones so we are going to analyze the various generations of cellular systems as studied in the evolution of mobile communications starting from 1st generation. First generation (1G) a wireless network was basically analog cellular systems with circuit switched network architecture. The main challenges of these wireless networks were basic voice telephony, low capacity and limited local and regional coverage. In 1990, 1G was replaced by 2G which provided rich set of services such as high voice quality and global mobility based on the digital radio signal technology. Here also voice was considered to be the main traffic. 2G includes standards such as Global System For Mobile Communications (GSM), General Packet Radio System (GPRS). Both 1G and 2G are based on circuit-switched technology for data communication at low speed. 2G was a huge success. 2G was followed by 2.5G which is an intermittent between 2G and 3G. It is based on both circuit switched and packet switched technologies providing high data rate with low power consumption. It uses the infrastructure of Global System for Mobile communications (GSM) and Code division multiple access (CDMA) to provide its services.

In the present generation, 2.5G is replaced by 3G which includes standards from 2.5G and also some other technologies such as WiMAX (Worldwide Interoperability for Microwave Access). It is totally based on the packet switching technology providing broad range of high-quality services to the end user to meet the demand of high data rate and increasing rate of network users. But 3G was unable to repeat the success story of 2G as it provided only few new features over 2G. Before 3G was deployed all over the world, the idea of technology beyond 3G started evolving. This idea was beyond the imagination of ordinary mobile user promising "connect anytime, anyhow, anywhere" This ubiquitous network access will be achieved by seamlessly integrating the available and new networks using a core IP based network layer. This vision is called as the 4th generation of communication (4G). The paper introduces the idea behind 4G providing a brief overview about its features, architecture and challenges faced in its implementation.

II. WHY LEAP TOWARDS 4G

Fourth generation (4G) technology will offer many advancements to the wireless market, including downlink data rates well over 100 megabits per second (Mbps), low latency, very efficient spectrum use and low-cost implementations.

With impressive network capabilities, 4G enhancements promise to bring the wireless experience to an entirely new level with impressive user applications, such as sophisticated graphical user interfaces, high-end gaming, high- definition video and high-performance Ad hoc and multi hop networks (the strict delay requirements of voice make multi hop network.

The use of the 4G service will be very similar to that of the 3G service whilst offering much higher data transfer rates and therefore allowing either more speed intensive

applications or more users to experience good speeds whilst only connected through 1 carrier.
Applications could include:

A. 4G Ultra high-speed internet access - E-mail or general web browsing is available.

B. 4G Data intensive interactive user services - Services such as online satellite mapping will load instantly.

C. 4G Multiple User Video conferencing - subscribers can see as well as talk to more than one person.

D. 4G Location-based services - a provider sends wide spread, real time weather or traffic conditions to the computer or phone, or allows the subscriber to find and view nearby businesses or friends whilst communicating with them.

E. 4G Tele-medicines - a medical provider monitors or provides advice to the potentially isolated subscriber whilst also streaming to them related videos and guides.

F. 4G HDTV - a provider redirects a high definition TV channel directly to the subscriber where it can be watched.

G. 4G High Definition Video on demand - a provider sends a movie to the subscriber.

H. 4G Video games on demand - a provider sends game data directly to the subscriber where they can play in real time.

III. WIMAX AND LTE AS NEXT GENERATION TECHNOLOGIES

Due to limitation in QOS and coverage range, Wi-Fi falls short as being wireless technology. The emergent 4G technologies such as Wi MAX and LTE are stronger as compared to Wi-Fi. These technologies are having strong QOS and wider coverage. In some key aspect Wi MAX and LTE resemble each other including operating in licensed spectrum bands, strong QOS support, wider coverage range.

A. WiMAX (WORLDWIDE INTEROPERABILITY FOR MICROWAVE ACCESS)

WiMAX is a communication technology for wirelessly delivering high-speed Internet service to large geographical areas.

It is a part of a "fourth generation," or 4G, of wireless-communication technology, WiMAX far surpasses the 30-metre (100-foot) wireless range of a conventional Wi-Fi local area network (LAN), offering a metropolitan area network with a signal radius of about 50 km (30 miles). WiMAX is based upon IEEE Standard 802.16.

B. LTE (LONG TERM EVOLUTION)

Figure 1 4G Network Structure
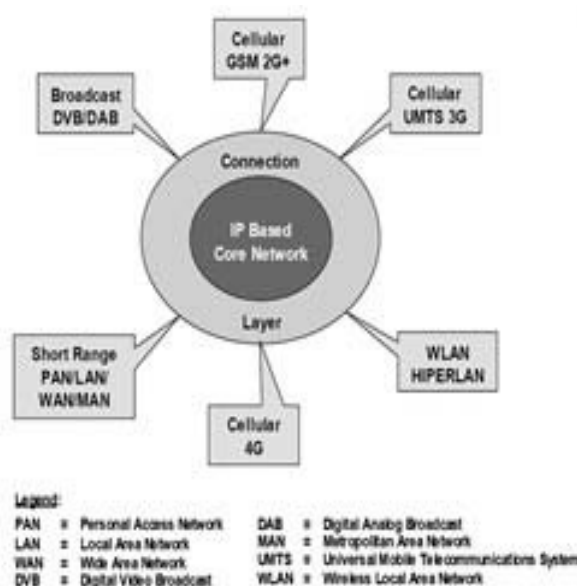
LTE is an emerging technology for higher data rates. It is also referred as 3.9 G or super 3G technology. LTE is developed as an improvement to Universal Mobile Telecommunication System by 3G Generation Partnership Project (3GPP). LTE uses Orthogonal Frequency Division Multiple Access (OFDMA). The download rate in LTE is 150 Mbps and it utilizes the available spectrum in a very sophisticated way. In LTE the IP packet delay is less than 5 mille seconds which provides the experience of wired broadband internet access in wireless environment. The mobile TV broadcast is facilitated by LTE over LTE network. LTE is a standard for wireless data communications technology and an evolution of the GSM/UMTS standards. The goal of LTE is to increase the capacity and speed of wireless data networks using new DSP (Digital Signal Processing) techniques and modulations that were developed in the beginning of the new millennium. Its wireless interface is incompatible with 2G and 3G networks, and so it must be operated on a separate wireless spectrum. The LTE specification provides down-link peak rates of 300 Mbit/s, uplink peak rates of 75 Mbit/s and QoS provisions permitting round-trip times of less than 10 ms.

IV. 4G NETWORK ARCHITECTURE

The widely accepted 4G network structure with IP as the core network used for communication; integrating the 2G, 3G and 4G technologies using a convergence layer can be defined.

The proposed layered/level Architecture of 4G network .This architecture fulfills the basic requirement of servicing the standalone and mobile subscribers on an "anytime, anywhere, anyhow" basis in dynamic network conditions. The architecture is based on Internet Protocol version 6 (IPV6) which operates at the transport layer enabling seamless communication across various
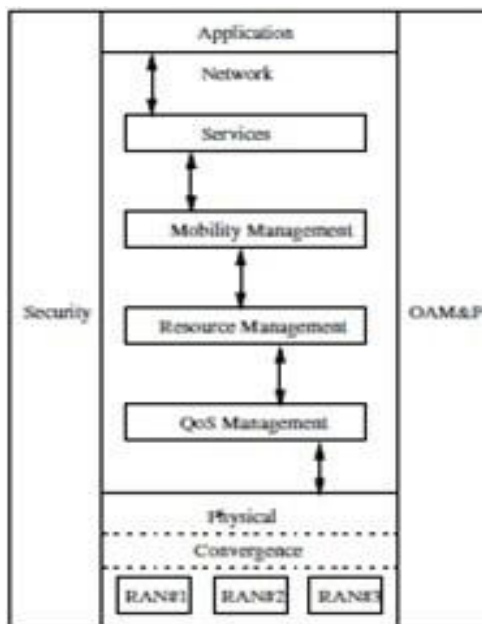
Heterogeneous networks and based on the key factors such as mobility, Quality of Service (QoS) and efficient resource management schemes. The functionalities provided by each layer and module can be described as follows:

A. APPLICATION

This layer is composed of various third party applications which provide value added services to its subscribers.

B. Network

This layer consists of various sub layers described as follows:

1) SERVICES

This layer manages the interaction between various value-added services and networks.

2) MOBILITY MANAGEMENT

This layer provides quality and uniform services to the mobile/stationary terminal across various heterogeneous networks. It provides features of low handover latency and packet loss during the provision of real-time and non-real time services to the end user moving across different networks. To achieve this, it performs tasks such as binding update (updating the care-off address of the mobile user), location management and common control signaling (signaling required to perform wireless network discovery), address assignment, handover control mechanism and so forth.

3) RESOURCE MANAGEMENT

This layer incorporates the functionalities of allocation, de-allocation and reallocation of the network resources which are acquired during the communication sessions within the same or different network domains.

This activity is performed during or before the communication activity. This layer also performs the task of congestion control, packet scheduling and packet classification.

4) QUALITY OF SERVICE (QOS) MANAGEMENT

This layer provides best optimal utilization of the available resources. In scenarios where the network resources are limited it provides an option to the applications to choose between high overall throughput and low end- to-end delay. It provides the best trade-off mechanisms depending on the application's preference. It encompasses several activities such as link utilization control, bandwidth control and so forth.

A. Physical

This layer consist of the core IPV6 network of 4G and other heterogeneous access networks such as GSM (Global System for Mobile communications), CDMA(Code Division Multiple Access) and WLAN in their physical view. This layer is composed of two sub-layers namely:

Convergence layer

This layer provides common control signaling mechanism across the core and other heterogeneous networks at the physical level. It also allows different radio access networks to transparently use the independent network services such as

mobility management, resource management and QoS management.

Different **RAN**

This layer consists of several radio access networks communicating with each other at the physical level.

1) Operation, Administration, Maintenance and Provisioning

This layer spans across all the layers of the network architecture and provides the functionalities of network controlling, network monitoring and fault detection. It also maintains the repudiation between various services and resources of several heterogeneous and core networks.

2. SECURITY

This layer also branches across all the layers of the 4G network architecture, which perform the function of authentication, authorization, encryption, establishment and implementation of service policy agreement between the various vendors.

V. KEY 4G TECHNOLOGIES

This section provides a brief description of the key technologies, which would enable 4G implementation.

A. OFDMA

OFDMA can be used for the downlink transmission (signal transmission from the base station to mobile terminal) of the symbols for achieving high spectral efficiency. It provides high performance on full bandwidth usage. It is a channel allocation scheme based on the orthogonal frequency division multiplexing technique that splits the data to be transmitted along the orthogonal narrowband carriers well-spaced by frequency. The technique used for splitting the data is Inverse Fast Fourier Transform (IFFT) which incorporates the advantage of transmitting the data at a higher rate. OFDMA is compatible with other technologies such as Multiple Input Multiple Output and smart antennas. OFDM not only improves the performance of the physical layer but also adds to the improvement of the Data Link Layer. It facilitates the optimization between various layers of network for usage of radio link from multiple radios.

OFDMA is currently applied on various wireless and wire line standards such as Wi-Fi, Wireless LAN, Ultra-Wideband (UWB), Wireless PAN, WiMAX, WiBro, Hiper MAN, Wireless MAN, 3GPP UMTS & 3GPP@ LTE (Long-Term Evolution).

B. SCFDMA

It can be used for the uplink transmission of the symbols. It is a channel allocation scheme used for data transmission based on single carrier frequency division multiplexing technique that allows the transmission of the symbols across a single carrier .The techniques used for splitting the data is IFFT described in the above section and Discrete Fourier transform (DFT) which performs the task of splitting the data across multiple sub-carriers and transmitting virtually as a single carrier. DFT is performed prior to IFFT.

SCFDMA provides low peak-to-average- power ratio (PAPR) as compared to OFDMA. In this scheme, as the data is transmitted along the multiple subcarriers and if one subcarrier is in problem it is easy to recover the data from the other subcarriers based on frequency selection for the channel. But the recovery of data at the receiver side requires the selection of the data from the multiple subcarriers and requires more efforts for removing the error in the data.

C. Multi-input and Multi-output (MIMO)

This is an antenna technology which uses multiple channels in radios to provide the functions of both the transmitter and receiver of data signals sent over the network as shown in the figure 1. It provides high spectral efficiency and link reliability facilitating significant increase in the data throughput and radio link usage without additional bandwidth and transmission power. This high efficiency is due to the availability of an independent path in a rich scattering environment for each transmitter and receiver antennas in the radio.

The MIMO channels can be used with OFDMA for transmission and reception of modulated signal over network to single or multiple users. This is currently used in WLAN - Wi-Fi 802.11n, Mesh Networks (e.g., WMAN - WiMAX 802.16e), RFID and Digital Home.

D. Multiuser-MIMO (MU-MIMO)

This is the variant antenna technology that enhances the communication capabilities of the individual radio terminal used by radios in the network by introducing multiple

independent radio terminals. This allows transmission and reception to and from multiple users using the same band.

E. Software Defined Radio (SDR)

SDR is a radio communication system implemented as software on the personal computer or embedded devices. It scans the available networks and then reconfigures itself for the selected network by downloading the software specific to that network. It is used for implementation of the multimodal, multi-band, multi-standard user terminals and a base station which allows accessibility across various wireless and wire line heterogeneous networks.

There are several advantages of SDR such as flexibility in network expansion i.e. Operator can expands its network infrastructure by adding few modems to base station transceiver system. It reduces the cost for development of multimodal, multiband and multi-standard user equipment. This will benefit both the end users and the service providers. The current SDR technology is not capable of supporting the multiple networks. It should be enhanced to support multiple networks.

VI. CHALLENGES IN 4G

A. Multimode user terminal

Multimode user terminal is a device working in different modes supporting a wide variety of 4G services and wireless networks by reconfiguring themselves to adapt to different wireless networks. They encounter several design issues such as limitations in the device size, cost, power consumption and backward compatibility to systems. One possible solution to this is the use of SDR, which adapts itself to the wireless interface of the network. Figure 4 shows multimode user terminal simultaneously interacting with the different access networks.
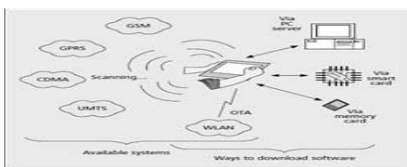
Multiple operators and billing system

In the current era of 2G and 3G networks, each operator has its own billing scheme based on the call duration, services used, etc. But in 4G each user can avail to different services made available by different operators. This would complicate the billing system for both the service providers and the end users. This asks for a unified billing system for all the services of the 4G network. To cater to these issues several frameworks are being studied based on the requirements of scalability, flexibility, accuracy and usability.

C. MANAGING CHANNEL QUALITY

There is a lot of talk about how OFDM will provide very high broadband speeds on 4G wireless networks, but the truth is that the data throughput rate on a channel of given RF is bandwidth is limited by channel quality, regardless of channel structure and coding. In urban areas where most of us will be using 4G services, channel quality is generally determined by levels of interference from other users of the same RF channel. As the channel is used more intensively within a given geographic area, interference levels rise. Indeed, managing mutual interference among users within a wireless network is the fundamental task in network design and optimization.

D. Most of the security schemes and the encryption/decryption protocols of the current generation networks were designed only for specific services. They seem to be very inflexible to be used across the heterogeneous architecture of 4G, which needs dynamically reconfigurable, adaptive and light-weight security mechanism.

For a successful 4G network, The other challenge for 4G is related to the fact that a wireless data channel is a shared resource. Whatever throughput it delivers has to be shared by all simultaneous users of that channel. A major problem in distinguishing between channel and individual throughput rates is typical usage patterns for Internet access have dramatically changed in the past few years and are still evolving rapidly. Not long ago, the most popular Internet applications (in terms of total demand) were "Web surfing" and e-mail. High bandwidth certainly enhances user experience for these sorts of activities, but on average, throughput is quite modest. This characteristic of high peak, moderate average user throughput demand is ideal for shared channels because it allows substantial numbers of simultaneous users to be served with satisfactory perceived speeds.

VII. CONCLUSION

The possible candidates for a successful 4G deployment are LTE- Advanced and Wi MAX 802.16m. Although comprehensive research work is required for 4G implementation in the field of network security to tackle potential security threats because a "secured" heterogeneous network will appeal more to the consumers of the present generation. So the technology is, it must be affordable in cost and worth deploying in throughput, coverage and capacity.

VIII.   REFERENCES

[1]   Bill Krenik "4G Wireless Technologies: When will it happen? What does it offer?" IEEE Asian Solid- State Circuits Conference November 3-5, 2008.

[2]   Ahmet AKAN, C¸ agatay EDEMEN "Path to 4G Wireless Networks" 2010 IEEE 21st International Symposium on Personal.

[3]   Leo yi, Kai Miao, Adrian Liu "A Comparative Study of WiMAX and LTE as the Next Generation Mobile Enterprise Network" Feb. 13-16, 2011 ICACT.

[4]   J. Ibrahim. 4G Features. Bechtel Telecommunications and Technical Journal, Volume 1, Number.1, December 2002, Page(s): 11-14.

[5]   Frattasi, S.; Fathi, H.; Fitzek, F.H.P.; Katz, M.D.; Prasad, R. Defining 4G Technology from the User's Perspective. IEEE Volume 20, Issue 1, Jan.-Feb. 2006, Page(s):35 - 41.

[6]   Santhi, K.R.; Srivastava, V.K. ; SenthilKumaran, G.; Butare, A. Goals of True Broad band's Wireless Next Wave (4G-5G). Vehicular Technology Conference, 2003. VTC 2003-Fall. 2003 IEEE 58th, Volume 4, Oct.2003, Pages(s): 2317-2321.

[7]   A. H. Khan, M. A. Qadeer, J. A. Ansari and S. Waheed. 4G as a Next Generation Wireless Network. Future Computer and Communication, 2009. ICFCC 2009. International Conference, April 2009, Page(s):334 – 338.

      2005, IEEE Volume 4, March 2005, Page(s):2406 - 2411.

[9]   Kappler C. UMTS Networks and Beyond. John Wiley & sons ltd, 2009.

[10]   M.Kottkamp,"LTE-Advanced Technology Introduc- tion," Rohde &Schwarz, 2010.

[11]   http://en.wikipedia.org/wiki/4G, 24 Nov 2014.

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