ISSN(Online): 2320-9801
ISSN (Print) : 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 5, May 2016

Use of 4G waveform towards RADAR

Nigidita pradhan[1], Rabindranath Bera[2], Debasish Bhaskar[3]

PG Student [DEAC], Dept. of ECE, Sikkim Manipal Institute of Technology, India[1]

Head of the Dept [HOD], Dept. of ECE, Sikkim Manipal Institute of Technology, India[2]

Assistant Professor, Dept. of ECE, Sikkim Manipal Institute of Technology, India[3]

Majitar, Rangpo, East Sikkim, India

ABSTRACT: This rapid development of broadband wireless access technologies in recent years was the result of growing demand for mobile Internet and wireless multimedia applications. So, the wireless network is advancing after 3G and providing better coverage, higher data rate and by reducing Latency. LTE is able to provide services in scalable bandwidth (1.4, 3, 5, 10, 15 or 20 MHz) [1].4G have different Downlink and uplink physical Channels. The Downlink physical channels are PDCCH, PCFICH, PBCH and PHICH. All these channels are assigned with different signal Transmission. This paper mainly focuses on the Physical Downlink channels. And each channels are redesigned as the RADAR and the Channel Estimator block is used to estimate downlink channel response (CR) with the pilot symbols assisted as the Refrence signal schemes the Platform used here is the Agilent Systemvue .Agilent SystemVue is focused Electronic Design Automation (EDA) environment for Electronic System Level (ESL). It enables system architecture and algorithm developers to innovate the physical layer of wireless and aerospace/defence.

KEYWORDS: PCFICH, PDCCH, PHICH, PBCH, Agilent SystemVue, Agilent Vector Signal Analyzer.

I. INTRODUCTION

Mobile communications has become an everyday commodity. In the last decades, it has evolved from being an expensive technology for a few selected individuals to Fourth Generation, is the successor of the today's existing 3G technology. And is deployed by 3rd Generation. Two groups, 3GPP (Third Generation Partnership Project) and 3GPP2 (Third Generation Partnership Project 2) are working together to form the foundation for LTE, where 3GPP represents the functions of GSM family and latter represents the functions of CDMA family OFDM signals have become an interesting choice for radar. They allow for separate estimation of target distance and Doppler shift by means of spectral estimation algorithms and are used to transmit information at the same time. This makes OFDM radar useful for mobile networks, e.g. in car to-car communication a network, where the additional feature of a radar system has a huge benefit, and does not even require additional spectrum usage or radio hardware**.**

II. LITERATURE SURVEY

Wireless network has been improved after 3G by means of higher data rates with better coverage and by reducing latency. The main objective of this paper is the realization of the SISO (Single Input- Single Output) architecture of PBCH downlink data channel with its own transmitter and receiver. Information is processed at transmitter by means of scrambling, modulation, layer mapping, precoding and mapping to resource elements. Similar to the transmitter, receiver also has to perform some techniques to retrieve the original data such as demapping from resource elements, decoding, delayer mapping, demodulation and descrambling [3].This paper presented a brief description of path to 4G networks, WiMAX and LTE Network architecture and OFDMA technology. It has been observed that the number of wireless broadband subscribers have passed the number of fixed broadband subscribers. So in a world going wireless, the technologies with higher throughputs get importance day by day [4]. This paper describes the applications of 4G technology considering the importance of switching to 4G systems as a better service compared to the 3G technology The author presents both external and internal diversity of each target to illustrate the causes and solutions of the adaptability feature. [5]. This paper presents the performance evaluation of STBC-OFDM systems covering channel

ISSN(Online): 2320-9801
ISSN (Print) : 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 5, May 2016

model and coding scheme, it includes Rayleigh fading channels by which it is observed that Bit Error Rate (BER) is reduced to achieve the high data rate [8].

III. OBJECTIVE for RADAR DESIGNER

During designing a radar system, the designer should have the following objective towards removal of RF environmental effects from radar reception:-

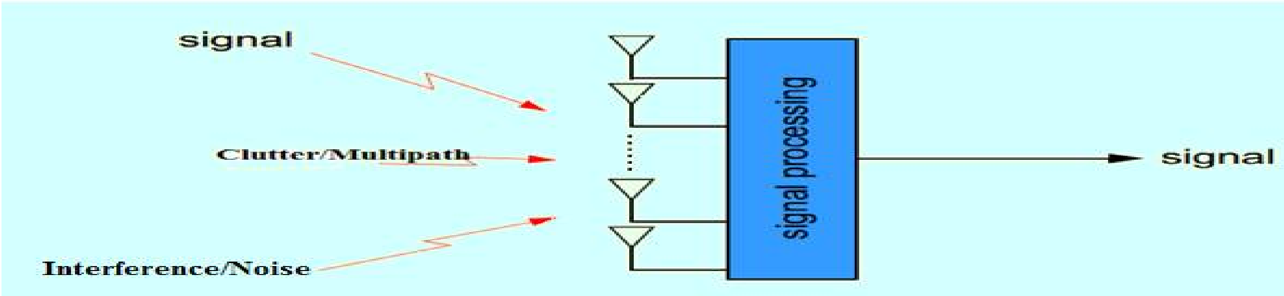


Fig.1.1. Depicts the Signal Processing in a radar receiving system

The perspective of the RADAR design is to eliminate the multipath, interference, noise and clutter and at the output of the RADAR receiver, the target should be visible. The RADAR source waveform selection is a major issue in this regards. If, the spread spectrum source is used the spectrum is visible as almost a continuous spectrum. Under severe multipath condition, this type of continuous spectrum is not suitable for clarifying the spectral components whether it is due to the multipath or due to the desired target return.

IV. RESOURCE UTILIZATION in 4G RADAR Operation

RESOURCEs	TECHNOLOGY	INTERFERENCE REDUCTION	MULTIPATH /CLUTTER REDUCTION	REMARKs
UNDER DIFFERENT CHANNEL IMPAIRMENTS				
TIME/CODE	DOWNLINK PILOT AND PN CODE BASED REFERENCE SIGNAL	GOOD	NOT SO GOOD	ANTI-JAMMING LIMITED BY CODE LENGTH
FREQUENCY	OFDM/ SC-FDM	NOT SO EFFICIENT IN INTERFERENCE REDUCTION	GOOD	MULTIPATH DEPEND ON SUB CARRIER SPACING

V. WAVEFORM SELECTION

i). Candidate: Orthogonal frequency Division Multiplexing (OFDM)

OFDM or Orthogonal Frequency division multiplexing which is also known as Discrete Multitone Modulation (DMT),is a modulation method for the modulation of a frequency channel based on the FDM(frequency division multiplexing) .In this technique, the frequencies and modulations of frequency division multiplexing are arranged orthogonally to each other to eliminate any interference between the channels.

Fig.1.2 OFDM Subcarrier

The main aim of OFDM is to send the low rate modulations in a parallel stream rather than sending a high rate wave front, as low rate modulations are less sensitive to multipath. With OFDM technology already proved and embraced, 4G development will gain momentum [1].

VI. 4G PHYSICAL DOWNLINK CHANNELS

i). Physical Broadcast Channel (PBCH)

It carries the Broadcast Channel (BCH) transport Channel. It supports QPSK Modulation. The BCH carries various cell-specific content and is used for all type of UE.As with the Synchronization signals the PBCH is transmitted in the centre of the channel but it occupies 6 RB (72 Subcarrier).

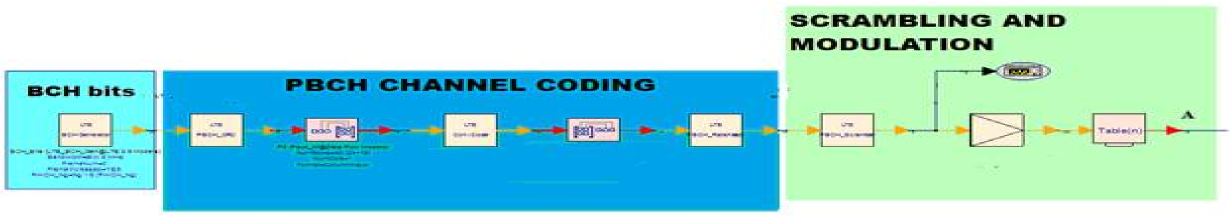


Fig.1.3 PBCH Transmitter

a). OPERATION:

- **BCH Generator:** The first block is the block is the BCH generator. It generates 24 bits of Master Information Bits.
- **CRC Generation:** It generates the 16 bits of CRC and it is scrambled with a antenna specific mask. The Generated CRC is attached to the MIB payload after which the size of the Payload will be 40 bits (24bitof MIB+16 bit of CRC).
- **Convolution encoding:** A tail bit convolution encoding is performed over the 40 bits and the output is 3 streams of 40 bits each**.**
- **Rate matching:** The rate matching here is nothing but a repetition coding where the 3 streams of size 120 bits (40x3bits) is just repeated 16 times to get 1920 bits. The repetition rate is very high since the MIB is a very vital and UE cannot afford to lose it.
- **Scrambling:** these 1920 bits are scrambled with a scrambling sequence as long as 1920 bits.
- **Modulation (QPSK):** A QPSK modulation is performed over these 1920 bits to obtain 960 complex QPSK Symbols.

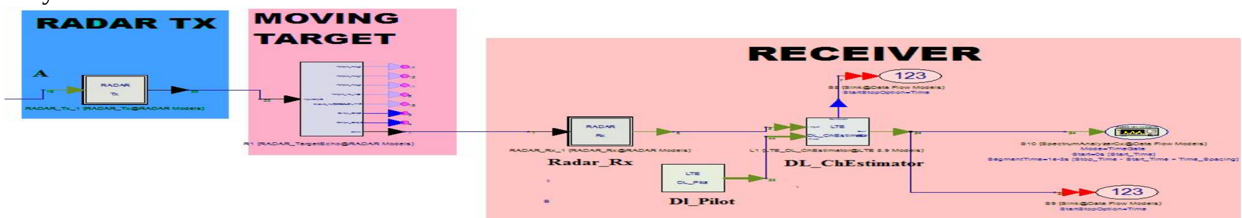


Fig.1.3.1: RADAR TX and ReceiverThe above Fig.1.3.1 shows the radar part in which the PBCH signal is passed through the RADAR Tx. Radar TX consists of the Following Ingredients as shown in the Fig.1.6 below.

ISSN(Online): 2320-9801
ISSN (Print) : 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 5, May 2016

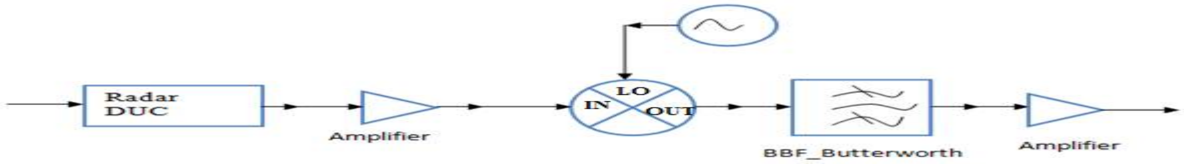


Fig.1.3.2: Ingredients of the Radar Transmitter

A digital complex baseband waveform is first passed through a digital up converter to produce an IF signal, and then mixed with an RF (complex envelope) to generate the RF signal. Then filtered with a band pass filter to decrease the out-band noise. Finally, a power amplifier is applied before output the RF signal.

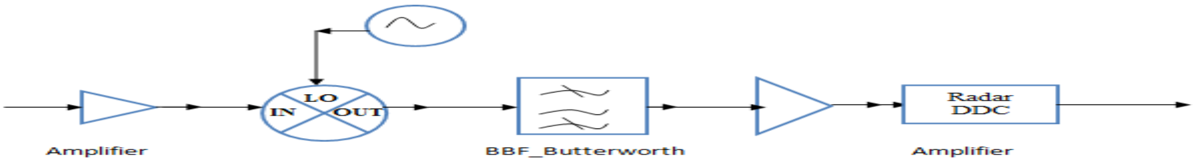
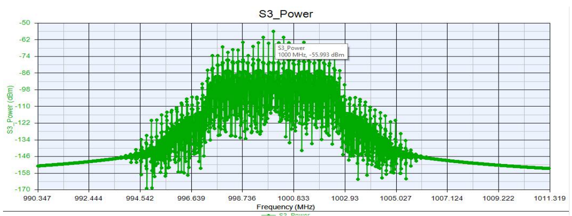


Fig.1.3.3: Ingredients of the Radar Receiver

An analogy envelop RF waveform is first passed through an RF power amplifier then mixed with an RF (complex envelope) to get the IF signal, followed by a passband filter then a power amplifier, and passed through a digital downconverter to generate the baseband signal.

b). RESULTS OBTAINED



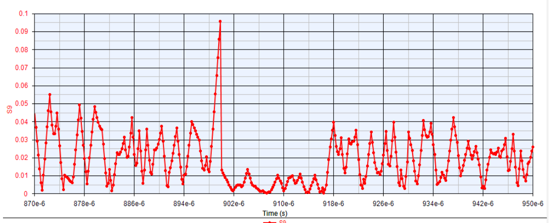


Fig.1.3.4. Spectrum Observed after the Target', BW=5MHz.

Fig.1.3.5. Spectrum Observed after the Channel estimation showing the Correlation peak.

The above spectrum is observed after the target and observed the Spectrum of the received power at the particular **Target Type** which has Standard RCS inbuild. Likewise we can see the received power of any **Target Type** which is shown below in the **Table 01**.

c). Table .01

TARGET	RCS (dBsm)	RX POWER (dBm)
Conventional unmanned winged missile	-3	-55.933
Small Single Engine Aircraft	0	-49.973
Small Fighter Aircraft or 4 passenger jet	3	-43.952
Large Fighter Aircraft	8	-34.41
Medium Bomber or Jet Airline	18	-23.952
Large Bomber or Jet Airline	16	-17.932
Jumbo Jet	20	-9.973
Small Open Boat	-17	-83.952
Small pleasure Boat	3	-43.952
Cabin cruiser	10	-29.973
Large Ship at zero grazing angle	40+	30.027
Pick up Truck	23	-3.952
Automobile	20	-9.973
Bicycle	3	-43.962
Man	0	-49.973
Bird	-20	-89.973
Insect	-50	-129.973

The above **Table 01** describes the type of target which has standard RCS and as per that standard the Rx power is observed in the Spectrum.

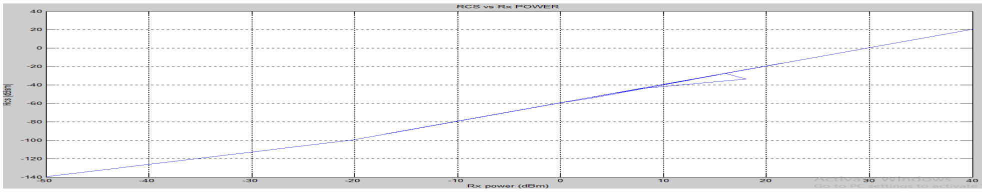
ISSN(Online): 2320-9801
ISSN (Print) : 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 5, May 2016

d). RCS CALIBRATION GRAPH



The above graph represents RCS vs. Received power which is tabulated in the Table 01. In the above graph the Received Power is increasing as the Target is changing.

ii). PCFICH

PCFICH conveys the number of control symbols in the current subframe. Since a subframe in the LTE FDD can have upto 14 symbols for normal cp scenario, among the 14 OFDM symbols there can be upto 3 control symbols depending upon the amount of control data the eNode has to transmit.

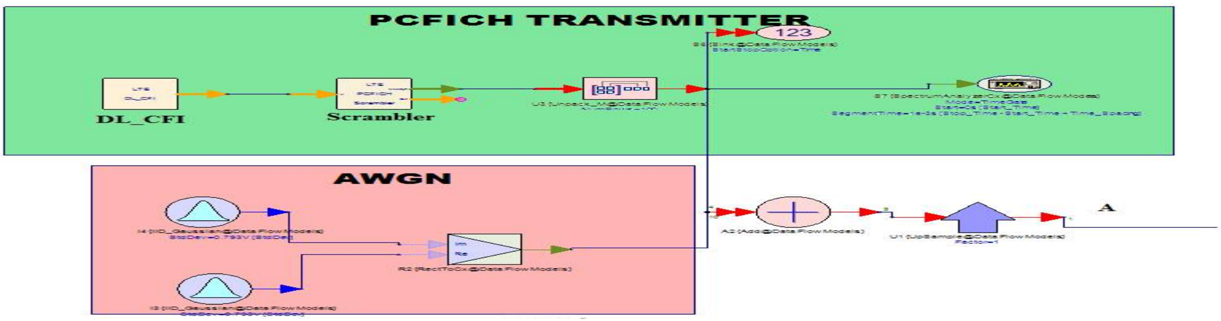


Fig.1.4. PCFICH Transmitter

a). OPERATION:

❖ **Block Coding**: Standard has 32 bit codeword corresponding to each CFI value. It's a simple Look up encoding, where the CFI is 1/32 rate encoded, which means the input to the Block coding Stage is CFI value and the Output is 32 bit codeword.

❖ **Scrambling**: In this stage, a 32 bit length scrambling sequence is generated using slot number cell ID. The generated scrambling sequence is XORed with 32 codeword's generated in Previous stage.

❖ **Modulation:** QPSK modulation is performed over 32 codeword and since QPSK takes 2 bit per symbol, the output of this stage is QPSK symbols.

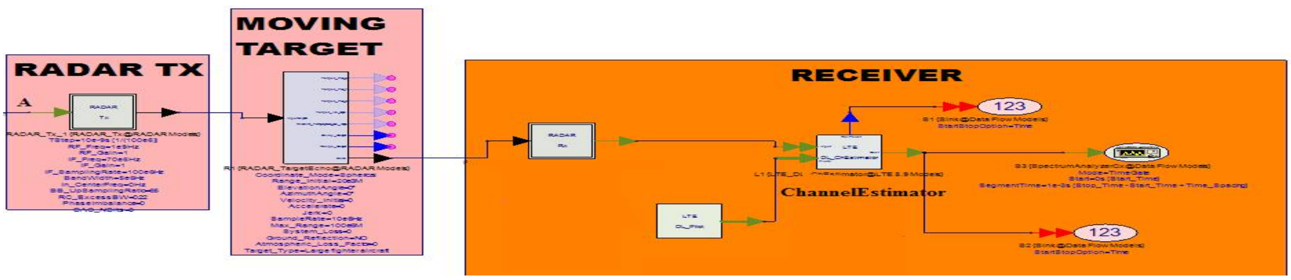


Fig.1.5: Radar TX and the Receiver

The Above Fig.1.5 shows the Radar transmitter and the Radar Receiver part which is explained in the Article 1.4.2.

ISSN(Online): 2320-9801
ISSN (Print) : 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 5, May 2016

b). RESULTS OBTAINED

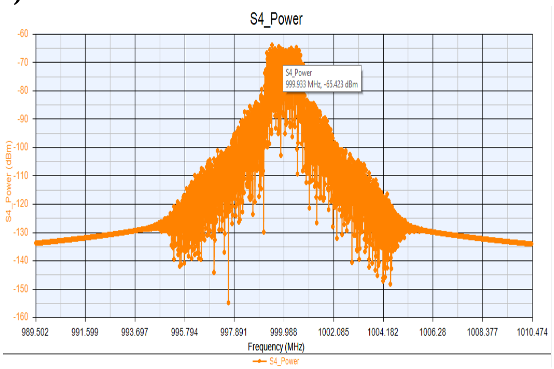


Fig.1.5.1.Spectrum observed after the **Target**

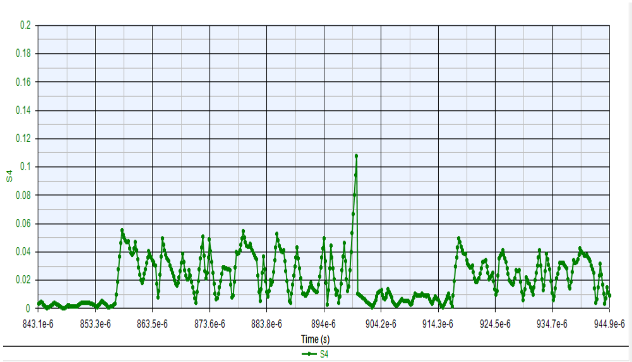


Fig.1.5.2: Spectrum observed after the Channel estimation showing the Signal Quality.

The above spectrum is the Spectrum observed after the Target Echo. Which shows the received power at given target RCS.

iii). PDCCH

A PDCCH is transmitted on one or an aggregation of several consecutive control channel elements (CCEs). A CCE is a group of nine consecutive resource-element groups (REGs). The number of CCEs used to carry a PDDCH is controlled by PDCCH format. A PDCCH format of 0, 1, 2 or 3 corresponds to 1, 2,3 or 4 consecutive CCEs being allocated to one PDCCH.

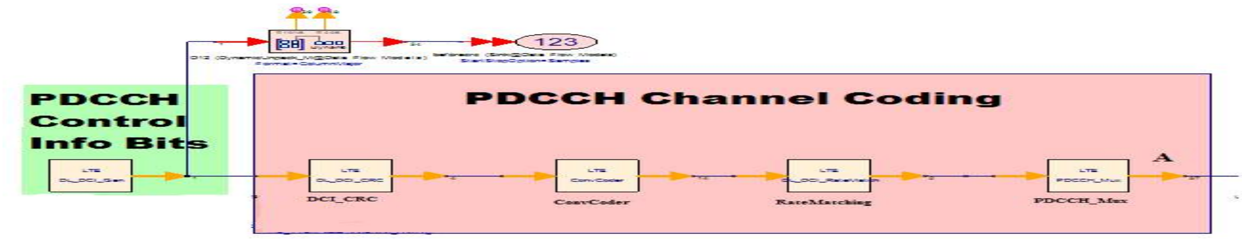


Fig.1.7: PDCCH Channel Coding

a).Operation

- **PDCCH_ControlBits**: The initial Block consist of PDCCH Control Information Bits.

- **PDCCH_ChannelCoding**: DCI message with the CRC attachment undergoes tail biting convolution coding. Convolution coding is a form of forward error correction and improves the channel capacity by adding carefully selected redundant information.LTE uses a rate 1/3 tail-biting encoder with a constraint length, k, of 7. This means that one in three bits of the output contain useful information while the other two add Redundancy. The tail biting convolution encoder initializes its internal shift register to last k bits of the current input block, rather than to all zeros state. Thus, the start and the end states are the same, without the need to zero-pad the input block. Since the overhead of terminating the coder has been eliminated, the output block contains fewer bits than a standard convolution coder. The drawback is that the decoder becomes more complicated because the initial state is unknown; however, the decoder does know the start and end states are same. The Rate Matching block creates an output bit stream with a desired code rate. As the number of bits available for Transmission depends on the Available resources the rate matching algorithm is capable of producing any arbitrary rate. The three bit streams from the turbo encoder are interleaved followed by bit interleaved collection to create a circular buffer. Bits are selected and pruned from the buffer to create an output bit stream with the desired code Rate. The blocks of coded bits for each control channel are multiplexed in order to create a block of data.

ISSN(Online): 2320-9801
ISSN (Print) : 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 5, May 2016

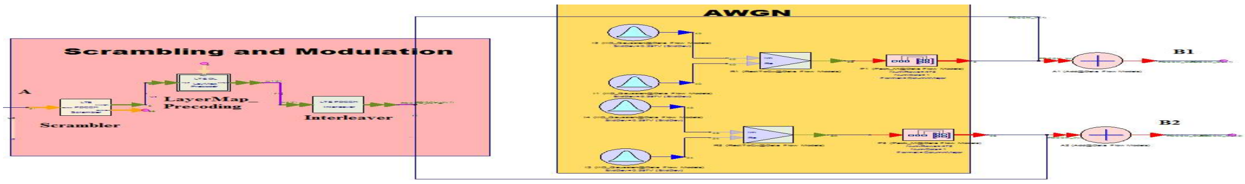


Fig: 1.6.1: Scrambling and Modulation

- **Scrambling and Modulation:** This Multiplexed Block of bits undergoes a bit-wise exclusive- or (XOR) operation with a cell-specific scrambling sequence. The scrambling sequence is pseudorandom, created using a length-31 Gold sequence generator and initialized using a slot number within the radio Frame, n_s , and the cell ID, N_{ID}^{cell} at the start of each subframe, as shown in the equation below.
- $C_{init} = \left\lfloor \frac{ns}{2} \right\rfloor 2^9 + N_{ID}^{cell}$
- Scrambling serves the purpose of intercell interference rejection. When a UE descrambles a received bits stream with a known cell specific scrambling sequence, interference from other cells will be descrambled incorrectly, therefore only appearing as uncorrelated symbols. The Scrambled bits then undergoes QPSK modulation to create a block of complex-valued modulation symbols.

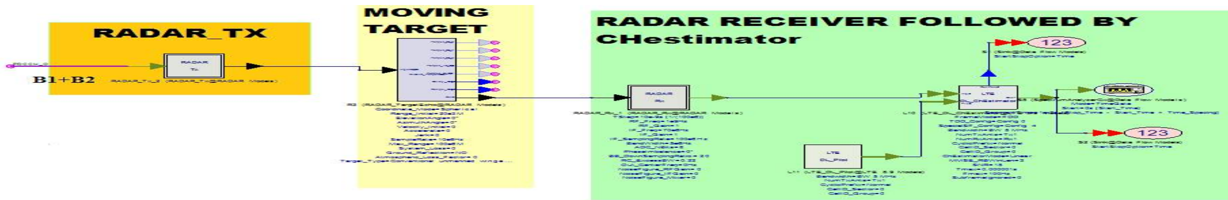


Fig.1.6.2: Radar Transmitter and the Radar receiver

The Above Fig.1.7.2 shows the Radar transmitter and the Radar Receiver part which is explained in the Article 1.5.2.

b). RESULTS OBTAINED

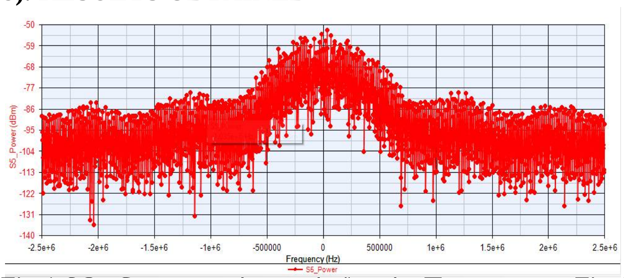


Fig.1.6.3: Spectrum observed after the **Target**

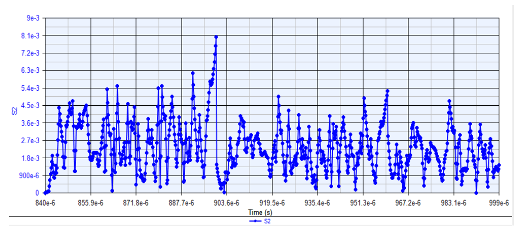


Fig.1.6.4. Graph observed after the Estimation showing the Signal Quality

iv). PHICH

The Physical Hybrid-ARQ Indicator Channel (PHICH) in the downlink carries Hybrid ARQ (HARQ) acknowledgements (ACK/NACK) for uplink data transfers. PHICHs are located in the first OFDM symbol of each subframe. A PHICH is carried by several Resource Element Groups (REGs). Multiple PHICHs can share the same set of REGs and are differentiated by orthogonal covers; PHICHs which share the same resources are called a PHICH group. Consequently, a specific PHICH is identified by two parameters: the PHICH group number, and the orthogonal sequence index within the group.

ISSN(Online): 2320-9801
ISSN (Print) : 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 5, May 2016

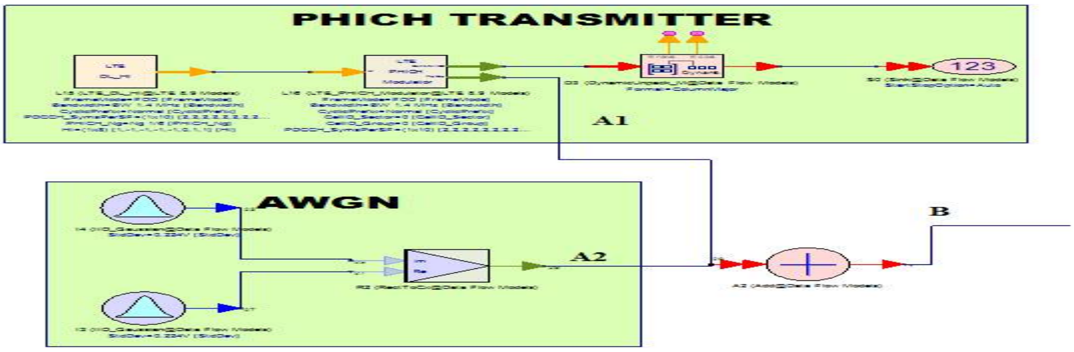


Fig.1.7. PHICH Transmitter

a). OPERATION:

The HARQ Indicator Codeword undergoes BPSK modulation, Scrambling, Layer mapping, precoding, and resource mapping.

- **Scrambling**

The block of modulated symbols is bitwise multiplied with an orthogonal sequence and a cell-specific scrambling sequence to create a sequence of symbols, d (0),…,d(M_{symb}−1). The number of symbols, M_{symb}, is given by the equation $M_{symb}=3\times N_{PHICHSF}$. The PHICH spreading factor, $N_{PHICHSF}$, is 4 for a normal cyclic prefix and 2 for an extended cyclic prefix. The orthogonal sequence allows multiple PHICHs to be mapped to the same set of resource elements. Scrambling with a cell-specific sequence serves the purpose of intercell interference rejection. When a UE descrambles a received bit stream with a known cell specific scrambling sequence, interference from other cells will be descrambled incorrectly and therefore only appear as uncorrelated noise.

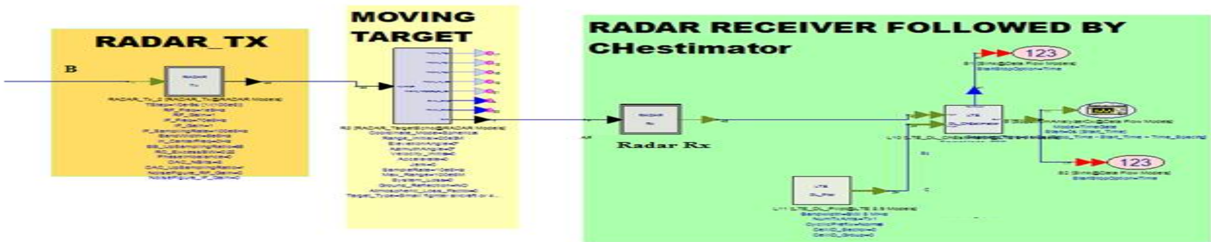


Fig.1.7.1: PHICH Transmitter followed by Radar Receiver

The Above Fig.1.7.1 shows the Radar transmitter and the Radar Receiver part which is explained in the Article 1.5.2.

b). RESULTS OBTAINED

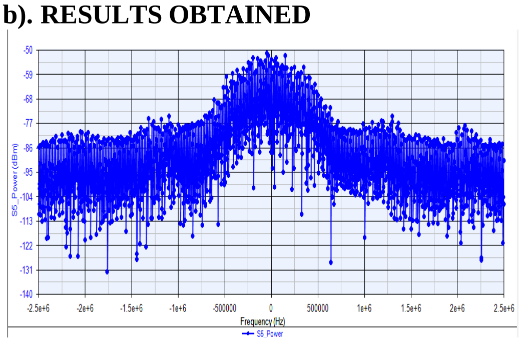


Fig.1.7.2. Spectrum observed after the **Target**

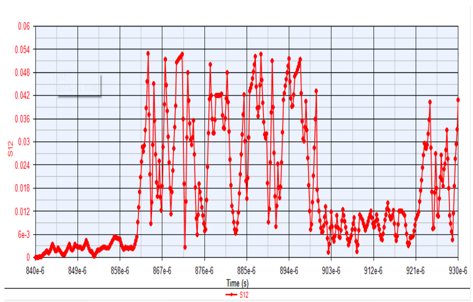


Fig.1.7.3: Graph observed after the Estimation Showing the Signal Quality

c). Table.02:

Sl no.	Downlink Channels	Target Type	RCS	Received Power(dbs)
1	PBCH	Large Fighter Aircraft	8	-32.791
2	PCFICH	Large Fighter Aircraft	8	-32.656
3	PDCCH	Large Fighter Aircraft	8	-52.431
4	PHICH	Large Fighter Aircraft	8	-34.165

From the above table we can see that for different downlink channels having same Target Type of Same Radar Cross section, their Received power is different. So, now we can choose the RADAR as per the Higher Power Achieved.Therefore, based on the Analysis PDCCH RADAR will be the best among the others.

VII. COMPARASION GRAPH

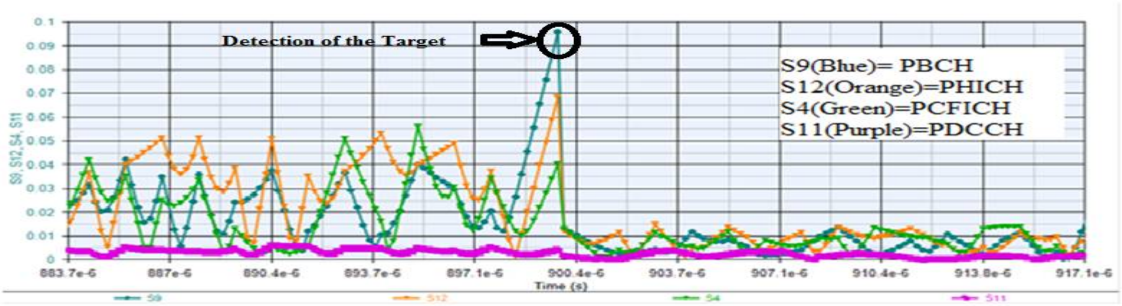


Fig.1.9: Comparison graph of Different Downlink Control Channels

VIII. CONCLUSION

As we can see in **Table 02** received power of the Physical Broadcast Channel (PBCH) is more compared to other Downlink channels. This is nothing but the correlating peak. This depicts that the quality of the signal transmitted through PBCH is better compared to the other Channels. Hence, we can consider PBCH as the efficient channel as compared to the Other Physical Downlink Channels.

REFRENCES

[1] M. Braun, T. Schu, C. Sturm and F. K. Jondral, 'On *the Single-Target Accuracy of OFDM Radar Algorithms,*' Communications Engineering Lab, Karlsruhe Institute of Technology (KIT), Germany,Institut fur Hochfrequenztechnik und Electronic, Karlsruhe Institute of Technology (KIT), Germany

[2] Maximum Likelihood Speed and Distance Estimation for OFDM Radar Martin Braun∗ , Christian Sturm‡ and Friedrich K. Jondral∗ ∗Communications Engineering Lab, Karlsruhe Institute of Technology (KIT), Germany, Institute fur Hochfrequenztechnik und Electronic, Karlsruhe Institute of Technology (KIT), Germany

[3] S. S. A. Abbas, A. Kanimozhi and S. J. Thiruvengadam, 'Realization *of the SISO Architecture for PBCH of 3GPP-LTE using PlanAhead Tool andVirtex-5 Device,*' Department of Electronics and Communication Engineering, Mepco Schlenk Engineering College, Sivakasi, 626005, India, Department of Electronics and Communication Engineering, Thiagarajar College of Engineering, Madura, 625015, India , Journal of Wireless Networking and Communications 2012, 2(3): 14-22

[4] Moray Rumney,' *LTE and the Evolution of 4G Wireless'*

[5] K.Kumaravel, 'Comparative Study of 3G and 4G in Mobile Technology,' Assistant Professor Dept. of Computer Science, Dr. N.G.P. Arts and Science College, Coimbatore, India , IJCSI International Journal of Computer Science Issues, Vol. 8, Issue 5, No 3, September 2011.

[6] P.Gautam,S. Kaur,R. Kaur, S. Kaur and H. Kundra, 'Review Paper on 4G Wireless Technology,'M-Tech research scholar, Rayat Institute of Engineering and IT Railmajra, Associate Professor & Head , Rayat Institute of Engineering and IT, Railmajra, International Journal of Advances in Science and Technology (IJAST),Vol 2 Issue I (March 2014).

[7] C.Malarvizi and V.Nithya *'Enhancing Cell Edge Performance in cellular Mobile System,'* University College of Engineering Thirukkuvalai, Anna University,India, International Journal of Future Generation Communication and Networking, Vol.8,pp.49-58, 2015.8.6.05.

[8] H.Thota, C.S Rani, K. Kagitha,A. Balagam4, A. Goriparthi ,N. Lakshmi Devarapalli, '*Performance analysis of OFDM for 4G wireless systems under various fading channels ,'* B.Tech, Electronics and Communication Engineering, DMS SVH College of Engineering, Machilipatnam, India ,Professor, Electronics and Communication Engineering, DMS SVH College of Engineering, Machilipatnam, India,Vol. 3, Issue 1, January 2015.