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Cipher Synchronization Characteristics in Device to Device Link Communication

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Abstract

In this paper, we review data link cipher synchronization characteristic of device to device link channel. It is shown that the relation of path loss vs. distance between transmitter and receiver. Path loss of propagation and retransmission of start sequence is required to analysis effect of start pattern in device to device communication. Also it is reviewed the relation of link delay and buffer size for retransmission of frame, which is included in start sequence.

Keywords: Buffer, Communication, Component, Delay, Link, Transmission

1. Introduction

Device-to-device (D2D) communications has been considered in respect of the physical closeness of communicating devices, increasing resource utilization, and enhancing communication range. Relative to the traditional mobile communication scheme, there is a need to design new peer detection scheme, physical layer procedures, and radio resource control algorithms[1]. The consideration of performance assessment for synchronization, low delay and low power consumption is reviews in[2]. Greg et al. presents about replacing the telecomm and protocol with the next generation uplink in[3]. Ravichandran et al. presents about design and development of wireless telecomm and telemetry IEEE802.15.4/ Zigbee standard in[4].

Vitalice and Cemal reviews about frame and burst acquisition in a satellite communication network Time Division Multiple Access (TDMA). This paper suggests that TDMA requires synchronization so that the bursts arrive at the satellite in the allotted time slots[5].

Yu Feng et. al reviews dynamic two way time synchronization for air borne pseudo satellite in[6]. In this paper, there are interested in accuracy of relative position in short time and modeled adoption of clock error, solving problem of signal traveling time. Fan Tao et. al. presents a novel carrier synchronization technology based on a modified COSTAS loop, that is supported by FFT and used to track residual frequency offset in[7].

Imran Ali et. al. specifies reference bursts constraints demand a careful investigation of R&B synchronization algorithm to estimate frequency and phase offsets and architecture of FFT KS and FFT PL synchronization method in[8]. Linnan Lee et. al. designs tracking of transmitted signal of DVB-S2 receiver[9].

Oren Jean describes establishing synchronization between stations using arbitrary signals from space of unknown origin and presents a Lagrange multiplier approach for finding the required direction[10]. Wang et. al. investigate uplink timing synchronization problem in GEO mobile SAT Long Term Evolution (LTE) systems[11]. Arash et. al. survey on device to device communication in[12].

Section 2 reviews propagation characteristics of channel model and Section 3 outlines transmission characteristics of link cipher synchronization in a D2D link, Section 4 summarizes the results of this study.

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2. Propagation Characterstics of D2D Channel Model

2.1 Simplified Path Loss Model

It is expressed a simple model of path loss in relation to a reference point d0 as Eq(1).

$$P_R = P_T K\left(\frac{d0}{d}\right)^{\gamma} \quad (1)$$

Where $d \geq d0$, K is constant which depends on the antenna characteristics and free space path loss(γ is 2) distance d0. P_R is the received power and P_T is the transmitted power. However in dB attenuation model, it is expressed in Eq (2).

$$P_R[\text{dBm}] = P_T[\text{dBm}] + \text{K dB} - 10\gamma \log_{10}\left(\frac{d}{d0}\right) \quad (2)$$

Where γ is path loss exponent.

The equation of space loss is as follows in Eq (3)

$$Space\ loss = P_T - P_R = 20\log\frac{4\pi fd}{c} \quad (3)$$

Where transmitted wavelength λ is c/f, d is different distance between transmitter and receiver, c is velocity of light.

In Figure 1, it is shown path loss versa distance between transmitter and receiver of D2D link.

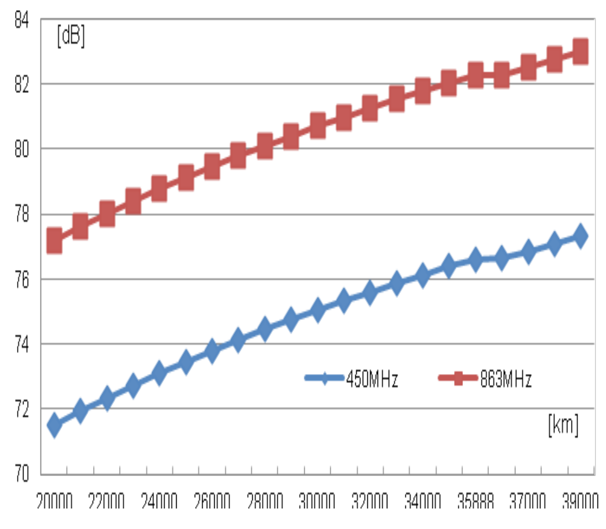

Figure 1. Path loss[dB] vs distance[Km] between transmitter and receiver.

2.2 Bit Error Ratio in Channel Model

In AWGN channel, BER of DPSK is expressed in Eq (4).

$$P_b = \frac{1}{2} e^{\left(\frac{-E_b}{N_0}\right)} \quad (4)$$

Where $\frac{E_b}{N_0}$ is signal to noise ratio for DPSK.

Given in Eq (4), Figure 2 is illustrated probability condition of fading channel (a) and AWGN channel (b).

The (a) is bit error probability, which is occurred in condition of fading channel and (b) is probability of bit error, which is occurred in condition of AWGN channel.

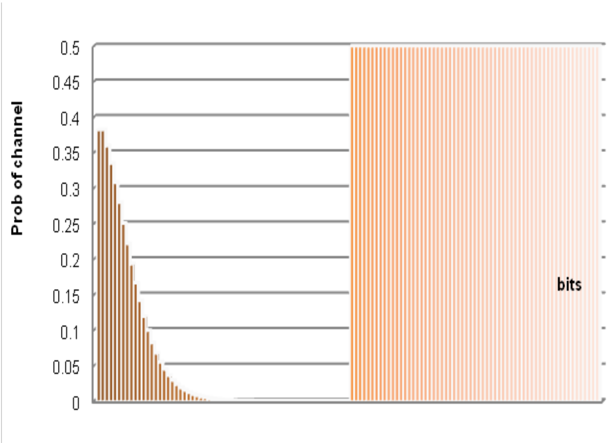

Figure 2. Bit error probability of fading channel(a) vs AWGN channel(b) in link cipher synchronizaiotn channel.

From Figure 2, detection probability of cipher synchronization is as follows in Figure 3.

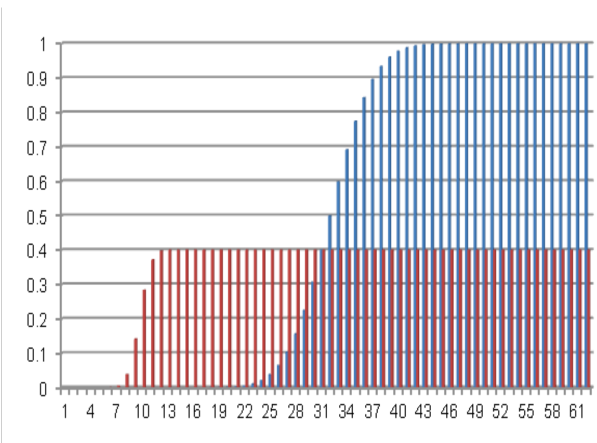

Figure 3. Detection probability of cipher synchronization bewteen AWGN channel and fading channel.

. In condition of bit error probability such as Figure 2(a), it is shown lower bound value as follows in Figure 3(a).

But if Figure 3(b) is shown upper bound value as follows upper bound value in Figure 2(b).

2.3 Transmission Characterstics of Cipher Synchronization in D2D Link

The Communication Link Transmission Unit (CLTU) consists of a start sequence, a set of BCH codeblocks and tail sequence. If the number of BCH code blocks in CLTU, is N, then length of CLTU is 2 + (N+1)*[8].

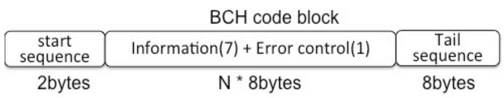

Figure 5. Find Cut Dimension – Pseudo Code.

Information bits are provided 56 information bits for each BCH code block. The start sequence is 2 bytes pattern such as 1110 1011 1001 0000. Also tail sequence is 8bytes such as 11000101 11000101 11000101 11000101 11000101 11000101 11000101 01111001.

Bit error rate of start sequence ($P_{start\ sequence}$) is expressed in start pattern as follows in Eq (5) and Figure 5.

$$P_{start\ sequence} = 1 - (1 - P_b)^{length} \qquad (5)$$

Where Length is start sequence length.

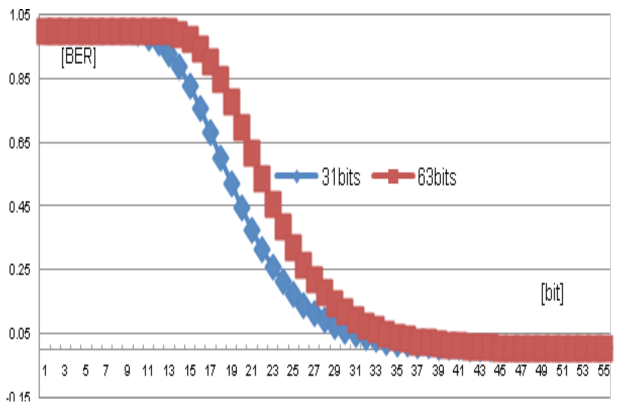

Figure 5. Bit error rate vs. start pattern sequence length.

Failed probability for recognize the start pattern is probability which two or more bit errors occurred in start pattern of 31bits as follows in Figure 6.

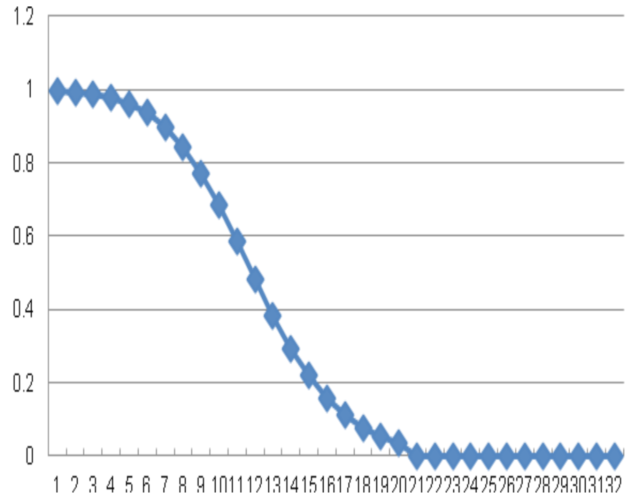

Figure 6. Fail probability of start pattern vs. start pattern sequence length.

For retransmission of start sequence, the probability of retransmission is as follows in Eq (6) and Figure 7. Where the number of retransmission iteration is i (with i=0, 1, 2, …)., and N = 3. Assume P_{rej} = 0.5.

$$P_{retransmission} = \frac{P_{rej}^{\ N}}{1 - P_{rej}^{\ N}} \qquad (5)$$

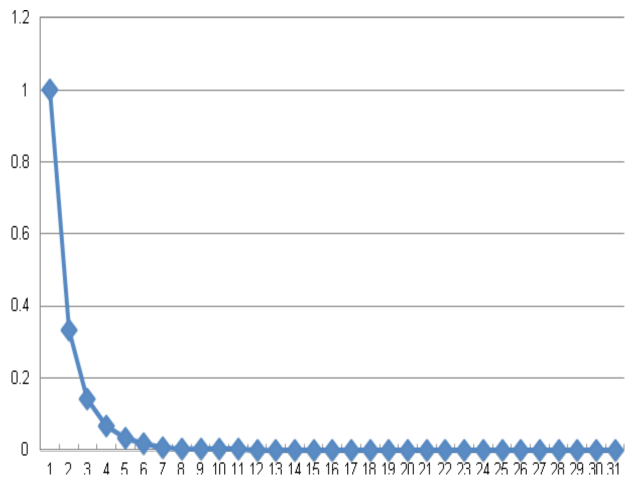

Figure 7. Probability of retransmission.

In condition that packet suffer no queuing delay, a bandwidth delay product of the link is as follow in Table 1 and Figure 8. If the congested state is occurred in the D2D queue and ABR packets may be in transit on the link, then the round trip propagation delay 2π is used. Given in Eq (7), the propagation delay of transmission link is $\pi = \frac{l}{c}$.

$$Q_{pkts} = \left(2 * \frac{l}{c}\right) * N_{pkts} \qquad (7)$$

Where Q_{pkts} is bandwidth delay values, l is link distance (meters) from source to destination, c is arrival velocity per second(the speed of light, m/sec), N_{pkts} is number of packet, which is processed per second(packets/sec).

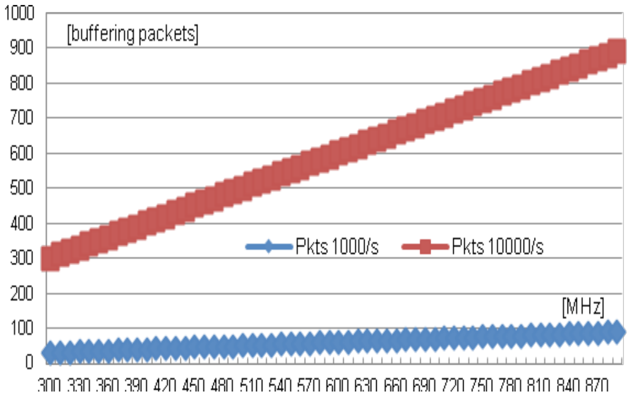

Figure 8. Buffering capacity of required packets for delay of synchronization bits.

From bandwidth delay condition, network queue should reserve buffering required packets in order to prevent packets loss from buffer overflow. If the distance between devices to device link is 3km and processing packets per 1 second is 10,000packets, the buffering required packets are 30 packets.

Table 1. Bandwidth Delay Product of the Link

Orbit	Km	Buffering required packets
Short distance	3	30
	5	50
Medium distance	15	150
	30	300
Long distance	50	500
	120	1200

The state of buffer overflow is as follows in Eq (8),
B_UB > (RTS – RP)* TD (8)

Where B (B_UB , B_LB) is buffer size of optimal, RTS is transmission rate, RP is processing rate, RCut off is lower bound of buffer size, and TD is network delay.

Assume that buffer size is 50K, required buffer size and overflow range is as follows in Figure 9.

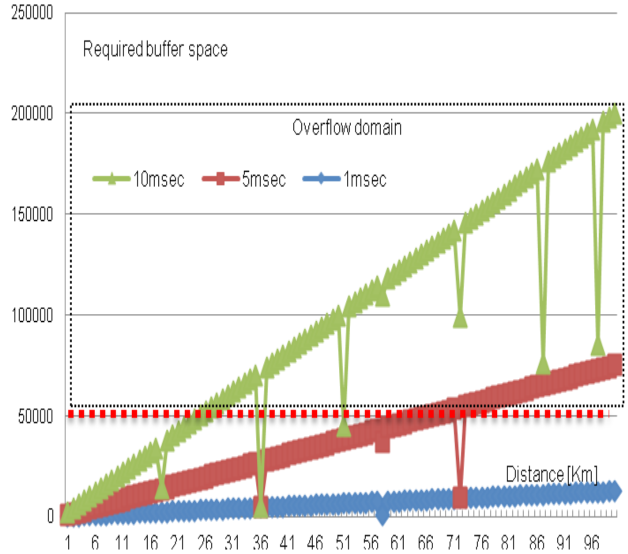

Figure 9. Buffering capacity of required packets vs. overflow range.

The state of buffer underflow is as follows in Eq (9),
RCut off * TD < B_LB (8)

3. Conclusion

In this paper, we describe link propagation of cipher synchronization in d2d link channel. Path loss of propagation analysis in d2d link channel is needed to effect bit error rate of start sequence in d2d communication link. Also it is reviewed the relation of link delay and buffer size for retransmission of link synchronization, which is included in start sequence.

4. Acknowledgement

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5. References

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