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Constant Bit Error Rate based Turbo Decoder Model using APP Decoder and AWGN Channel

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***Abstract*—Model of Turbo Decoder presents in this paper, this model having two main advantages low bit error rate and bit error rate is constant, not varies with signal to noise ratio, which is very helpful for decoding. Performance is increased due to these two factors.**

***Key Words*—Turbo Decoder, Bit Error Rate, Signal to Noise Ratio, Performance**

I. INTRODUCTION

Turbo codes are high performance code developed in 1990-91[1] for Forward Error Correction (FEC) and better bit error rate compare to other convolution code and block code. Turbo codes having performance near Shannon Capacity limit. Turbo codes are so useful, when first introduces no can believe that these type of performance can be achieved. Now a day where high performance required use turbo code is essential, for example in 4G LTE network turbo codes having used. Turbo decoder model is different for different network. In this paper a model of turbo decoder present, it has following advantages-

- Bit error rate have advantages in communication mainly in wireless communication if less bit error rate, then channel having better decoding speed.
- Bit error rate is constant not varies with signal to noise ratio. So in the signal path noise will not effect on data and not need to use any other equipment to remove noise.
- Due to these two factors the performance is also increased, because performance is depend upon these two factors.

So turbo decoder model present have several advantages, it is very useful in wireless communication. The turbo codes have specially designed for different generation of wireless communication.

II.TURBO ENCODER AND DECODER

Turbo Encoder uses some convolution code and interleaver in between them [2]. The input to the second encoder is the interleaved version of the first encoder input. The structure of the encoder is called parallel because same set of bits are used.

The generation matrix in Turbo Encoder can be represented as-

$$G(D) = \left[1, \frac{g1(D)}{go(D)}\right]$$

Here g1(D) and go(D) are the feed forward and feedback polynomial.

A simple turbo Encoder shown in Fig. 1-

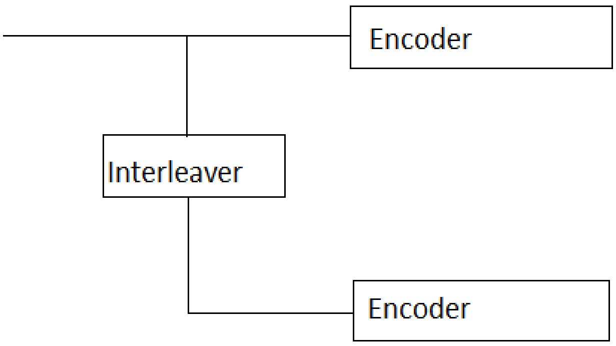

Fig.1 A simple Turbo Encoder

Turbo Decoder uses parallel concatenated or iterative decoding scheme [3]. In iterative decoding scheme the two APP decoder is used, in which the output of one decoder is the input of the second decoder. For rearranging the data in some way some interleaver used, as per the requirement different interleaver may be used.

A simple Turbo Decoder in fig. 2 –

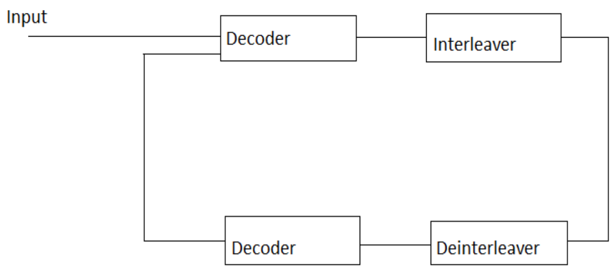

Fig.2 A simple Turbo Decoder Model

Turbo Decoder decoding through the different iteration, depend on the situation we choose the no of iterations.

III. TERMINOLOGY USED IN THE TURBO DECODER

Different terminologies used in the Turbo decoder as follows-

A. APP Decoder

The APP Decoder performs a posteriori probability (APP) decoding of a convolution code [4].

Input signal in APP decoder is-

- Input L(u)
- Input L(c)

Output signal in APP decoder is-

- Output L(u)
- Output L(c)

L (u) represents the log–likelihood of the encoder sequence bit; L(c) represents the log-likelihood of the code bits.

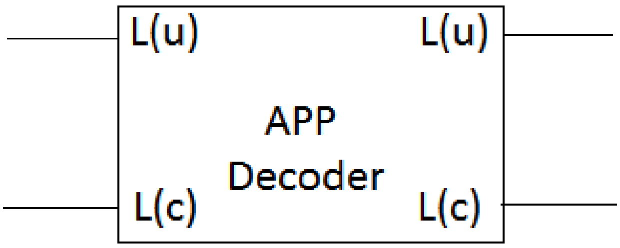

Fig.3 APP Decoder

As shown in figure Fig. 3 the APP decoder has two input and two output , the termination method used in the APP decoder is truncated or terminated and algorithm may be used between True APP, max, max*.

B. Random Interleaver

Random Interleaver rearranges the elements of input vector by using random permutation [5].

It accepts different data type some as int8, uint8, int16, and uint16 etc.The input vector must match with output column vector.

C. Random Deinterleaver

It works opposite of the Random Interleaver, before going to the second decoder the input vector is converted into the same input which is taken from the starting.

D. Bit to Integer Converter

As the name specifies it maps bit into its crosspoending integer. For unsigned integers, if *N* is the Number of bits per integer, then the block maps each group of *N* bits to an integer between 0 and 2^N-1. As a result, the output vector length is 1/*N* times the input vector length. For signed integers, if *N* is the Number of bits per integer, then the block maps each group of *N* bits to an integer between -2^{N-1} and 2^{N-1}-1.

E. Integer to Bit Converter

It maps vector of integer values into bits. If number of bits per integer is N and treat as unsigned then input must be 0 to 2^N -1,if number of bits per integer is N and treat as signed then input values must between -2^{M-1} and 2^{M-1}-1.

F. AWGN Channel

AWGN channel added noise in the signal, passes through it. The accepted theory that involve in the communication theory is-

- The noise is additive.
- The noise is white.
- The noise samples have a Gaussian distribution.

AWGN used as a channel model in which the only impairment to communication is a linear addition of white noise with a constant spectral density and a Gaussian distribution of amplitude. The model does not account for fading, frequency selectivity, interference, nonlinearity or dispersion [6].
The relative power in a AWGN channel describe in terms of-

- SNR
- EsNo(Ratio of symbol energy to noise power spectral density)
- EbNo(Ratio of bit energy to noise power spectral density)

Block Diagram AWGN channel fig. 4-

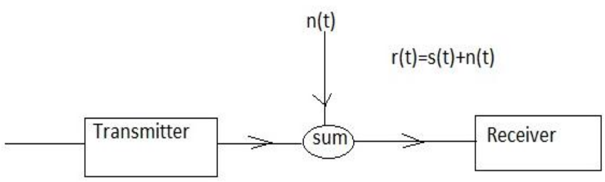

Fig.4 AWGN channel

G. QAM Modulator

In QAM modulator there are two carrier signals they are difference in 90 degree. One carrier is sine wave other is cosine wave.

H. QAM Demodulator

The QAM demodulators have reverse function of the QAM modulator. One phase is quadrature phase other phase is local phase

IV. SIMULATION RESULT

Simulation is carried in the MATLAB simulink. The turbo decoder used is connected with the transmitter [9-10] at the convolution with AWGN channel and QAM modulator [11-12].

AWGN channel used having number of bits per symbol is 1, input signal power is 1, symbol period is 2.

Turbo decoder has less bit error rate by using model shown in Fig. 5, the signal to noise ratio is zero. The two types of bit error rate method are used nowadays [13-14] for graph first one is that theoretical method and second one is Monte Carlo simulation [15-16] for bit error rate.

Number of error detected is 100 and total number of symbol compared 192.In APP decoder the termination method is truncated and algorithm is true APP.

TABLE I
BER analysis

Bit Error Rate	Signal to noise ratio
0.5208	0
0.5208	5
0.5208	10
0.5208	20

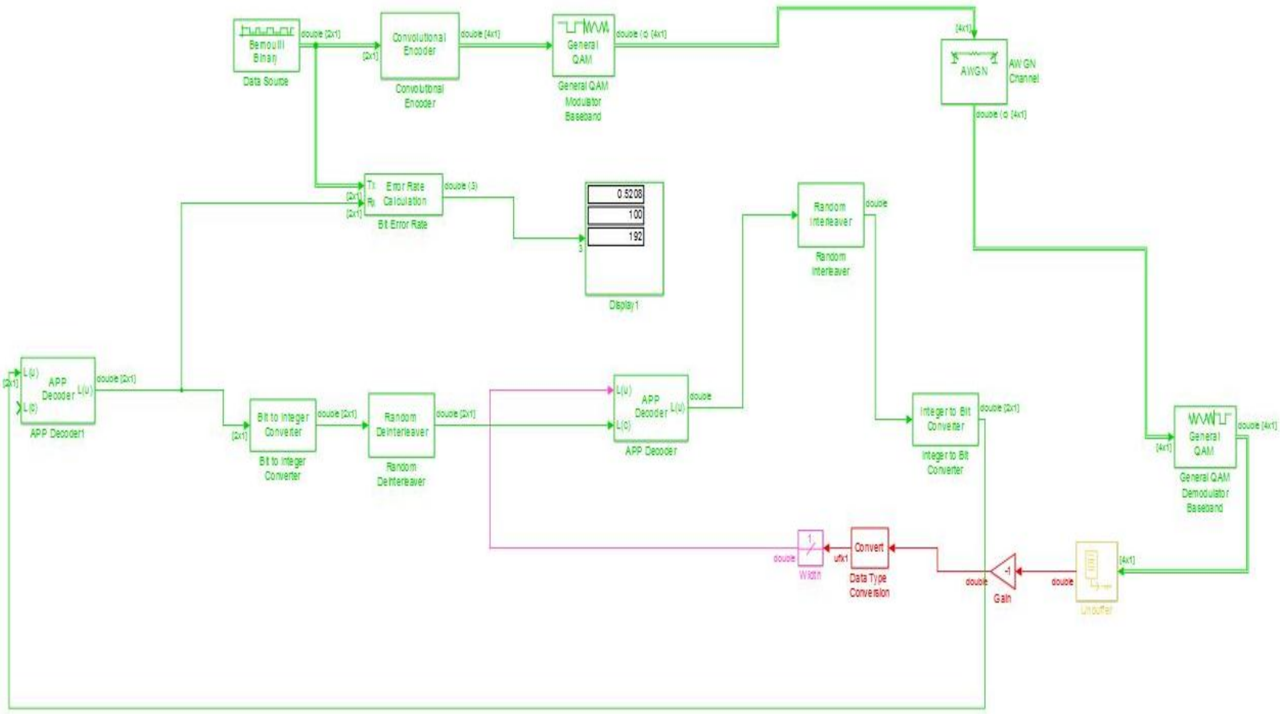

Fig.5 Turbo decoder Model

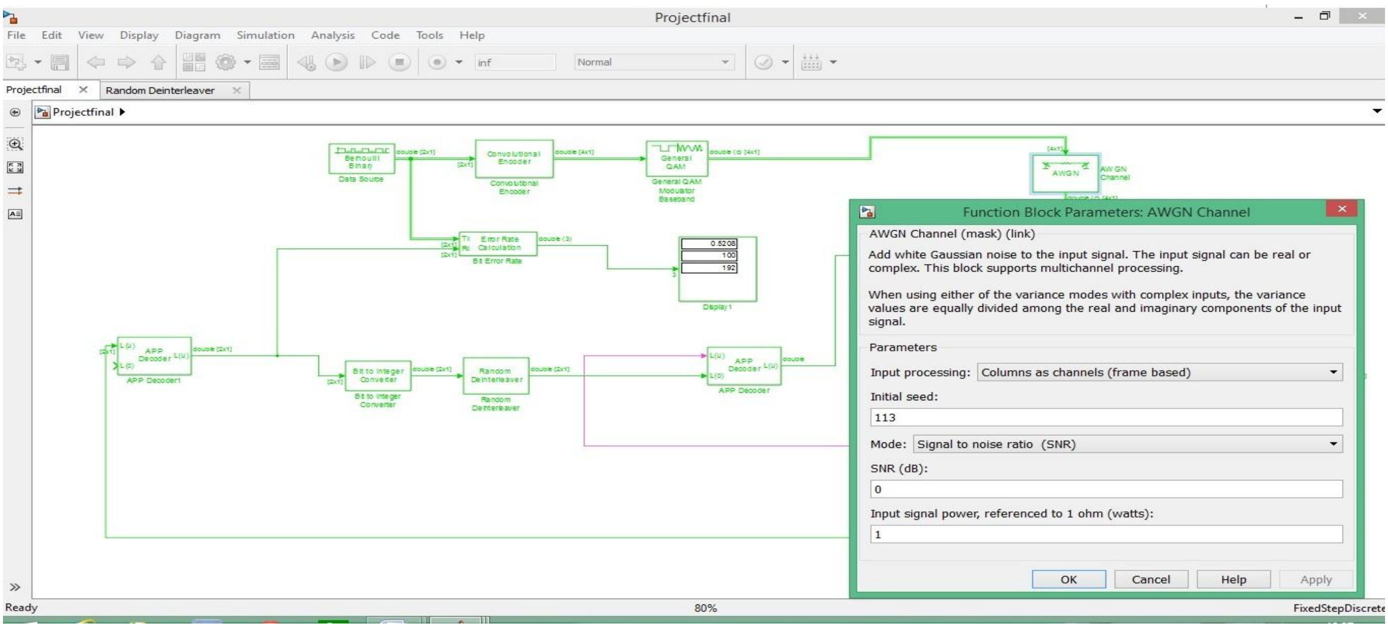

Fig.6 Turbo Decoder Model with SNR 0 db

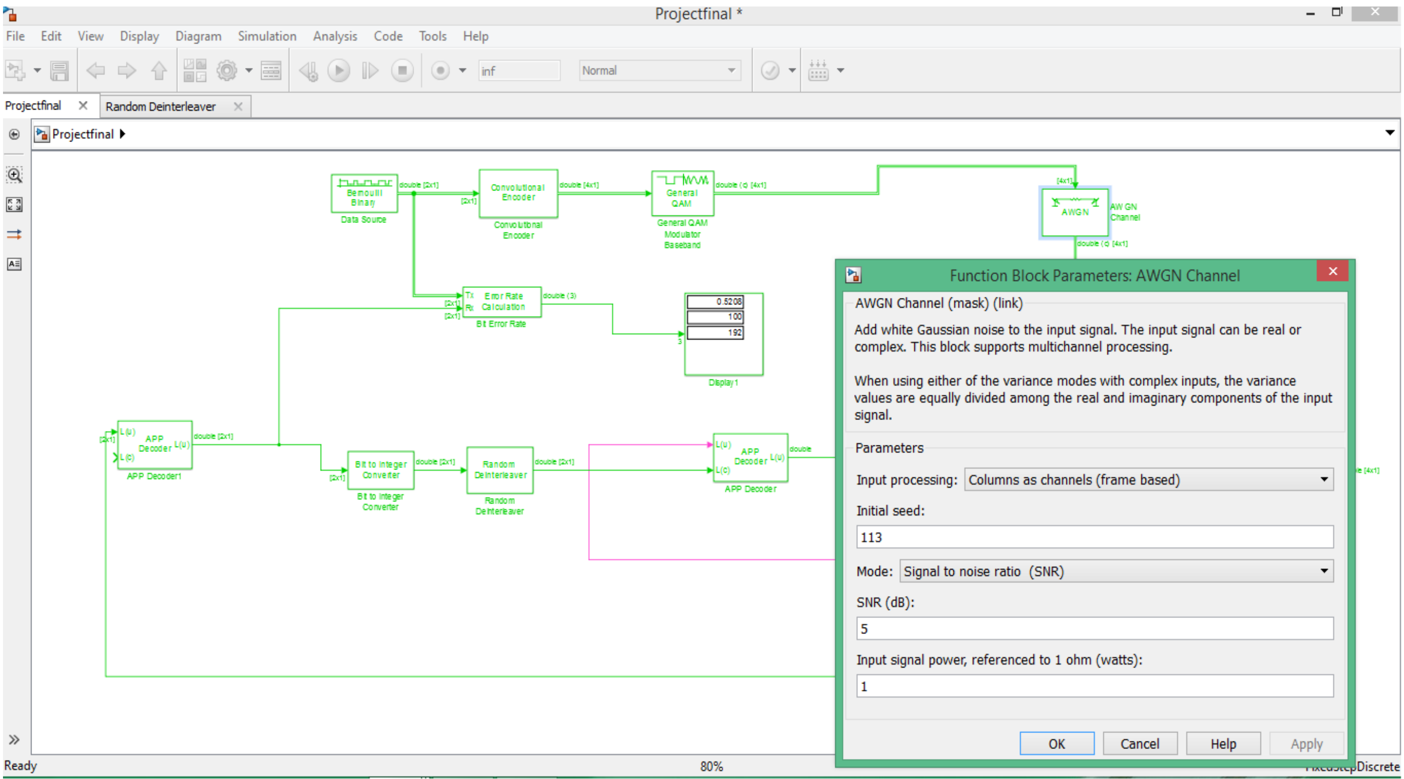

Fig.7 Turbo Decoder with SNR 5 db

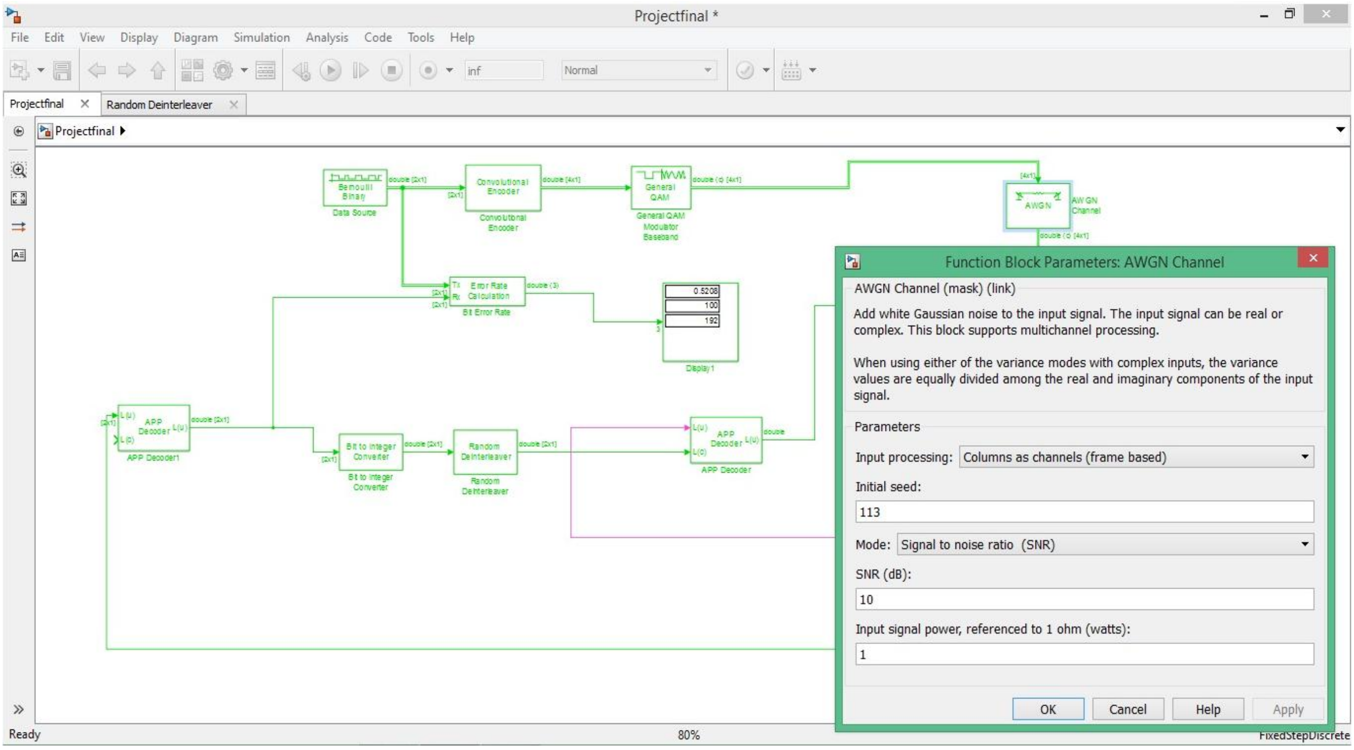

Fig.8 Turbo Decoder Model with SNR 10 db

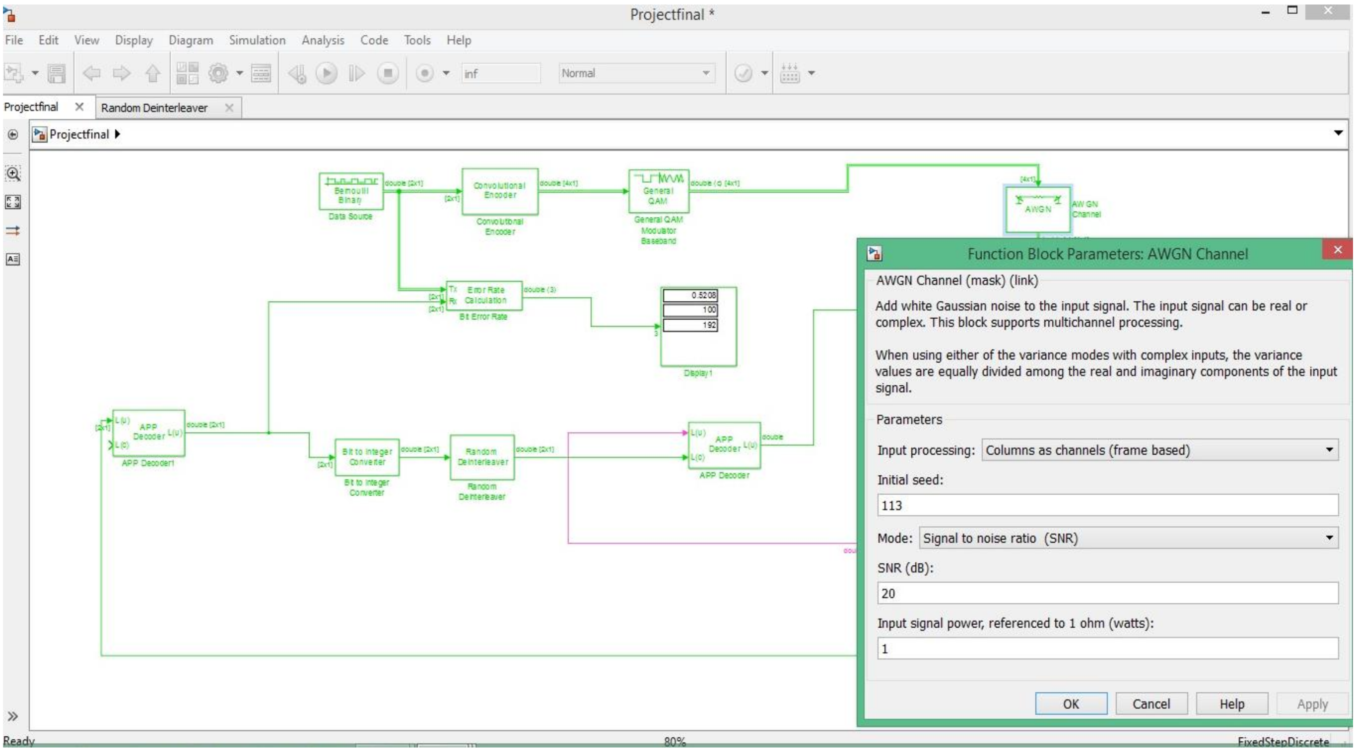

Fig.9 Turbo Decoder with SNR 20 db

The bit error rate is 0.5208 as shown after the simulation, the bit error rate are constant while signal to noise ratio will increase. The sequence of four MATLAB simulation are present here, in which in first case Fig.6 signal to noise ratio is zero , in second case Fig.7 the signal to noise ratio is 5 and in third case Fig.8 the signal to noise ratio is 10 in fourth case Fig.9 signal to noise ratio is 20 .It shows when we increases the signal to noise ratio bit error rate will not changed.

TABLE II Acronyms

Acronyms	Full form
BER	Bit error rate
SNR	Signal to noise ratio
BPSK	Binary phase shift keying
AWGN	Additive white Gaussian noise
APP	A posteriori probability
LTE	Long term evolution
FEC	Forward error correction

V.CONCLUSION

I proposed turbo decoder which have constant bit error rate with signal to noise ratio varies. It is very helpful for decoding. The power and efficiency will also increased due to BER and SNR as it effect the turbo decoder, less BER increase the efficiency [17-18] and decoding power. when less noise occur [19-20] the decoding is more effective communication [21], 4G.

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