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# PERFORMANCE ANALYSIS AND COMPARISON BETWEEN TWO TECHNIQUE OF GPON NETWORK FOR VARIOUS COMMUNICATION APPLICATION

**Sanjeev Verma[1], Supriya Raturi[2] and Malay Ranjan Tripathy[3]**

*[1-3]Amity School of Engineering and Technology, Amity University Uttar Pradesh, Noida, India.*
*Email: [1]verma.sanjeev1992@gmail.com, [2]supriya3raturi@gmail.com, [3]mrtripathy@amity.edu*

***Abstract:*** Today's generation needs a high-speed internet data for various application such as video chat, live broadcast, voice over internet, internet browsing. To fulfill this requirement, we need a network which is energy efficient and capable to work in any condition. In this paper, main focus is to put a network which is capable to provide a maximum Q-factor and minimum bit error rate by varying optical fiber length and user defined bit according to the need of customer. Here we introduce two technique, first one is uniform fiber bragg grating (FBG) and second one is ideal dispersion compensation FBG. By using user defined bit 1010101010 as input at kilometer 60 km, get a Q-factor of 20.055 and minimum BER of 6.30015e-090 as output using uniform FBG technique and using user defined bit 1010101010 as input at kilometer 60 km, get a Q-factor of 26.5287 and minimum BER of 2.04948e-155 as output using ideal compensation dispersion FBG technique.

***Keywords:*** PON, BER, NRZ.

## 1. INTRODUCTION

An optical fiber communication is one of the fast-growing technology for transmission and reception of information. Optical network has a competence to support upcoming and next generation services. There are many advantages of using optical fiber: high bandwidth, high security, compact signal deprivation, additional resistance to electromagnetic interference. In recent years, Passive optical network (PON) has been expansively researched and pragmatic to satisfy demand of increased bandwidth. PON technology is widely deployed because it reduces price and power consumption due to reduction in need of repeaters and amplifiers.

PON is well-thought-out used network because they make fiber available to the home in an economical way. The PON is standardized by the ITUT and the IEEE and made by the Full-Service Access Network (FSAN). Basically, there are two major standards of PONs which are Ethernet PON (EPON) and gigabits PON (GPON). GPON is considered over EPON because it has capability to provide next generation facilities and services.

Different works on GPON have been reported in the literature since last decade. A review on WDM-PON is made in a research paper by Banerjee et. al., [1]. TWDN-PON for next generation PON stage 2 is discussed in a paper [2]. Detail review on PON technologies is made by Effenberger et. al., [3]. More works on GPON are reported in the papers [4-5]. Recent works on uniform fiber bragg grating and ideal dispersion compensation fiber bragg grating are also presented in various research papers [6-10].

In this paper, focus is made on the quality of network, how it is efficiently capable to provide various services to the customer as per their requirement. Here, two technique are discussed, one is uniform fiber bragg grating (FBG) and second is ideal compensation dispersion FBG which act as a channel between the transmitter and receiver. The simulation design of a network is made in "OPTISYSTEM" software.

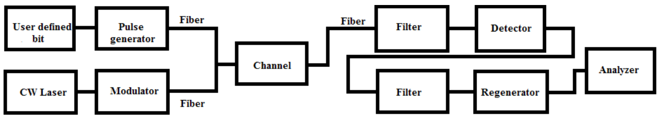



**Figure 1: Simulation block of proposed model of passive optical network (PON)**

The main parameters which defined the quality of network are maximum Q-factor and minimum bit error rate (BER). Q-factor is a dimensionless parameter. Q-Factor is also known as quality factor which describe how a bandwidth related to its central frequency. Q-factor measures the value of analog transmission signal and calculates the recital of a transmitted signal or data in terms of its SNR. As such, it considers physical parameters for example chromatic dispersion, material dispersion, losses, noise and any polarization or non-linear property which can corrupt the signal and ultimately causes various error like bit erroring the optical fiber communication link. In addition, the higher the value of Q-factor the greater the SNR, therefore lower the probability of BER.

This paper is organized as follows. Section II, discusses on simulation of the design and section III explains about FBG and technique. The results and discussion is made in section IV and section V concludes the paper.

## 2. SIMULATION SETUP

As mentioned in the introduction the focus of the paper is to design effective and efficient optical fiber network for long distance application to fulfill the requirement of customers as per their need by defining the concepts of gigabit point to multipoint which is a Passive optical network (PON) and measured most cost operative network to install fiber to the home (FTTH) and fiber to the building (FTTB).

### A. Transmitter Section

Transmitter section is also known as optical line terminal (OLT) consisting of optical amplifier devices and transmitters. Figure 2 shows the transmitters using a CW laser operating on 7dBm power with 199.1 THz frequency. Modulator is dual drive mach-zehnder with NRZ pulse coding. An optical fiber CWDM of length 1 km is connected to the dual drive mach-zehnder and optical attenuator of attenuation of 0db. Figure 3 shows the transmitter using a CW laser working on 8dBm power with frequency of 200.1 THz. Here modulator is mach-zehnder with saw-down pulse generator. An optical fiber of length 1km is connected to the mach-zehnder.

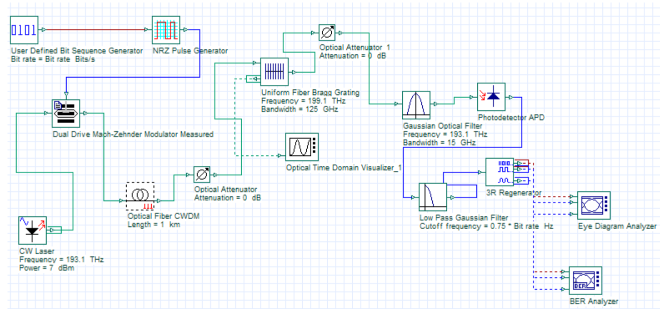



**Figure 2: Design of simulation setup using uniform FBG**

### B. Transmission Channel

The standard ITU-T G.652 optical fiber cable has been used by PON or GPON transmission channel. In figure 2, uniform fiber bragg grating with frequency 199.1 THz and bandwidth 125 Ghz act as a channel between a transmitter and receiver with optical time domain visualizer. In figure 3, ideal dispersion compensation FBG with frequency 200.1 THz, bandwidth 125 GHz, insertion loss 0 dB, depth 100 dB and dispersion -800 ps/nm act as a channel between a transmitter and receiver.

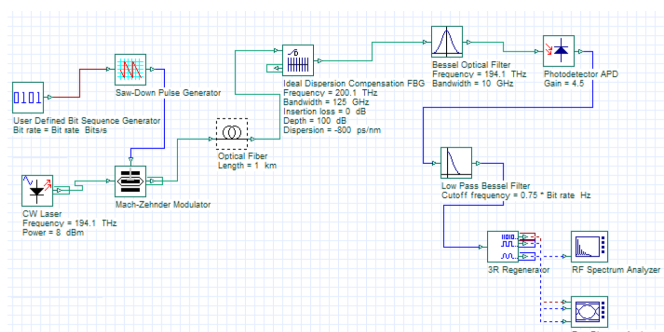



**Figure 3: Design of simulation setup using ideal dispersion compensation FBG**

### C. Receiver Section

Receiver section is also known as optical network unit (ONU). ONU consists of upstream and downstream devices. Figure 2 shows the upstream transmitter using Gaussian optical filter with frequency 193.1 GHz and bandwidth 15 GHz. The downstream receiver uses photo detector PIN and low pass Gaussian filter with cutoff frequency 0.75* bit rate Hz. In figure 3, the upstream transmitter uses a Bessel optical filter with frequency 194.1 THz and bandwidth 10 GHz. The downstream receiver uses photodetector PIN and low pass Bessel filter with cutoff frequency 0.75* bit rate Hz.

## 3. FIBER BRAGG GRATING AND TECHNIQUE

FBG were presented in late 1980s and became a subject of research with many applications. The FBG works on the principle that when ultraviolet light (UV) illuminates a certain kind of optical fiber, the refractive index of the fiber is changed permanently, this effect is called photosensitivity. Alternatively, the refractive index will last for several years if it is followed by proper annealing [11].

$$\lambda refl = 2n\Lambda \quad (1)$$

Equation (1) show bragg relation where $n$ is the refractive index and $\Lambda$ is the variation of the fiber bragg grating's innermost wavelength of the reflected component. Optical fiber gratings are important components in fiber communication and fiber sensing fields. For normal fiber gratings, by properly choosing the period, length, index modulation amplitude, chirp and apodization function, one can flexibly design and optimize grating reflection or transmission spectra to satisfy many applications [12].

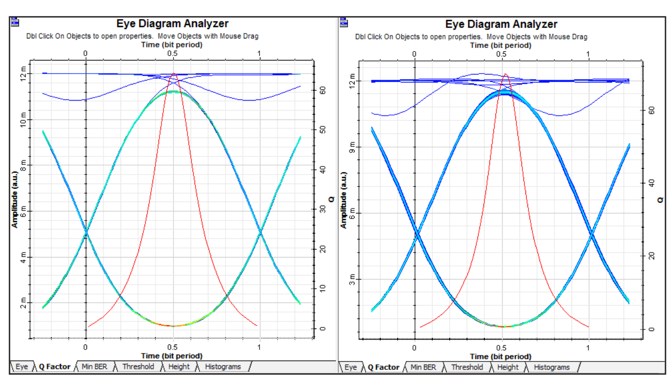
## 4. RESULTS AND DISCUSSION

As shown in the simulated result which is taken with the help of eye diagram analyzer, it is clear that as the optical fiber length is varied the important parameter such as Q-factor and BER is also varies. Long distance communication as well as in small distance communication demand or require a noise less and distortion less transmission. First network using uniform FBG technique give maximum quality factor at length 10 km which is 69.8934, similarly another network with ideal compensation dispersion FBG give maximum quality factor at length 10 km which is 106.573. Further changes in optical fiber length for uniform FBG technique give Q-factor as 64.2708 (L = 1KM), 69.8934 (L = 10KM), 62.6619 (L = 20KM), 40.449 (L = 30KM), 29.2734 (L = 40KM), 23.5305 (L = 50KM), 20.055 (L = 60KM), 17.4049 (70KM), 15.506 (80KM), 13.882 (90KM), 12.4259 (100KM), 10.9887(110KM). Similarly, further change in optical fiber length for ideal compensation dispersion FBG technique give Q-Factor as 165.053 (L = 1KM), 106.573 (L = 10KM), 83.3089 (L = 20KM), 63.7072 (L = 30KM), 52.8268 (L = 40KM), 35.5048 (L = 50KM), 26.5287 (L = 60KM), 16.8964 (L = 70KM), 12.1208 (L = 80KM), 7.94164 (L = 90KM), 5.40482 (L = 100KM), 3.44793 (L = 110KM).

The main reason to use an eye diagram analyzer is to display the received pulse and built the function which can approximate the Q-factor and BER according to the change in optical fiber length.

**Table 1**
**Comparison between different fiber length using Uniform FBG**

| *Optical fiber length (KM)* | *Q-Factor* | *Minimum bit error rate (BER)* |
|---|---|---|
| 1KM | 64.2708 | 0 |
| 10KM | 69.8934 | 0 |
| 20KM | 62.6619 | 0 |
| 30KM | 40.449 | 0 |
| 40KM | 29.2734 | 7.84788e-189 |
| 50KM | 23.5305 | 6.79349e-123 |
| 60KM | 20.055 | 6.30015e-090 |
| 70KM | 17.4049 | 2.65373e-068 |
| 80KM | 15.506 | 1.1175e-054 |
| 90KM | 13.882 | 2.90665e-044 |
| 100KM | 12.4259 | 6.91902e-036 |
| 110KM | 10.9887 | 1.63138e-028 |



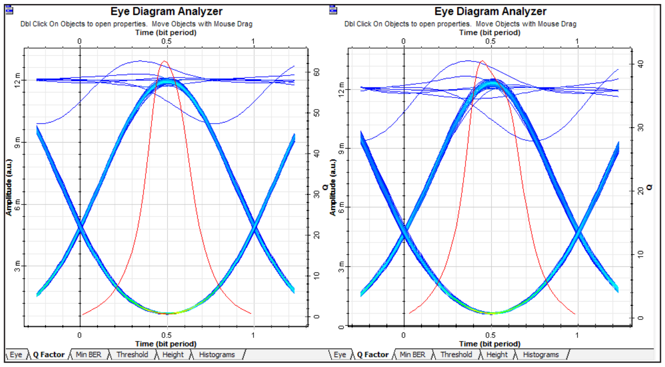



**Figure 4:** **Q-factor of 1KM, 10KM, 20KM, 30KM**

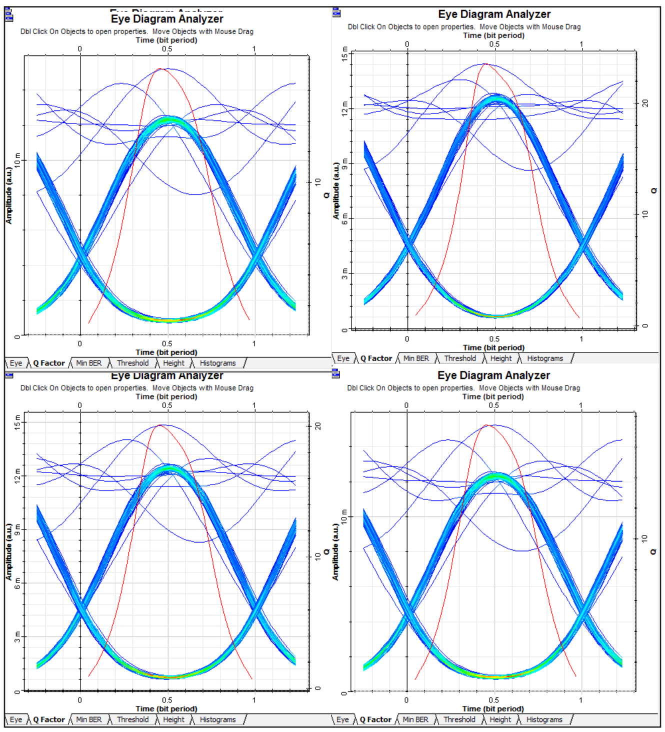



**Figure 5:** **Q-factor of 40KM, 50KM, 60KM, 70 KM**

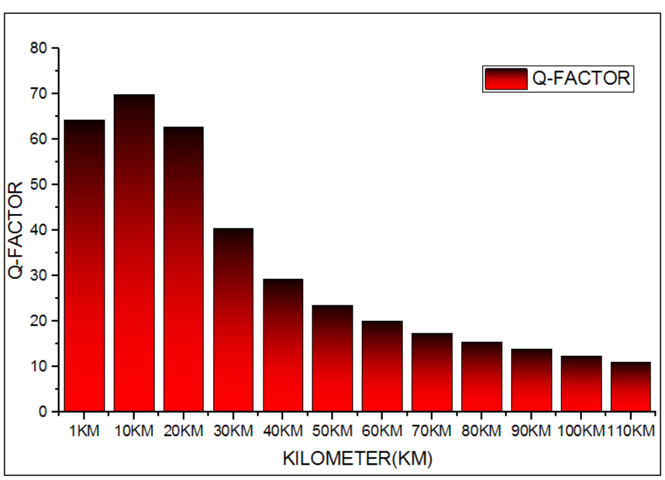



**Figure 6:** **Q-factor V/S KM using Uniform Fiber Bragg Grating**

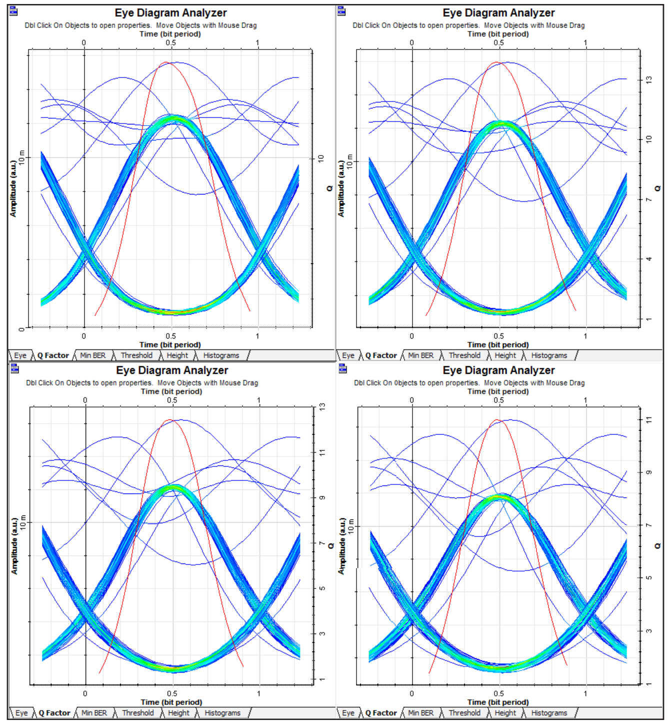



**Figure 7:** **Q-factor of 80KM,90KM,100KM,110KM**

**Table 2**
**Comparison between different fiber length using ideal compensation dispersion FBG**

| *Optical fiber length (KM)* | *Q-factor* | *Minimum Bit error rate (BER)* |
|---|---|---|
| 1KM | 165.053 | 0 |
| 10KM | 106.573 | 0 |
| 20KM | 83.3089 | 0 |
| 30KM | 63.7072 | 0 |
| 40KM | 52.8268 | 0 |
| 50KM | 35.5048 | 2.00003e-276 |
| 60KM | 26.5287 | 2.04948e-155 |
| 70KM | 16.8964 | 2.21848e-064 |
| 80KM | 12.1208 | 3.55657e-034 |
| 90KM | 7.94164 | 9.15561e-016 |
| 100KM | 5.40482 | 2.81203e-008 |
| 110KM | 3.44793 | 0.000259475 |

**Table 3**
**Comparison with different references**

| | *Kilometer (KM)* | *Q-factor* | *Minimum Bit error rate (BER)* |
|---|---|---|---|
| This work | 20KM | 62.6619, 83.3089 | 0,0 |
| [13] | 20KM | 2.53573 | 0.004864 |
| [14] | 20KM | 2.37751 | 0.00574314 |

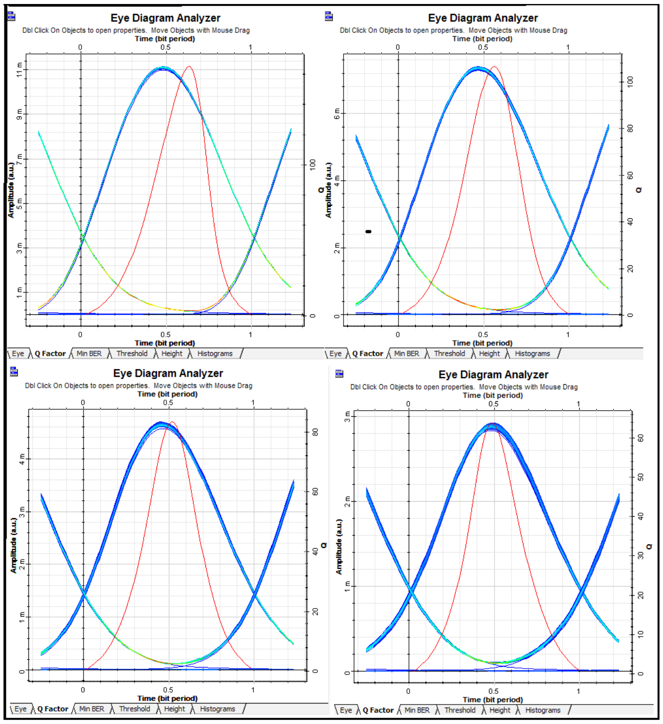



Figure 8: Q-factor of 1KM, 10KM, 20KM, 30KM

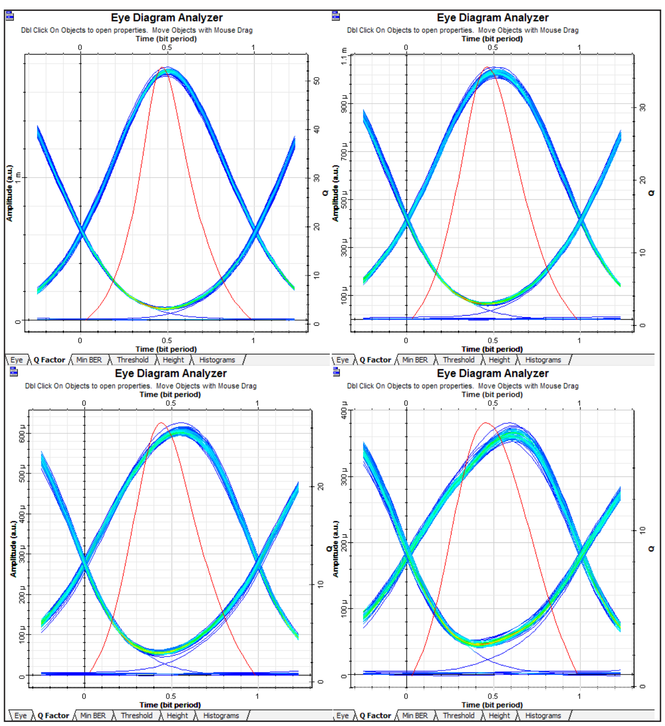



Figure 9: Q-factor of 40KM, 50KM, 60KM, 70KM

## 5. CONCLUSION

In this paper, the comparison between two techniques is done. In case of fiber bragg's grating (FBG) technique it is seen that Q-factor of 20.055 and minimum BER

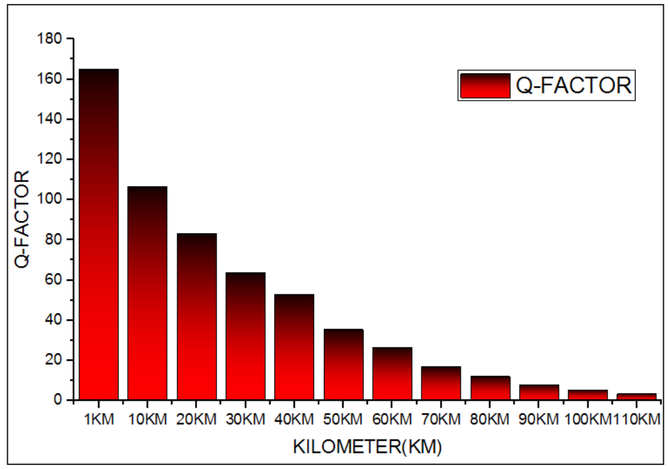



Figure 10: Q-factor V/S KM using Ideal Compensation Dispersion FBG

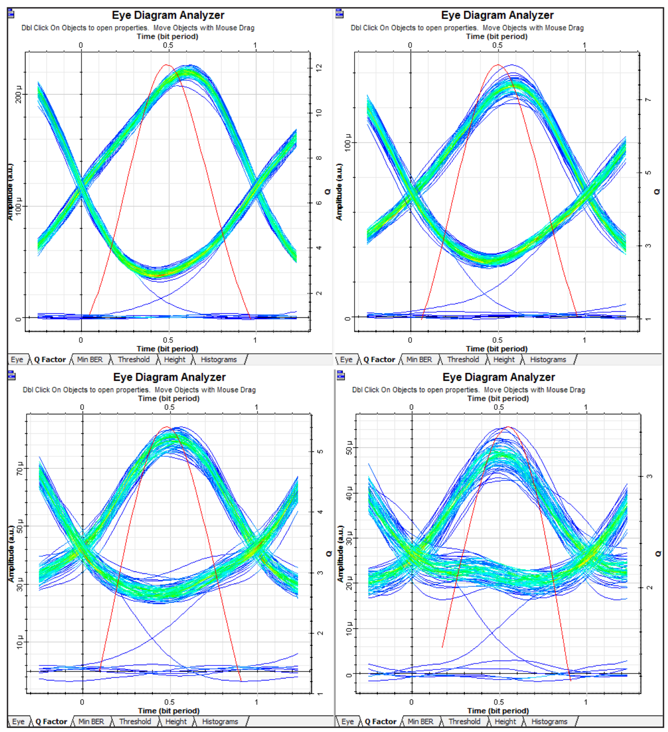



Figure 11: Q-factor of 80KM, 90KM, 100KM, 110KM

of 6.30015e-090 are obtained at 60 KM distance for 1010101010 as input bit. Similarly, in case of ideal compensation dispersion FBG technique it is observed that Q-factor of 26.5287 and minimum BER of 2.04948e-155 are obtained at 60 KM distance for 1010101010 as input bit. So, the proposed design of both network has a capability to support various wired communication and wireless communication application like Home-automation, LAN, 5G, FI-WI, WI-FI, fiber to the home (FTTH), fiber to the building (FTTB) depend on the need of customer.

Fiber bragg's grating technique is used to compensate the dispersion effect in communication unit which lead to inter symbol interference (ISI).

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