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PERSPECTIVES OF ALGORITHMS TRANSFORMATION OF NOISE-IMMUNE SIGNALING OF DVB-T2 STANDARD INTO A DUPLEX COMMUNICATION SYSTEM

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ПЕРСПЕКТИВЫ ТРАНСФОРМАЦИИ АЛГОРИТМОВ ПОМЕХОУСТОЙЧИВОЙ ПЕРЕДАЧИ СИГНАЛОВ СТАНДАРТА DVB-T2 В ПРОТОКОЛЫ ДУПЛЕКСНОЙ СВЯЗИ

В данной работе рассматриваются новшества, внедренные в стандарт телевизионного вещания DVB-T2, с точки зрения переноса его особенностей из системы с односторонней передачей в дуплексные многопользовательские системы. Детально рассмотрены механизмы обеспечения устойчивости сигнала в пределах физического канала. Значительное внимание в статье уделено особенностям стандарта, отвечающим за мультисервисность системы.

The DVB-T2 standard is the latest standard for television broadcasting. The DVB-T2 standard is rated to improve the throughput of DVB-T2 networks at least 30% with the same infrastructure and frequency resources in comparison with DVB-T. DVB-T2 is fundamentally different as a system level architecture (MAC-layer - control of access to multimedia), as functions of the physical layer. A fundamental difference with the previous standard is the concept of the physical layer PLP (Physical Layer Pipe).

These innovations are a platform for transferring features of DVB-T2, as a system with one-way transmission, to an alternative multi-user and multi-service duplex system.

An important feature of the considered standard can be characterized by the multiservice system, i.e. orientation to several services. The DVB-T2 system is capable of transmitting several independent multimedia streams, each of which is processed in its backbone - a physical layer (PLP) channel.

Much attention in the algorithms of the standard is paid to ensuring the stability of information transfer. Streams are different in their structure, by the way each stream has an own modulation scheme, coding rate and time intervals.

The packets of each stream are combined into frames. The header of the frame contains information about the length of the packet and the position of the first packet, which allows reconstructing the frames on the receiving side. The size of each frame, that contains any content and/or internal signaling, is constant for PLP, but depends on the code rate of the LDPC and the length of the FEC blocks.

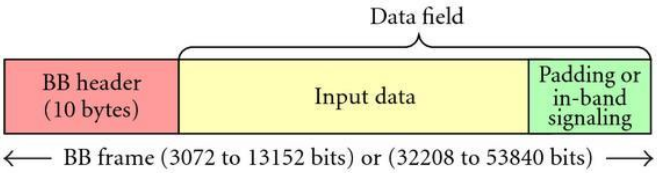

Fig.1. Streaming frame structure

In comparison to the duplex satellite communications system (SCS), where combination of convolutional codes and Reed Solomon codes are commonly used, encoding in DVB-T2 is more efficient, since convolutional codes are considered one of the least effective codes. Therefore, it is possible to propose more complex in calculating long-block LDPC for SCS, as in the DVB-T2 standard. A block LDPC code or a long BCH would provide the same encoding speed for the same communication parameters, thereby increasing the noise-immunity of the signal and the system capacity.

One of the innovations of DVB-T2 is the introduction of a modulation scheme with a "rotating" signal constellation. Literally, the generated modulation symbol rotates in a complex plane by a certain angle depending on the number of modulation levels (29° for QPSK, 16.8° for 16-QAM, 8.6° for 64-QAM and arctg (1/16) for 256-QAM). In addition, before starting the rotation, the symbol coordinate (Q) of each modulation symbol is cyclically shifted within the same code word.

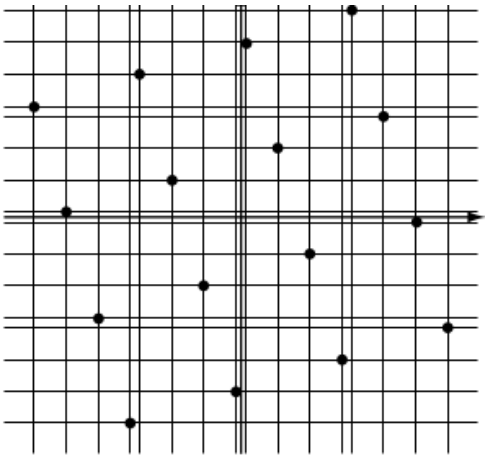

Fig.2. Signal constellation 16-QAM after turning

Such a turn can significantly improve the noise-immunity of the signal for typical ether problems. Turning the diagram to a precisely chosen angle, each point of the constellation receives unique coordinates (Q-coordinates and I-coordinates) that are not repeated by the remaining points. Thus, if one carrier or symbol lost as a result of interference, information about another coordinate would be preserve, this will allow the symbol to be restored but with a lower signal-to-noise level.

In a remarkable term of events the multi-user system is the factor that the DVB-T2 standard implements the OFDM technology. The OFDM (Orthogonal frequency-division multiplexing) technology is a method for modulating a plurality of carriers,

i.e. distributing a multitude of flows, within its bandwidth with a frequency step. The modulation rate of an individual carrier is sufficiently small, which makes it possible to use effective noise-immune encoding and take measures to combat intersymbol interference (introduce special guard intervals in each OFDM symbol). This is an essential factor for increasing the stability of duplex radio relay communication.

An additional tool for combating the multipath and its duration is using three cascades of displacements in the DVB-T2 standard: bit, time and frequency interleaving. This allows the LDPC decoder to be free from the effect of grouping errors in fading.

In this case, bit interleaving is responsible for randomizing bits within FEC blocks.

The time interleaving redistributes the FEC block data by symbols within the frame of the DVB-T2 frame. This increases the resistance to impulse noise and the characteristics change of the transmission path.

Finally, frequency interleaving allows data to be randomized within the OFDM symbol in order to mitigate the effect of selective frequency fading. These circumstances make it possible to ensure that the distorted elements, including batch errors, in the decoder will be scattered over the LDPC FEC frame, which should allow the LDPC decoder to perform the reconstruction.

The structure of the streaming FEC frame with BCH & LDPC coding is shown in figure 3. The total length of the frame with superimposed noise protection encoding is 64800 bits.

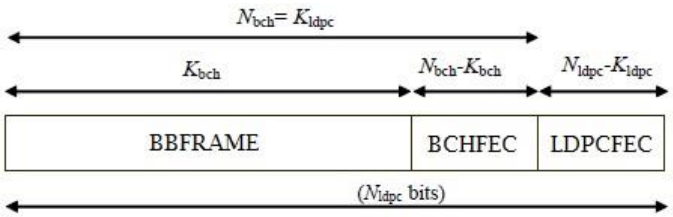

Fig. 3. Format of data with BCH & LDPC coding

In a conclusion paragraph, we can admit that the DVB-T2 standard contains many effective and advanced algorithms for noise-immune signaling that could be useful in duplex radio-relay and satellite communication systems.

References

1. Frame structure channel coding and modulation for a second generation digital terrestrial television broadcasting system (DVB-T2). – Draft ETSI EN 302 755 V1.4.1, February 2015.
2. Balyar V.B. Comparative characteristics of digital terrestrial television broadcasting standards of DVB-T/T2/V.B. Balyar, O.V. Gofaizen // Digital technology. - 2012. - Vol. 11. - P. 31-46.