The main strength of WiMAX is its high data transfer speeds, supporting both point-to-point and broadband access for multiple devices. Its versatility across different frequencies and compatibility with stationary and mobile devices make it suitable for a wide range of wireless applications.

Thus, WiMAX (IEEE 802.16) remains a relevant and versatile technology, particularly in cognitive radio networks and remote regions, offering high data transfer speeds, dynamic spectrum utilization, and adaptable communication capabilities, despite facing competition from LTE and 5G.

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THE METHOD OF STEPWISE HYBRID TIME SEGMENTATION BASED ON BANDPASS FILTERING WITH TIME-FREQUENCY ADAPTATION

In modern conditions of increased requirements for communication quality and data transmission speed, especially in complex interference environments, it is necessary to ensure effective filtering and adaptive signal ensemble formation. This is required to minimize mutual correlation between signals, improve data transmission quality, and ensure resistance to interference. These challenges can be addressed using the method of stepwise hybrid time segmentation based on bandpass filtering with time-frequency adaptation.

The core idea of the method lies in the integration of time segmentation with filtering in the frequency domain, allowing the signal's behavior to be considered at each stage of formation. This approach provides a dynamic transition between the time and frequency domains, taking into account the mutual correlation properties of the signal and enabling improved signal characteristics.

The main steps of the algorithm for the method of stepwise hybrid filtering with domain transitions include the following.

1. Initial Stage. The signal undergoes bandpass filtering in the frequency domain to isolate the necessary frequency bands and reduce mutual correlation between components.

2.Time Shift. After each stage of spectral filtering, a time shift of the signal components is performed to preserve temporal connections and adapt the filtering according to changes in the time domain.

To ensure optimized modeling of signal characteristics, considering both linear and nonlinear changes, methods for signal ensemble formation, such as Volterra integral equations, can be used to model signal variations at each stage of filtering.

After each stage of frequency domain filtering, the signal transitions to the time domain for adaptive segmentation. This adaptive segmentation involves selecting optimal time intervals, where each segment is processed separately, allowing for the minimization of correlation between signal components.

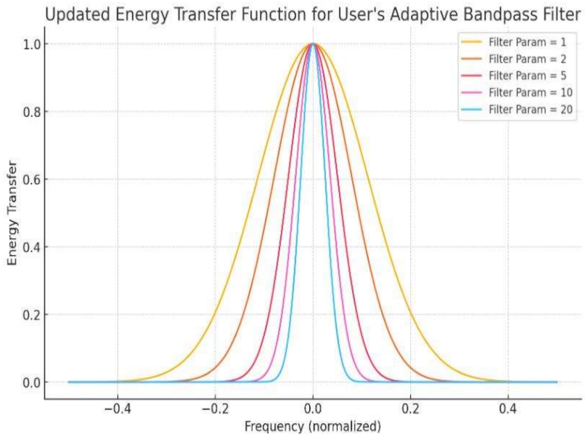
For the analysis of time segments, it is advisable to use the Hilbert-Huang Transform (HHT), which can identify local oscillations and adapt further processing based on the detected characteristics.

At each stage of filtering (both in the frequency and time domains), it is effective to apply Lagrange multipliers to find the optimal filtering and segmentation parameters, considering constraints such as minimizing mutual correlation.

Additionally, after each transition between domains, L'Hôpital's rule(*) can be used to analyze the boundary values of signal parameters. This helps to avoid issues at critical points, where changes in the signal could lead to significant information loss.

A key feature of the method of stepwise hybrid time segmentation based on bandpass filtering with time-frequency adaptation is the combination of frequency-domain filtering with adaptive time shifts. This provides a comprehensive approach to signal ensemble formation, where each stage involves returning to the time domain for analysis and further adjustment.

The use of different transformations at each transition between the time and frequency domains (e.g., HHT in the time domain, DCT in the frequency domain) allows for flexibility and adaptability in signal processing while maintaining a low level of correlation between components. Accounting for nonlinear components using Volterra equations enables a multistep approach to modeling signal changes, ensuring high accuracy and uniqueness (Fig.1).



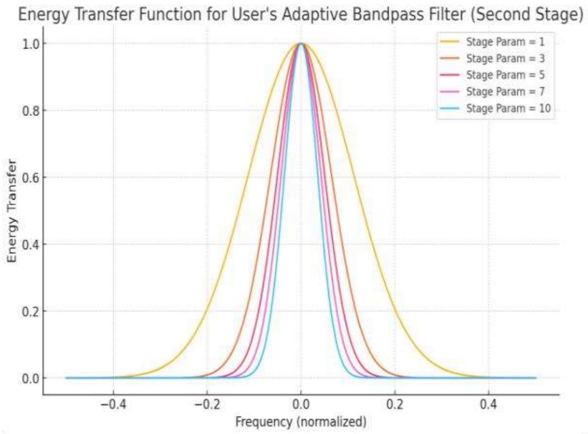


Fig. 1 Energy transfer functions before and after filtering for hybrid time segmentation

The proposed method not only transitions to the time domain but also integrates time and frequency analysis, taking into account variable signal parameters. This creates a more flexible model for signal ensemble formation, suited to real-world conditions in complex interference environments.

*L'Hôpital's rule is named after the French mathematician Guillaume de l'Hôpital. It is a mathematical principle used primarily in calculus to analyze the limits of indeterminate forms, especially when functions approach 0/0 or ∞/∞. The rule applies in mathematical contexts where derivatives help in determining the limit of a function at critical points

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SPECTRAL MONITORING METHOD BASED ON MULTISTAGE FILTERING AND AIC & BAYESIAN INFORMATION CRITERIA

The relevance of implementing multistage recurrent spectral monitoring methods with adaptation to dynamic radio environments is driven by several key factors. Firstly, the growing use of wireless technologies has led to an increase in the number of devices, which in turn creates significant pressure on the frequency spectrum. Secondly, the limited availability of frequency resources makes the efficient use of the spectrum a critically important task in modern telecommunication systems. Thirdly, the dynamic nature of the spectral environment, characterized by rapid changes, necessitates the use of adaptive methods capable of ensuring stable and reliable operation of cognitive radio systems. Given these challenges, the implementation of a multistage recurrent spectral monitoring method with adaptation to dynamic cognitive radio environments, particularly under conditions of fading and distortions, becomes essential. This method involves multistep filtering processes (Kalman filters, Wiener filters, and median filters) and the application of Akaike and