Analysis and design of channel interleavers for terrestrial broadcast
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## Motivations

- In terrestrial broadcast standards such as DVB-T2, channel interleaving is achieved through stacking several specific interleavers
- **Aim:** propose design criteria for channel interleavers based on span properties in the time and frequency domains and on the distribution of mutual information (MI)

## Span properties

- **Frequency span:** $S_{f}(i) = \min |f_{i} - f_{j}| + |f_{n(i)} - f_{n(j)}|$
- **Time span:** $S_{t}(i) = \min |t_{i} - t_{j}| + |t_{n(i)} - t_{n(j)}|$
- **Design criterion:** maximize time and frequency spans

## Analysis of DVB-T2 interleaver

- **Frequency histogram** for $N_{f} = 357$ OFDM symbols
- **Time histogram** for $N_{f} = 1705$ carriers

**CI:** Cell Interleaver  **TI:** Time Interleaver  **FI:** frequency Interleaver

## Design of interleavers with good span and MI distribution properties

### Studied interleavers

- **Regular interleaver (RI):** $\Pi(i) = P \times i \mod N_{F}$ with $P = P_{r} \times N_{F} + P_{f}$, $N_{F}$ being the number of cells in an ODFM frame
- **Double regular interleaver (2RI):** $\Pi(i) = N_{F} \times i + f_{n(i)}$ with $f_{n(i)} = (P_{r} \times i + f_{i}) \mod N_{F}$ and $f_{n(i)} = P_{r} \times i \mod N_{F}$
- **Almost regular permutation (ARP):** same as RI with cyclic shift in $\Pi(i)$ expression
- **Double almost regular permutation (2ARP):** same as 2RI with cyclic shifts in $f_{n(i)}$ and $f_{n(i)}$ expressions

## Mutual information distribution

- **Average mutual information (MI) per FEC block**
  \[
  AMI_{j} = \log 2 - \frac{\sum_{i} \max(0, z_{i} (-1)^{b_{i}})}{N_{F}}
  \]
- **Design criterion:** minimize the variance of MI distribution over FEC blocks in the OFDM frame $\Rightarrow$ uniform distribution of the MI

**Conclusion:**

- Analysis and design of channel interleavers for terrestrial broadcast
- Importance of span properties and MI distribution
- Interleaver design criteria for optimal performance