ITUWorkshop

# The future of television for Europe

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# ITU Workshop on “Future of television for Europe”

## Energy and spectral efficiency of MIMO for Digital Terrestrial Television Broadcasting


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# Introduction to DTTB efficiency

**DTTB** is more **energy-** and **spectrum-efficient** than unicast systems for delivering audiovisual content to large audiences.

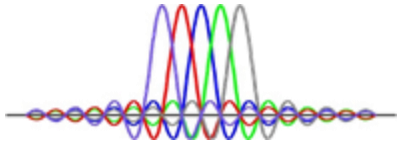
Can we make it even more efficient?

**Yes, we can!**

# Ways to improve efficiency in DTTB

There are two main approaches for **improving DTTB efficiency**:

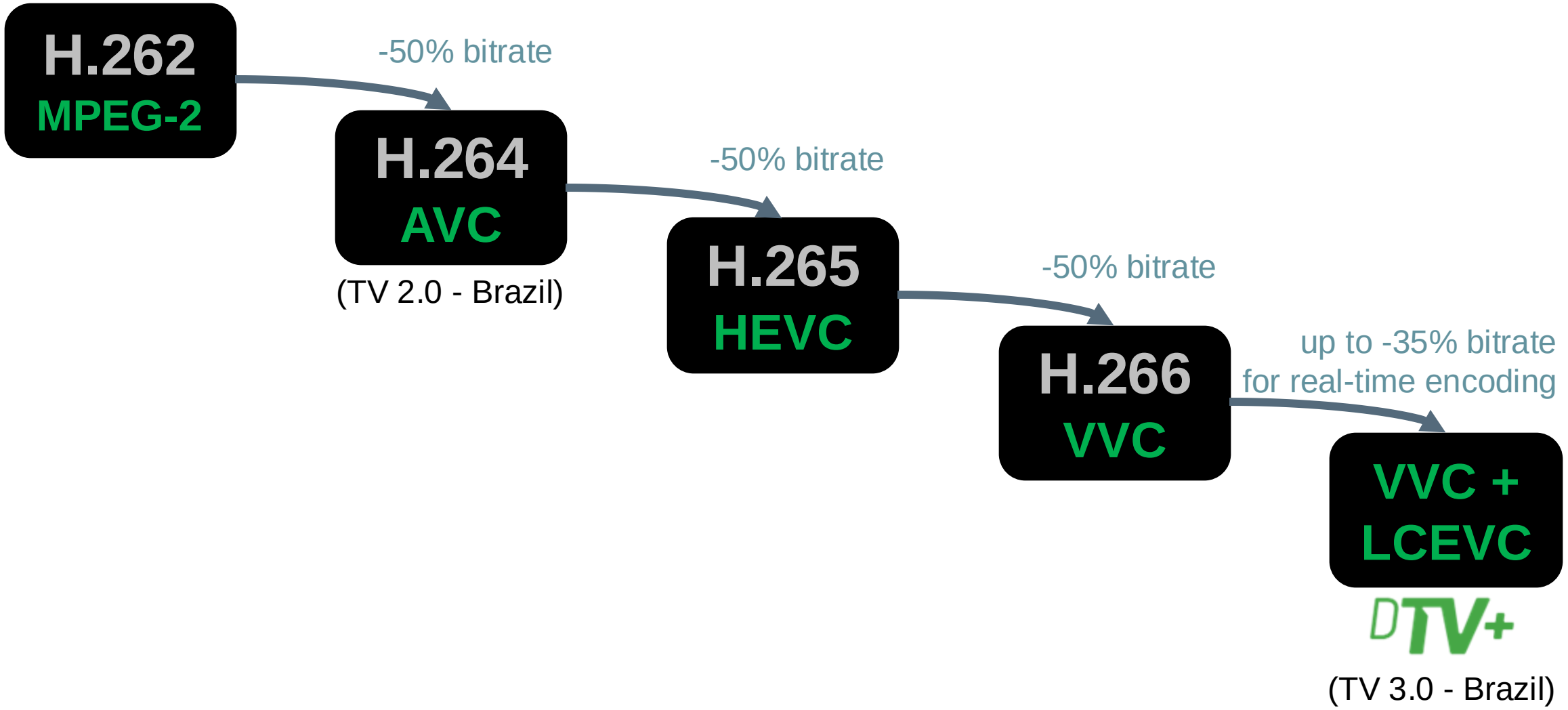

1) Improving **source coding** efficiency; and



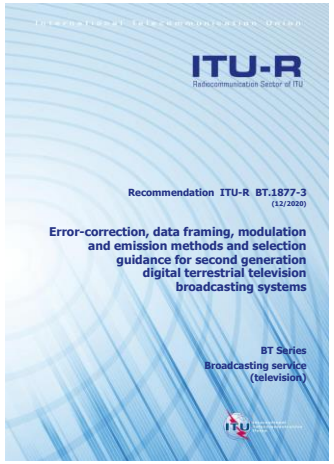
2) Improving **physical layer** efficiency.

Improving **energy efficiency** in DTTB also enhances **spectrum efficiency** and vice-versa.

# Improving source coding efficiency

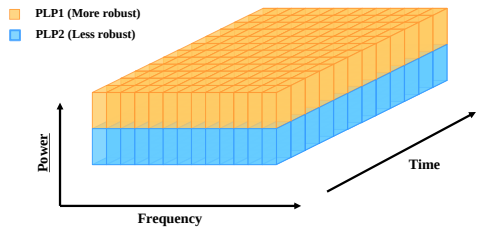


# Improving physical layer efficiency

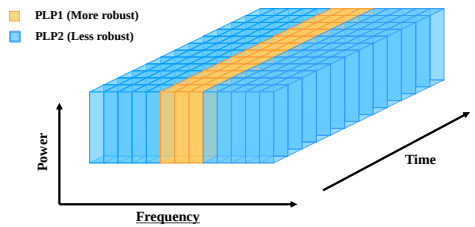



**Second-generation DTTB systems** (as defined in Rec. ITU-R BT.1877) offer higher spectral and energy efficiency than first-generation DTTB systems (as defined in Rec. ITU-R BT.1306). For example, in the case of the Brazilian TV 3.0 Project (DTV+), the ATSC 3.0 physical layer provides about **1.4x** the bitrate of the ISBD-Tb system used for TV 2.0 in Brazil for the same C/N requirement.

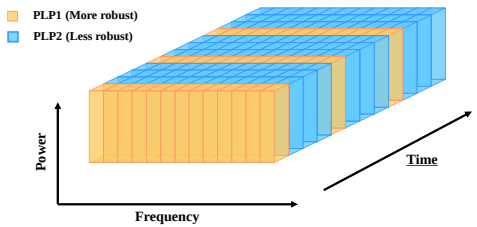
Furthermore, when operating DTTB systems with more than one PLP for service-specific robustness, **LDM** enables significantly higher spectral and energy efficiency than FDM and TDM.




**LDM**




**FDM**



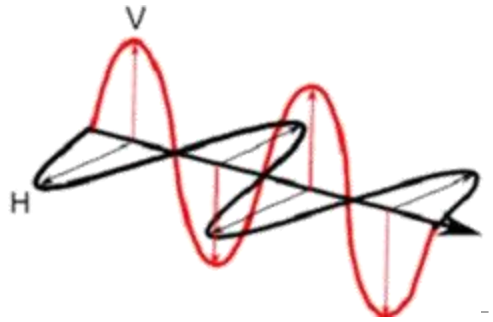

**TDM**

# Further improving physical layer efficiency

While second-generation DTTB systems are already close to the theoretical efficiency limit (the Shannon limit), another card is still on our sleeve: **MIMO** (Multiple Input, Multiple Output).

In the TV 3.0 Project (DTV+), cross-polarized (horizontal/vertical) 2x2 MIMO demonstrated its **feasibility** and **robustness** even for indoor reception at non-line-of-sight conditions. This feature is already supported in the currently published ATSC 3.0 physical layer specification, which is recommended for adoption in the TV 3.0 Project.

It nearly **doubles the bitrate** of SISO (Single Input, Single Output) for the same C/N requirement. (ATSC 3.0 MIMO = 2x ATSC 3.0 SISO = 2.8x ISDB-Tb SISO)




# is green

The table below shows examples of **transmission power** required for the same coverage at different bitrates in SISO and MIMO, using a 6 MHz channel with ATSC 3.0.

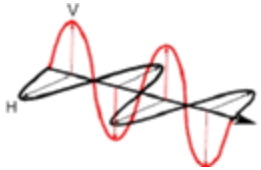
| transmission mode | bitrate (Mbps) | C/N AWGN (dB) | transmitter power (kW ERP) |
|---|---|---|---|
| SISO | 16 | 12.8 | **1 x 10** |
| MIMO | 16 | 6.6 | **2 x 2.4** |
| SISO | 32 | 23.4 | **1 x 114.8** |
| MIMO | 32 | 12.8 | **2 x 10** |

# MIMO for DTTB

**MIMO** has been used in many other wireless systems for many years for a very good reason. Now, the time has come for it to be used in **Digital Terrestrial Television Broadcasting**.

Many TV 3.0 (DTV+) trials with MIMO have been performed in Brazil already, and we plan to have **experimental transmissions** running **24x7** in **2025** and **commercial operations** starting in **2026**.

The **combination** of cross-polarized (horizontal/vertical) 2x2 **MIMO** ATSC 3.0 physical layer with **VVC+LCEVC** (which is **15x more efficient** than the current Brazilian DTTB system configuration) will enable us to provide **UHD HDR free-to-air services for indoor reception**, at the **highest possible spectral and energy efficiency**.




DTV+

VVC + LCEVC

*For more information about the TV 3.0 Project (DTV+), please visit*
https://forumsbtvd.org.br/tv3_0

# Thank you for your attention!

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