Successive Refinement of Images with Deep Joint Source-Channel Coding

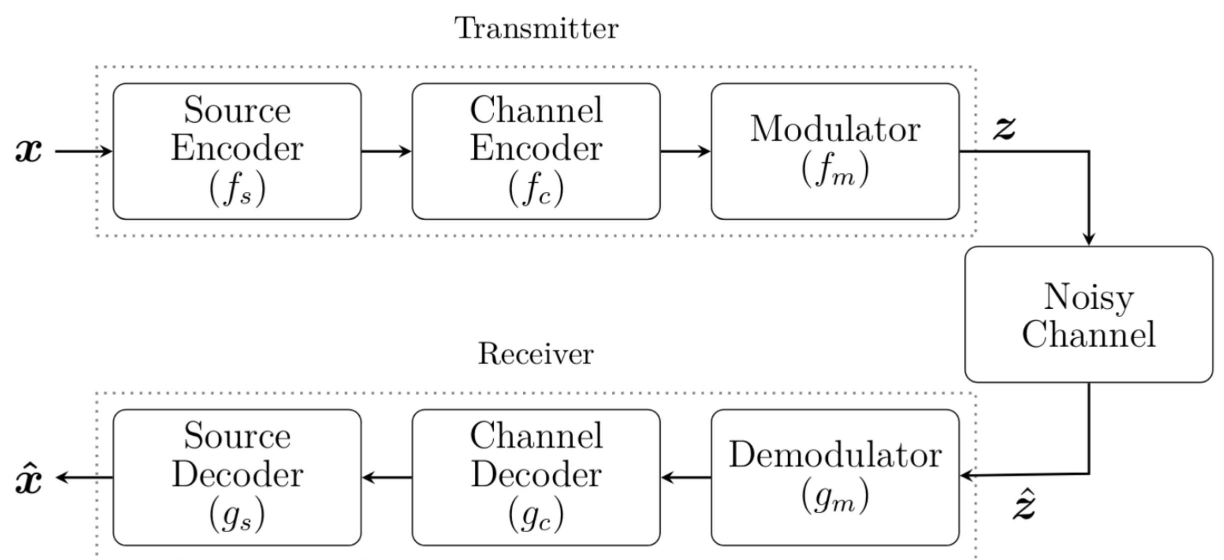
David Burth Kurka and Deniz Gündüz

Information Processing and Communications Laboratory
Department of Electrical and Electronic Engineering, Imperial College London

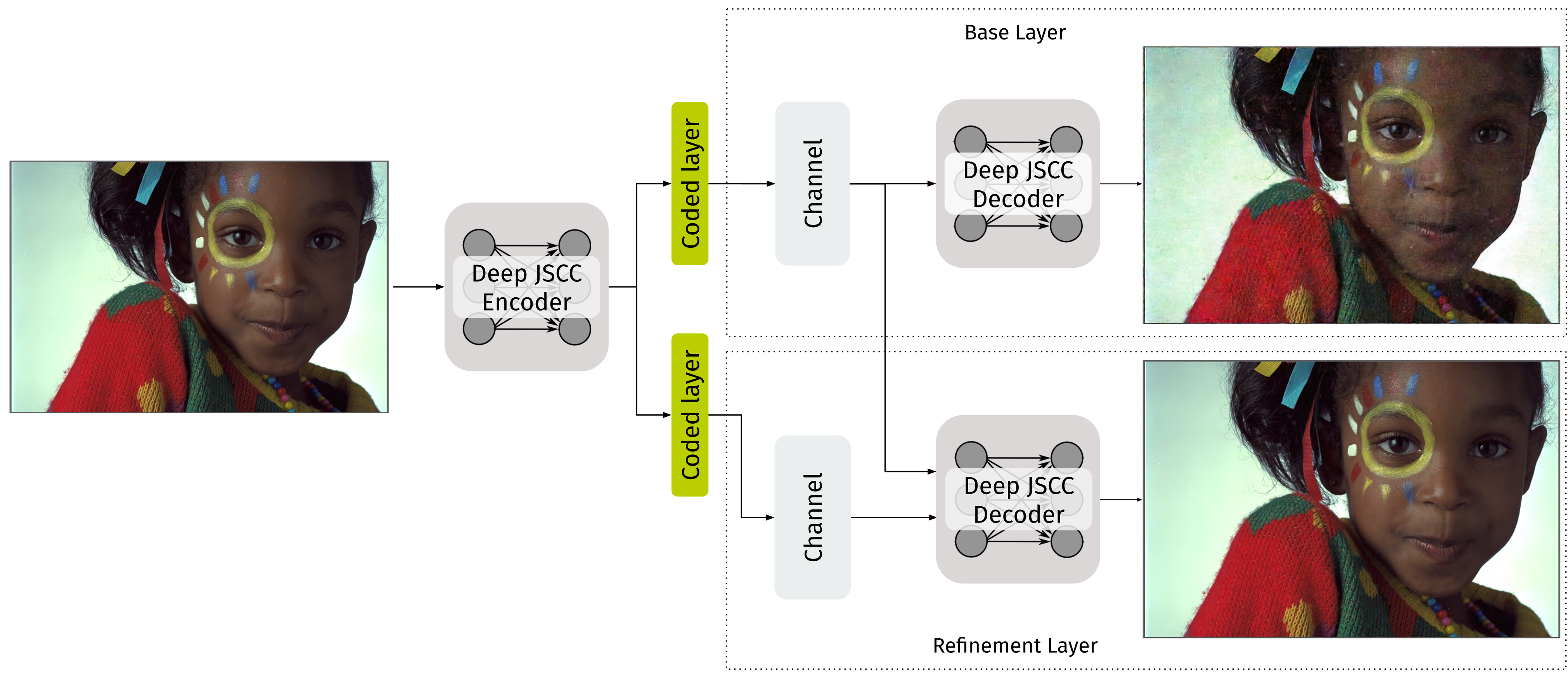
Image Transmission Under Challenge

*How to transmit images under **extremely low latency**, **bandwidth** and **energy constraints**?*

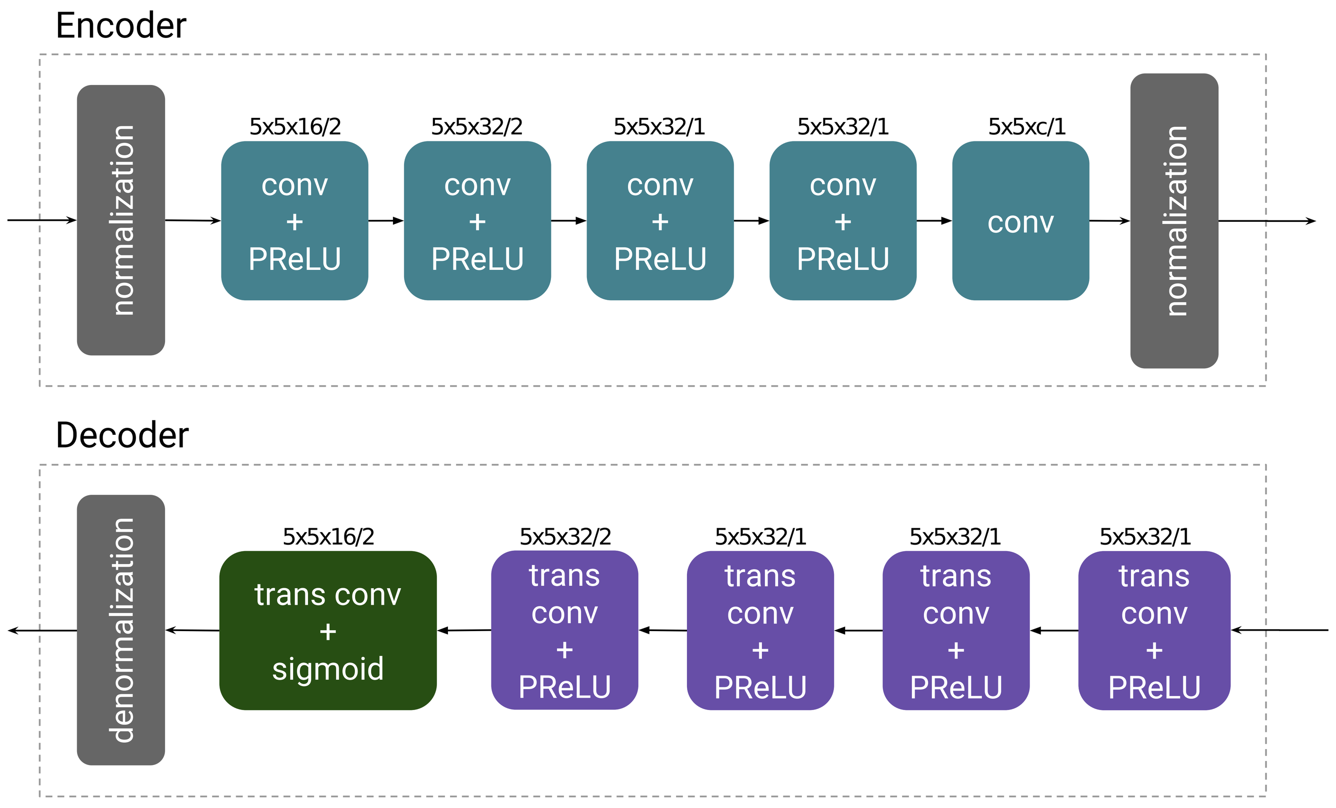
- Traditional approach - Shannon Separation Theorem:



- Optimality holds only for **infinite blocklength** and complexity
- Design assumes a specific channel quality, being vulnerable to variations and **non-ergodic channels**



Can We Learn To Do Better?

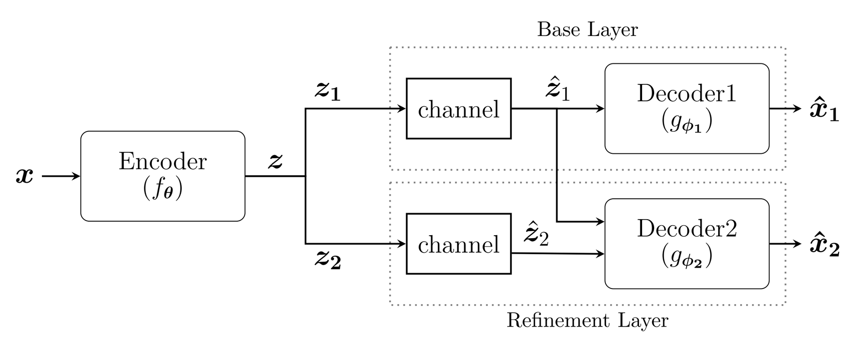


- **Autoencoder:** unsupervised deep neural network for code design
- **Direct mapping** from pixel values to channel inputs
- **Low-delay:** bandwidth compression; **Low-energy:** power constraint

Sucessive Refinement with Deep Joint Source-Channel Coding

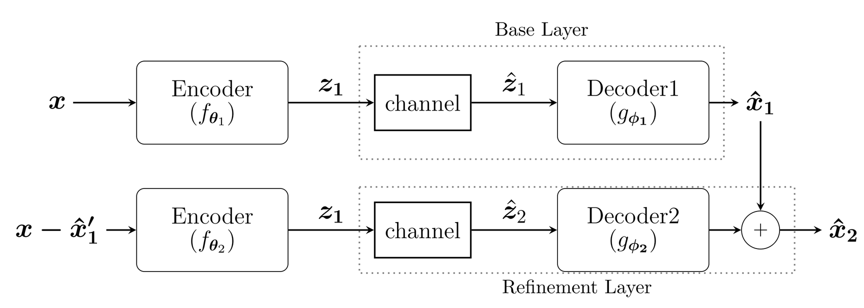
- Optimality of separation proven for **hierarchical joint source-channel coding**
- Ideal source distributions known to be **successively refinable** (e.g., Gaussian sources over Gaussian channels)

Multiple Decoders



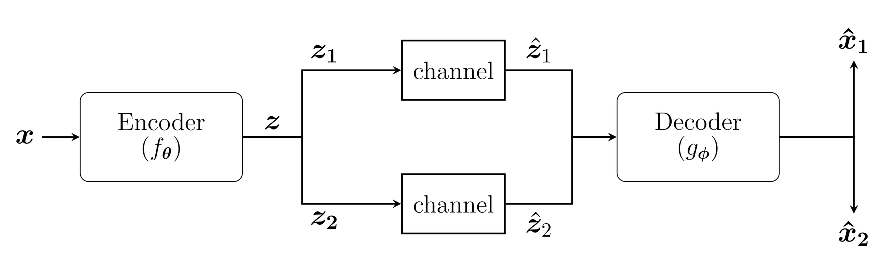
- \+ Best performance
- − Computational complexity

Residual Transmission



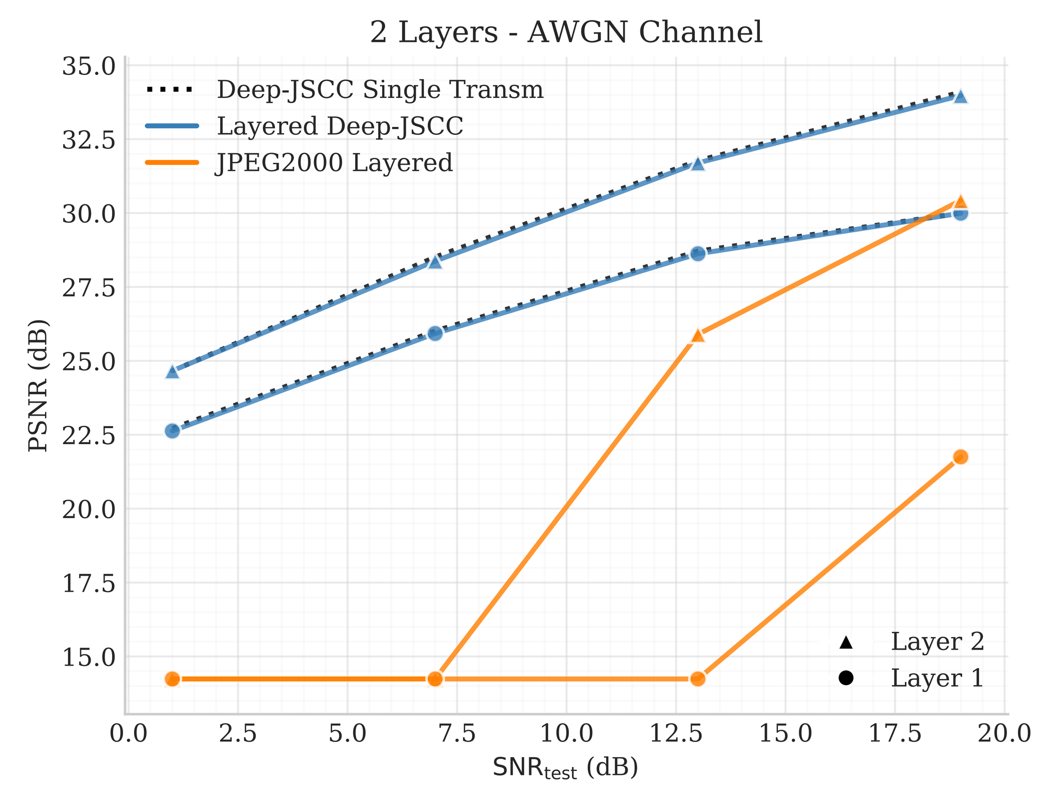
- \+ Expandable design
- − Inferior performance

Single Decoder



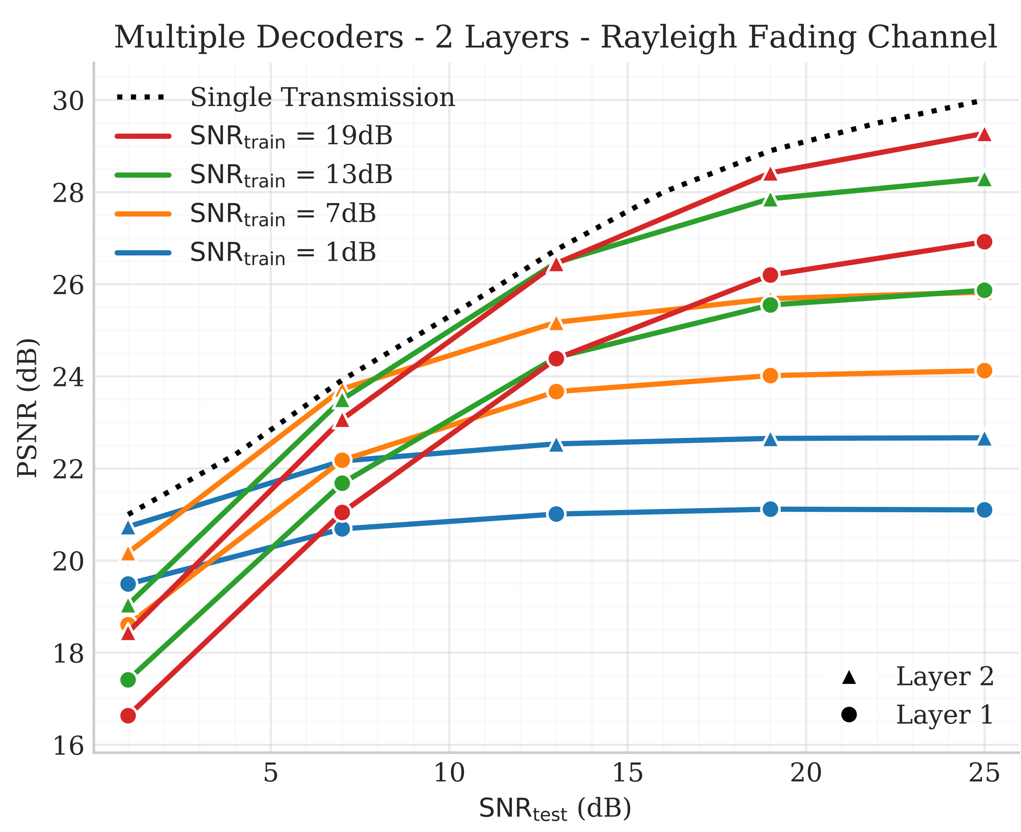
- \+ Simplified structure
- − Performance loss

✔ Competitive Performance



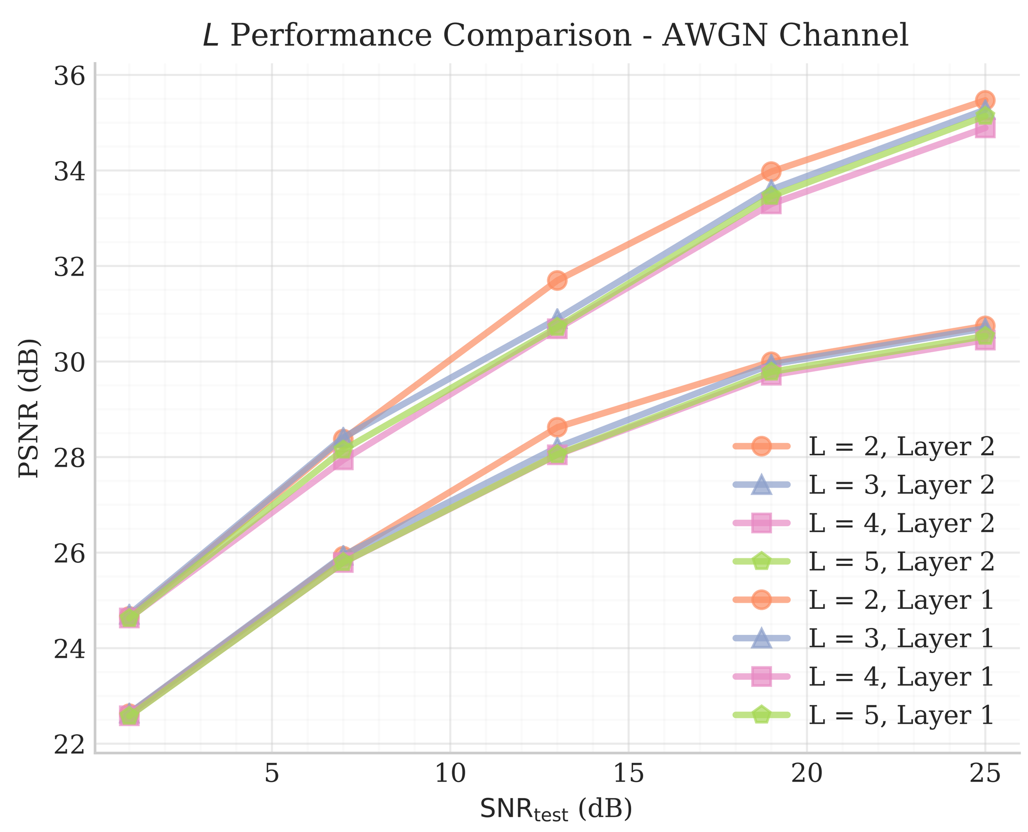
Excel at low SNR and high compression rates!

✔ Analog Behaviour



Graceful degradation and no cliff effect!

✔ Performance Independence



Negligible performance loss due to layering!

References

- E. Bourtsoulatze, D. Burth Kurka and D. Gunduz, **Deep joint source-channel coding for wireless image transmission**, *IEEE Trans. on Cognitive Comm. and Networking*, 2018.
- Y. Steinberg and N. Merhav, **On hierarchical joint source-channel coding**, *International Symposium on Information Theory (ISIT)*, 2004.

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