Interference Exploitation in Wireless Networks

State-of-the-art wireless technology treats interference as noise, wasting valuable resources. Compute-and-forward, a combination of network coding and a new type of forward error correcting code, allows to exploit interference.

**Introduction**

Network coding: Relays mix data of different connections by computing and retransmitting linear combinations (xor) of bits.

- Alice: has a wants b
- Bob: has b wants a

b = (a ⊕ b) ⊕ a
a = (a ⊕ b) ⊕ b

Wireless medium: superposition of signals as well as noise. — Computation code: A new type of error correcting code that enables the decoding of linear combinations of bits.

Combining network and computation coding is called compute-and-forward [Nazer & Gastpar], or reliable physical-layer network coding.

**Example: XOR Erasure Channel**

Alice and Bob are exchanging bits. The Relay receives the xor of these bits, or an erasure. Using only network coding (below left), this takes 8 time slots. Compute-and-forward (below right) requires only 5 time slots. Compute-and-forward increases efficiency.

**Challenge 1: Queueing**

- Compute-and-forward leads to a new class of queueing networks.
- Example for a relay of two connections:

  - No compute-and-forward: Jackson network
  - Compute-and-forward: new transition structure

  - Product-form models (e.g., Jackson networks) can not be used to model compute-and-forward.
  - New tools are required to analyze wireless networks that employ compute-and-forward.

**Challenge 2: Larger Networks**

- Develop scheduling mechanisms that support compute-and-forward.
- Determine network capacity under compute-and-forward:
  - Without compute-and-forward interference leads to scheduling constraints.
  - Compute-and-forward significantly reduces constraints, increasing capacity.
  - Example for nodes on hexagonal lattice:

**Challenge 3: Integrate**

- Compute-and-forward: The number of constraints reduces, capacity is increased.

**INTEX Project**

- NWO “Interference Exploitation in Wireless Networks”, 612.001.107
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  - TU Delft: Multimedia Signal Processing Group
  - EPFL: Laboratory for Information in Networked Systems

**Publications**


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