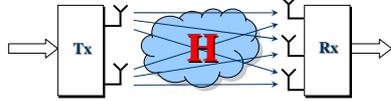


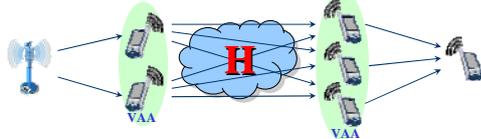
# Relaying and Cooperative Communications

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## Motivation



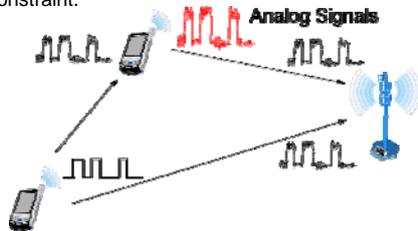
- Multiple-Input Multiple Output (**MIMO**) system
  - Advantages: high data rate, high diversity degrees → reliable communications.
  - Disadvantages: difficult to implement for a small mobile equipment.



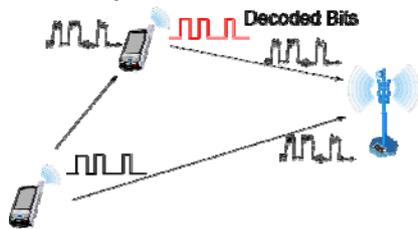
- Option: Virtual Antenna Array (**VAA**) → Distributed MIMO
  - Some spatially separated relaying nodes (e.g., mobile phone) are formed into virtual antenna arrays (VAAs).
  - Two VAAs can be further composed to a distributed MIMO system.
  - Some capacity enhancement techniques like Space-Time Codes can be applied to improve the performance of the end-to-end communication.

## Relaying Protocols

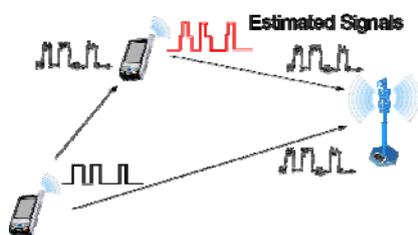
- Amplify-and-Forward (A&F)
  - Relays simply amplify the received signal subject to their power constraint.



- Decode-and-Forward (D&F)
  - Relays decode their received signals, re-encode the information and transmit the signals to the destination or other relays.

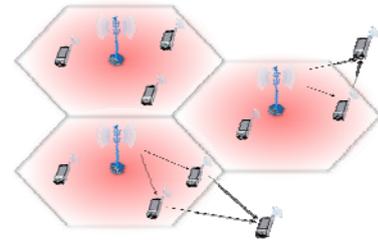


- Estimate-and-Forward (E&F)
  - Relays quantize (estimate) their received signals, and send them to the destination or other relays.

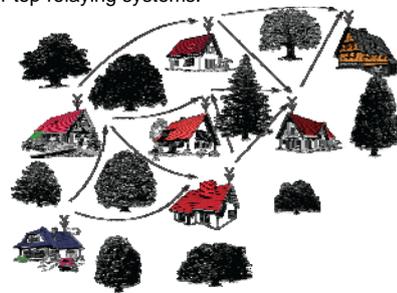


## Applications

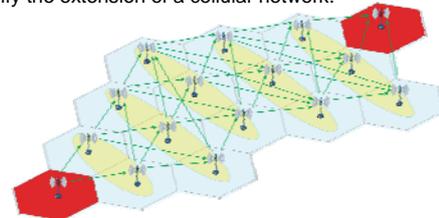
- 3G/4G Cellular Coverage & Capacity Extension
  - Extend the coverage area of a cellular network
  - Improve the performance of handovers
  - Reduces the number of new cells



- In-Home Broadband Access
  - Provide high-speed connections and link stability to residential areas via roof-top relaying systems.



- Wireless Backhaul Networks (Distributed MIMO multi-hop)
  - Allow high data rate connections between the base-stations without additional hardware, e.g., microwave equipment or optical fiber.
  - Simplify the extension of a cellular network.



## Performance

- Cooperative transmission scheme (distributed MIMO multi-hop) outperforms the traditional SISO multi-hop system significantly, i.e., ca. 80% power reduction.

