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Dynamic Spectrum Sharing for Cognitive Radio Networks

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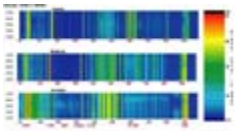
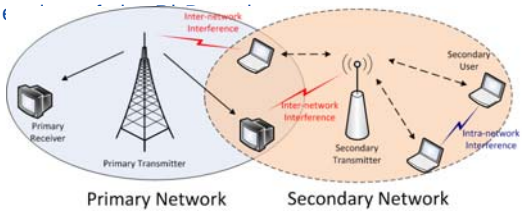
Background and Motivations

- There is a severe imbalance between spectrum scarcity and spectrum underutilization.

- Cognitive Radio (CR)
  - Can sense and reason its surrounding environment, thereby, dynamically and autonomously adjust its operating parameters to coexist with the primary system in a nonintrusive manner.
  - Has the potential to significantly improve the spectrum utilization.
- Obje



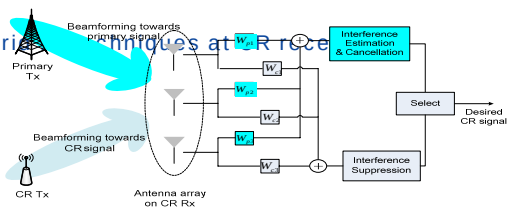
  - Model, evaluate, manage and cancel the interference in CR networks.

Interference Cancellation (IC) in CR Networks

- Various IC techniques applicable to CR Networks

IC Type \ Location	Gray Space	Black Space
IC at CR Receivers	Interference suppression • Cyclostationarity based • Transform based • Higher-order-statistics based	Interference estimation & cancellation: • Extract & cancel • Reconstruct & cancel Interference suppression
IC at CR Transmitters	• Receiver beamforming Spectrum shaping Predistortion filtering Spread spectrum Transmitter beamforming	

- Hybrid techniques at CR rece



Nash Bargaining over MIMO Interference Channels (IFCs)

- Nash bargaining (NB):
  - A cooperation scheme for secondary multiple-input multiple-output (MIMO) users to maximize the Nash product

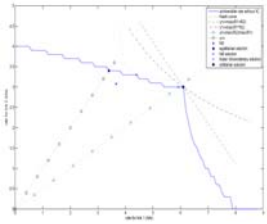
$$\max_{Q} \prod_{i=1}^{L} (I_i(Q) - I_i^{NE})$$

$$s.t.\ tr(\boldsymbol{Q}_i) \le p_i$$

$$I_i(Q) > I_i^{NE} \qquad i = 1,...,L$$

- Characteristics of NB
  - Fairness of the NB solution

Solution \ Metric	Jain's Fairness Index
Nash bargaining	0.9830
Nash equilibrium	0.9923
Kalai-Smorodinsky	0.9030
Utilitarian	0.8960
Proportional	0.8960



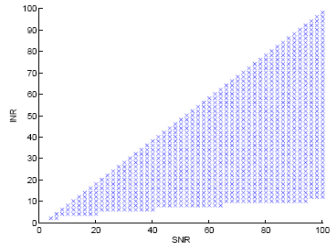
  - Feasible NB set

$$\boldsymbol{Q}_i^{NE} = \boldsymbol{U}_i(\mu_i \boldsymbol{I} - \boldsymbol{D}_i^{-1})^{+}\boldsymbol{U}_i^{H}$$

$$\Downarrow\Downarrow$$

$$\boldsymbol{Q}_i^{NB} = \mathbf{V}_i \boldsymbol{\Lambda} \mathbf{V}_i^{H}$$

  - The signal-to-noise ratio (SNR) and interference-to-noise ratio (INR) impacts on the existence of the NB solution



  - Uniqueness of the NB solution

    Sufficient condition: INR being sufficiently small

Summary & Future Work

- Inter-network interference: We have reviewed various Interference cancellation (IC) techniques applicable in CR networks.
- Intra-network interference: We have investigated the MIMO IFCs from a game-theoretic prospective (Nash bargaining over MIMO IFCs).
- Future work is to model interference in CR networks and optimise the spectrum sensing and access policies from a cross-layer perspective.

Related Publications

Journals

[1] X. Hong, Z. Chen, C.-X. Wang, and S. A. Vorobyov, "Interference cancellation for cognitive radio networks", *IEEE Veh. Technol. Mag.*, submitted.

[2] Z. Chen, S. A. Vorobyov, C.-X. Wang, and J. Thompson, "Characterization of Nash bargaining over MIMO interference systems", *IEEE Trans. Wireless Commun.*, to be submitted.

Conferences

[3] Z. Chen, S. A. Vorobyov, C.-X. Wang, and J. Thompson, "Nash bargaining over MIMO interference [illegible] Dresden, Germany, June 2009, accepted

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