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Social-Community-Aware Resource Allocation for D2D Communication Underlaying Cellular Networks

–Fang Wang, Yong Li, Zhaocheng Wang and Zhixing Yang

Aim

Exploit ties in human-formed social networks to enhance D2D resource sharing and allocation

Contribution

Two step coalition game

- Coalition formulation between communities
- Optimization formulation for D2D resource allocation

Game formulation

- Defined on $(\mathbb{I}, \nu)$.
- Payoff for each community, $u_i(S) = \alpha \boldsymbol{R}_i(S) - \beta C_i(S)$.
- Payoff for the coalition, $\nu(S) = \sum_{i \in S} u_i(S)$ for $\nu(\phi) = 0$.
- A collection is preferred over the other if atleast one player achieves a payoff improvement without hurting other players' benefits.
- Communities decide on which coalition to join based on merge-and-split rules.

Optimization problem

$$
\begin{aligned}
& max \sum_{n \in \mathbb{N}_S} y_n(S) q_n \\
& s.t. \sum_{t=1}^{T} \sum_{m \in \mathbb{M}_S} x_{m,n}^t W R_{m,n} \delta - y_n(S) q_n \geq 0 \ \forall \ n \in \mathbb{N}_S \\
& \sum_{n \in \mathbb{N}_S} x_{m,n}^t \leq 1, \ \forall \ m \in \mathbb{M}_S, \ t \in \{1, \dots, T\} \\
& \sum_{m \in \mathbb{M}_S} x_{m,n}^t \leq 1, \ \forall \ n \in \mathbb{N}_S, \ t \in \{1, \dots, T\} \\
& x_{m,n}^t = \{0, 1\} \ \forall \ m \in \mathbb{M}_S, \ \forall \ n \in \mathbb{N}_S, \ t \in \{1, \dots, T\} \\
& y_n(S) = \{0, 1\} \ \forall \ n \in \mathbb{N}_S \\
& where \ R_{m,n} = \log_2 \left(1 + \frac{P_n h_{nn}^2}{P_m h_{mn}^2 + N_0} \right)
\end{aligned}
$$

Verification

Comparison with exhaustive search algorithm and non-cooperation schemes in terms of system utility,calculation time and community payoffs.

Stochastic Geometry Study on Device-to-Device Communication as a Disaster Relief Solution

–Akram Al-Hourani, Sithamparanathan Kandeepan and Abbas Jamalipour

Contribution

- Expression for network level service success probability (with chain relaying).
- Measure for the extent of disaster alleviation introduced by D2D network.
- Comparison between two disaster propagation scenarios, random BS phase-out and concentrated phase-out.

System Model

- D2D communication only in the uplink frequency bands.
- Decode-and-forward relaying when SINR at the destination is below a threshold.
- BS and Tx deployed according to a homogenous PPP with density, λ_b.
- After disaster, BS density changes to $(1 - D)\lambda_b$ where damage ratio, $D \in [0, 1]$.

Approach

- Link success probability, $P_s(P_T, \alpha, P_I, \lambda_I, W, \Theta, r_0) = Pr\{SINR \geq \Theta\}$.
- Link level performance $= P_{UL}P_{DL}$.
- Network level performance for 3 scenarios
  - Cellular-only: κ_0
  - Single hop relay network: $\kappa_1 = \kappa_0 + H_1 - \kappa_0 H_1$
  - Chain relay network: $\kappa_n = \kappa_{n-1} + \kappa_0 H_0^n - \kappa_{n-1} H_0^n$
- Performance difference, $\Delta S_n = \kappa_n - \kappa_0$; $DAB = D|_{\Delta S_n = 0}$

Verification

- Comparison between analytical results and Monte Carlo simulations
- Damage ratio vs network level success probability
- Performance with concentrated phase-out is lower for more severe damage ratios.

Base-Station Sleeping Control and Power Matching for Energy-Delay Tradeoffs With Bursty Traffic

–Jian Wu, Yanan Bao, Guowang Miao, Sheng Zhou and Zhisheng Niu

Problem

With a bound on mean delay, minimize the average total power consumption
Obtain optimal energy-delay tradeoff through joint Sleeping Control (SC) and Power Matching(PM) optimization.

System model

- Traffic: IPP with parameters (λ, r_1, r_2)
- BS Power:

$$P_{BS} = \begin{cases} P_0 + \Delta_P P_t & \text{active mode} \\ P_{\text{sleep}} & \text{sleep mode} \end{cases}$$

- BS SC and PM: Sleeping threshold(N) based SC

$$\mu = \frac{B}{l} \log_2(1 + \gamma P_t) \tag{1}$$

Approach

- Extended IPP/M/1 queueing model with N-based sleeping and adjustable service rate.
- Obtain expressions for delay and power for SC and PM.
- Energy efficient to incorporate N-based SC when

$$N + f(N, \mu, \lambda, k, r_2) > \frac{2\lambda E_s}{(1+k)(P_0 - P_{sleep})} \tag{2}$$

- Analyse the behaviour of transmit power with BS SC as compated to PM.
- Solve iteratively for N and P_t until minimum average power consumption is observed.

Other interesting papers

- L.Lei, Y.Kuang, N.Cheng, X.Shen, Z.Zhong and C.Lin, "Delay-Optimal Dynamic Mode Selection and Resource Allocation in Device-to-Device Communications-Part I:Optimal Policy".
- L.Lei, Y.Kuang, N.Cheng, X.Shen, Z.Zhong and C.Lin, "Delay-Optimal Dynamic Mode Selection and Resource Allocation in Device-to-Device Communications-Part II: Practical Algorithm".
- L. Zhou, X. Hu, E. C.-H. Ngai, H. Zhao, S. Wang, J. Wei and V. C. M. Leung, "A Dynamic Graph-Based Scheduling and Interference Coordination Approach in Heterogeneous Cellular Networks".
- D. Hwang, B. Clerckx, S. S. Nam and T.-J. Lee, "Opportunistic Multiuser Two-Way Amplify-and-Forward Relaying With a Multiantenna Relay".