Trends in Signal Processing - SPCOM

Moderator: Dr. Geert Leus, TU Delft

Presenters: Dr. Robert Heath, UT Austin, WNCG
Dr. Shuguang Cui, Texas A&M Univ.
New Dimensions of SPCOM

Mathematical Tools
- Sparse structure
- Machine learning
- Stochastic geometry
- Optimization/Game theory
- Manifolds

Expansive Applications
- Cellular
- Heterogeneous networks
- Underwater
- Visible light

Networking Concepts
- Cognitive overlaid networks
- Cyber/physical hybrid networks
- Social networks
- Energy / water / transportation
1. Single user $\rightarrow$ Network

2. Centralized $\rightarrow$ Distributed $\rightarrow$
   \[\begin{aligned}
   &\text{Distributed with security/privacy constraints} \\
   &\text{Centralized with fog/cloud computing}
   \end{aligned}\]

3. Cross-layer $\rightarrow$ Cross-network

*Dr. Shuguang Cui*
Cognitive Radio (CR)

- SPCOM in CR: spectrum sensing and dynamic resource allocation
- Spectrum sensing
  - Multi-antenna individual vs. collaboration
  - Centralized vs. distributed
  - Primary user information exploration
  - Effort to protect CR receiver
- Dynamic resource allocation
  - MIMO → multi-user → multi-hop
  - Primary vs. secondary dynamics:
    - Finite network case
    - Asymptotic case
  - Game theoretical approaches
- Joint sensing and resource allocation
Smart Grid

- A large MIMO cyber-physical closed-loop control system
  - Large cyber portion
  - Unsecure and unreliable cyber
  - Complex/hybrid time scales
- SPCOM for Smart Grid
  - Filtering:
    - State estimation
    - Anomaly detection
  - Communication
    - Secure cyber communications
    - Private cyber communications
  - Joint filtering and communication
    - Challenge in closed-loop design
    - Unified design framework with hybrid time scales
Compressive Sensing

- Sparsity in time, frequency, angle, space, ...
- Applications: channel estimation, spectrum sensing, DoA estimation, large field sensing and state estimation
- Opportunities:
  - More general theoretical performance analysis under SPCOM setups
  - Extensions to robust designs
  - Applications to new areas: Smart Grid, Social Networks, …
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Cellular Systems

- Multicell coordination / network MIMO / CoMP
  - How to feedback and distribute channel state?
  - Interference alignment vs. joint transmission
  - What is a reasonable amount of coordination?
  - How do realistic impairments impact performance?
  - Can clusters be formed dynamically?
Heterogeneous Networks

- Cellular networks are growing more complex
  - How do infrastructure concepts coexist?
  - Is distributed interference management possible?
  - How to perform decentralized precoding, channel estimation, and feedback?
Beyond Usual Wireless

- Underwater
  - Big delay/doppler spread
  - Low propagation speed
  - Anisotropic propagation
  - Lack of channel models

- Visible Light Comm.
  - Fog, smoke, rain, …
  - MIMO
  - Multi-user scenarios
  - LOS vs. NLOS
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*Dr. Robert Heath*
Questions?

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