

**Information Theory for Mobile Ad-Hoc Networks (ITMANET):
*The FLoWS Project***

FLoWS Team Update:

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**ITMANET PI Meeting
Jan 27, 2011**



New Theory and Insights



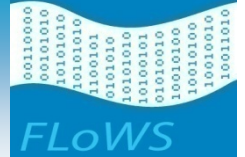
Key New Theory and Insights

- Thrust 0
 - New definitions of reliable communications in the face of uncertainty
 - Performance over finite time windows
- Thrust 1
 - Network Equivalence
 - Network Coding in Noise/Loss
 - Multiterminal Strong Converses
- Thrust 2
 - Layered and structured codes
 - Control/capacity connections for time-varying channels with noisy and/or rate-constrained feedback
 - Generalized capacity and separation
- Thrust 3
 - Stochastic Multi-period Network Utility Maximization
 - Relaxation and distributed techniques for network optimization
 - Mean Field Equilibrium for Stochastic games
 - Learning in dynamic environments
- Interthrust
 - Coordination via Communication
 - Relaying, cooperation and cognition
 - Network coding
 - Capacity regions for more than 3 users

Recent Accomplishments



Thrust 0 Recent Achievements



Models

Coleman, Effros, Goldsmith, Medard, Zheng:
Channels and Networks with Feedback

Effros: networks with side information

Cover: Coordinated

Networks

El Gamal: More than 3 users

Moulin: Mobility

Goldsmith: Cognitive Nodes

Medard, Zheng: Distortion-Outage tradeoff

Effros, Goldsmith: Expectation and
Outage in Capacity and Distortion

Zheng: UEP

Goldsmith: Diversity/multiplexing/delay tradeoffs

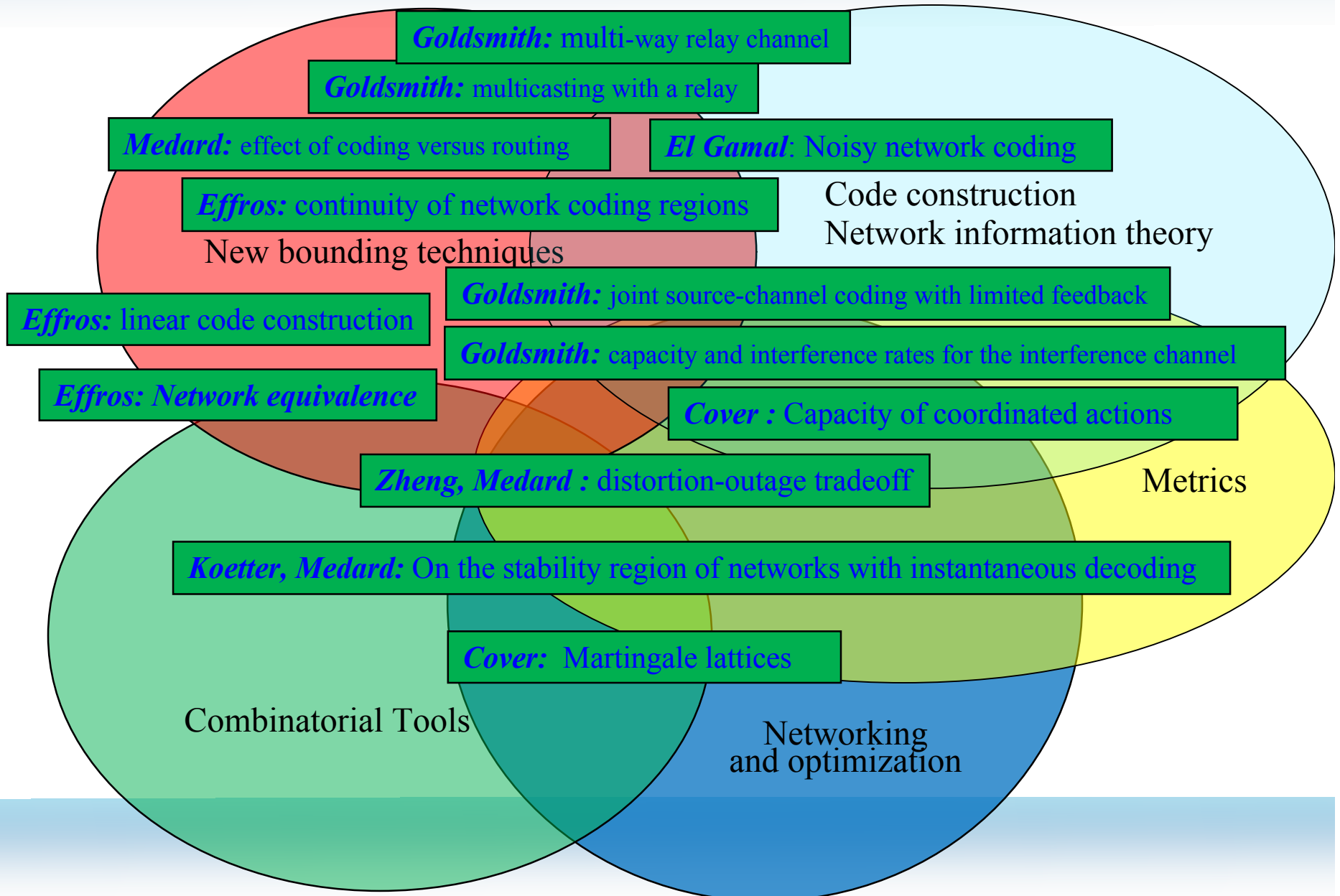
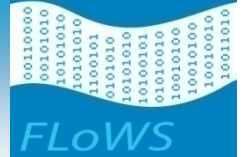
Medard: delay/energy minimization

Medard: Stability Regions

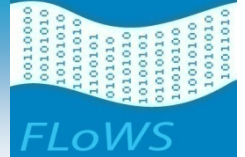
Shah: multicast capacity

Metrics

Thrust 1 Recent Achievements



Thrust 2 Recent Achievements



Dynamic Network Information Theory

El Gamal: Noisy Network Coding

Goldsmith: Multicast with relay; BC with cognitive relay

Shah: Positive Recurrent Medium Access

Moulin: exploiting mobility of relay networks

Effros: distributed network coding with coded side information

Cover: coordination capacity

Moulin: finite-blocklength codes

Effros: linear representation of network coding

Coleman: Control principle for feedback channels

Medard, Zheng: Diversity-distortion tradeoff

Goldsmith: Joint source channel coding / outage

Zheng: tilted matching for feedback channels

Medard, Goldsmith: *Wireless network coding*

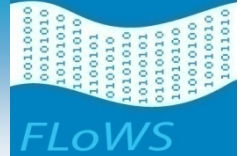
Effros: two stage polar codes

Zheng: Instantaneous Efficiency

CSI, feedback, and robustness

Structured coding

Thrust 3 Recent Achievements



Optimization

Distributed and dynamic algorithms for resource allocation

Boyd, Goldsmith: Wireless network utility maximization as stochastic control

Boyd: Distributed optimization

El Gamal: Overhead in distributed algorithms

Shah: Distributed MAC using queue based feedback

Ozdaglar: Distributed second order methods for network optimization

Ozdaglar: State-dependent distributed optimization

Medard: Decoding and network scheduling for increased capacity

Ozdaglar: Noncooperative power control using potential games

Johari: Large network games

Meyn: Q-learning for network optimization

Johari: Mean field equilibrium

Ozdaglar: Near potential games for network analysis

Johari: Supermodular games

Stochastic Network Analysis

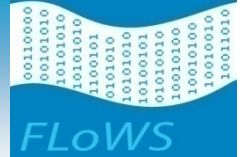
Flow-based models and queuing dynamics

Effros: Noncooperative network coding

Game Theory

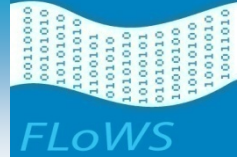
New resource allocation paradigm that focuses on heterogeneity and competition

Publications to date



- 5 books or book chapters; 1 more under development
- 46 published/accepted journal papers, 28 submitted
- 169 conference papers (published or to appear)
- SciAM paper appeared
- Comm. Magazine paper to appear this month
- Publications website:
 - http://www.stanford.edu/~adlakha/ITMANET/flows_publications.htm

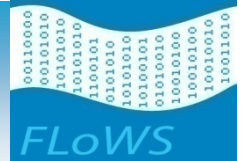
Phase 4 Progress Criteria



- Demonstrate the consummated union between information theory, networks, and control; and why all three are necessary ingredients in this union.
- Write a monograph to be published by NOW jointly in *Foundations and Trends in Information Theory* and in *Foundations and Trends in Networks* on our new information theory for MANETs. Also publish a shorter version in IEEE Proceedings.
- Use our results to provide challenges and solutions for the broader community that designs and builds MANETs

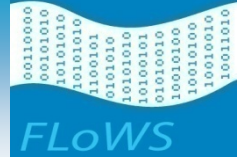
Work Products (possibly merged with Nequit)

How to maximize ITMANET impact



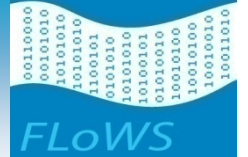
- Community Website
 - “go-to” website for network information theory
 - Merging of two current websites, with hooks?
 - Get feedback at ITA
- IEEE Proceedings special issue
 - Survey paper on FLoWS results and conclusions
 - Invited papers on all major topics within/between thrust areas
- Survey paper
 - Part of Proceedings Special Issue
- Tutorials and Short Courses
 - (for web and IT school)
 - In each thrust area/across thrust areas
 - Link to website
- Position paper about follow-on programs (ITMANET 2.0)
 - DC Govt/Industry Day for our last meeting

Transitions via DC Day



- Transition to other DARPA programs
- Transition to and synergies with other government research programs
- Transitions to and synergies with corporate research programs/investments

Tech Transfer



- Standards
- Patents
- Company Workshops
- Commercial Transfer