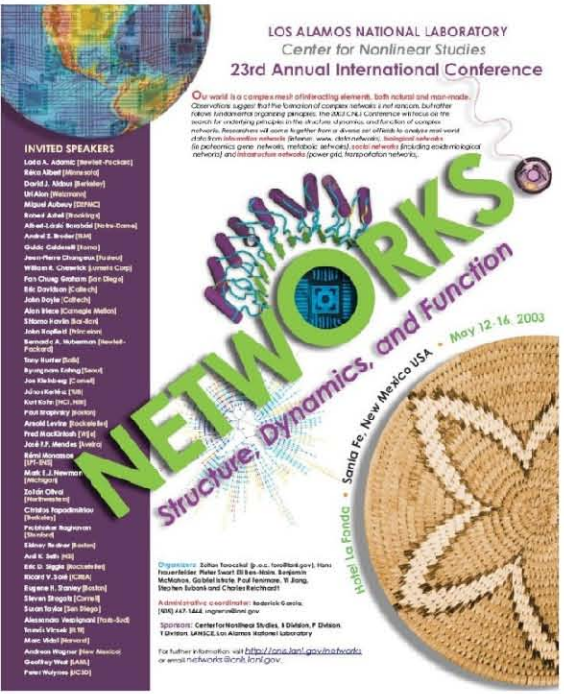
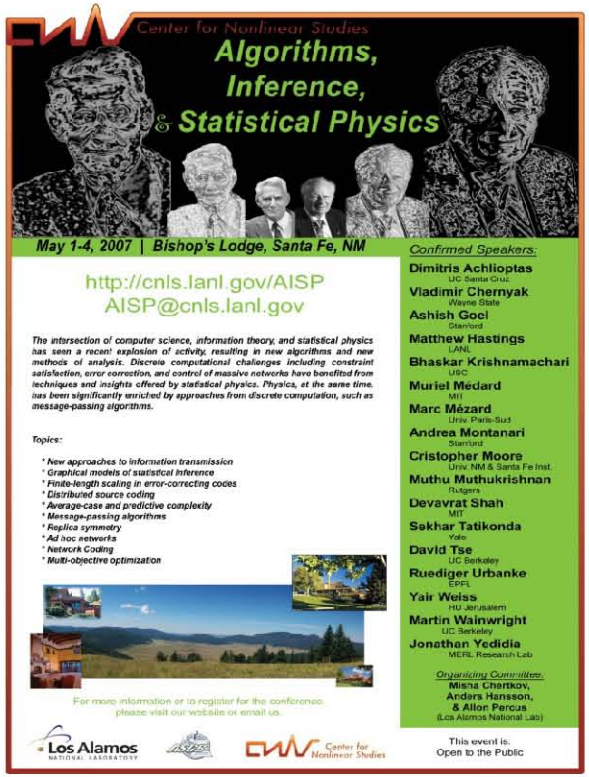
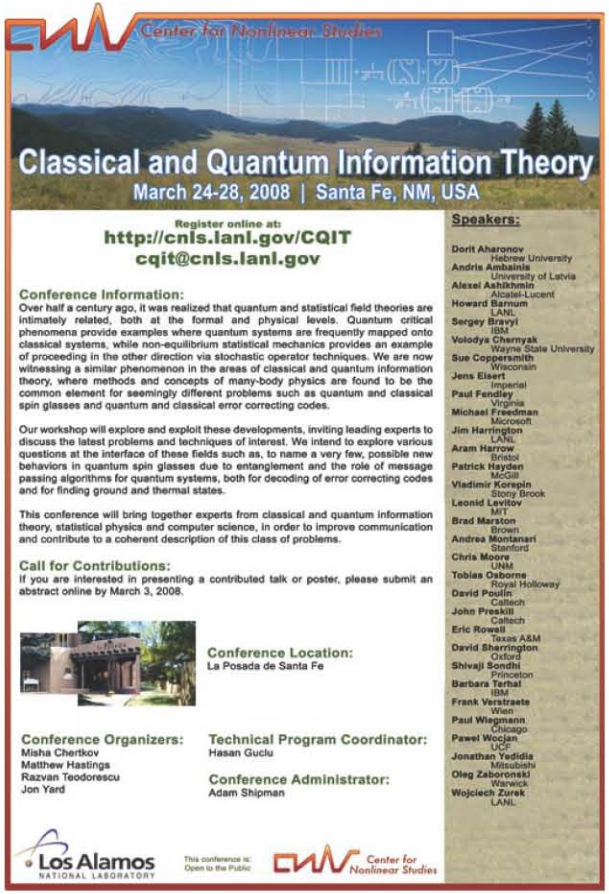
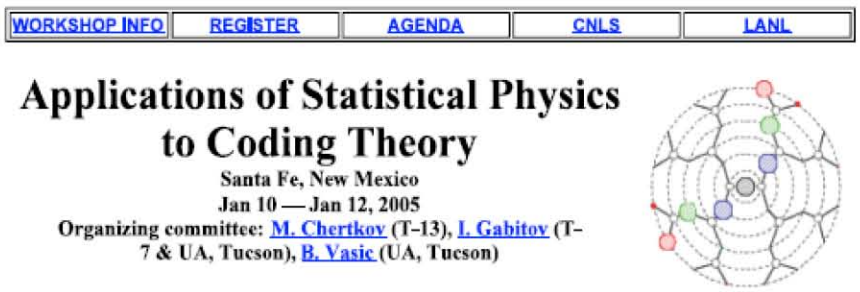
CNLS & Information Theory, Computer Science, Statistical Physics

- Conferences & Workshops









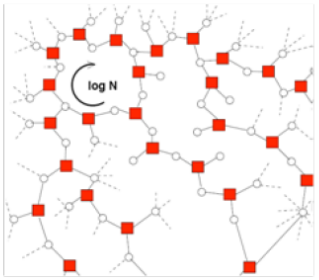
Physics of Algorithms (DR) : our R & D approach

Physics methods:

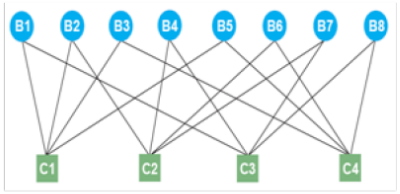
- finite-size scaling
- phase transitions, universality
- stochastic calculus, optimal fluctuations
- renormalization-group
- percolation
- kinetic theory
- computational tree

•State the problem in terms of optimization and/or inference

- physical correlations
- optimization/inference duality
- frustrations (conflicts)
- graph theory, stat. mech.



Spin representation of SATisfaibility complexity

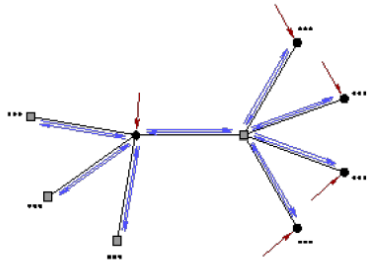


Spin representation of inference device

•Develop and Extend a Heuristic Algorithm

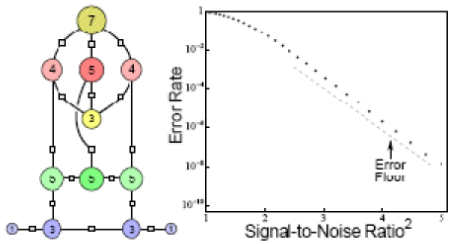
- NP hardness
- approximate algorithms (heuristics)
- Belief-Propagation (BP) shortest-path, max-flow

→ BP is exact on the tree
Loop calculus (improving BP)
Chertkov et al '06-'08

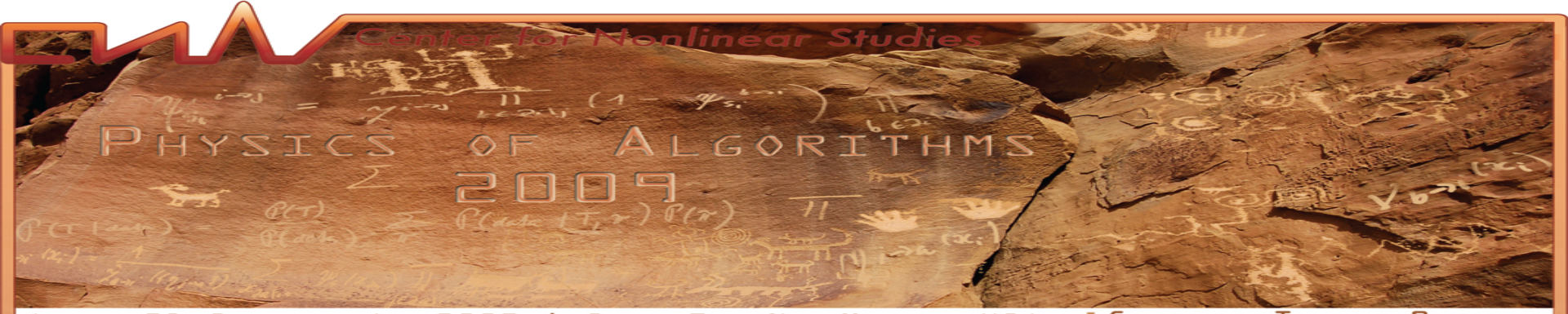


•Analyze the Algorithm

- bit-error-rate
- Monte-Carlo, Molecular Dynamics
- rare-events (extreme statistics)



Instanton approach for estimating rare events M. Stepanov, et al '05-'07



August 31-September 4, 2009 | Santa Fe, New Mexico, USA

http://cnls.lanl.gov/poa
conferences@cnls.lanl.gov

Optimization, inference and learning involve emerging computational problems in many areas of science and engineering. Typically stated in the framework of computer science and information theory, these problems are also linked to concepts and approaches native to statistical, mathematical and quantum physics.

This interdisciplinary field has seen a recent explosion of activity, resulting in new algorithms and new methods of analysis. Discrete computational challenges including constraint satisfaction and error correction have benefited from techniques and insights offered by statistical physics. Physics, at the same time, has been significantly enriched by approaches from discrete computation, such as convex optimization and message-passing algorithms.

Our workshop will bring together leading experts from physics, computer science, machine learning, operation research and information theory to discuss the current hot topics and new challenges in the intersection of these fields. Specific topics will include:

* Graphical models
* Statistical inference and learning
* Monte Carlo algorithms
* Belief propagation and message passing algorithms
* Satisfiability and combinatorial optimization
* Phase transitions and cavity approach
* Combinatorial approaches (walks, loops, etc) relevant to these topics

Organizing Committee

Michael Chertkov, Los Alamos National Laboratory
Jason Johnson , Los Alamos National Laboratory
Allon Percus, Claremont Graduate University
Lenka Zdeborova, Los Alamos National Laboratory

Los Alamos NATIONAL LABORATORY EST. 1943

This conference is:
Open to the Public with Registration

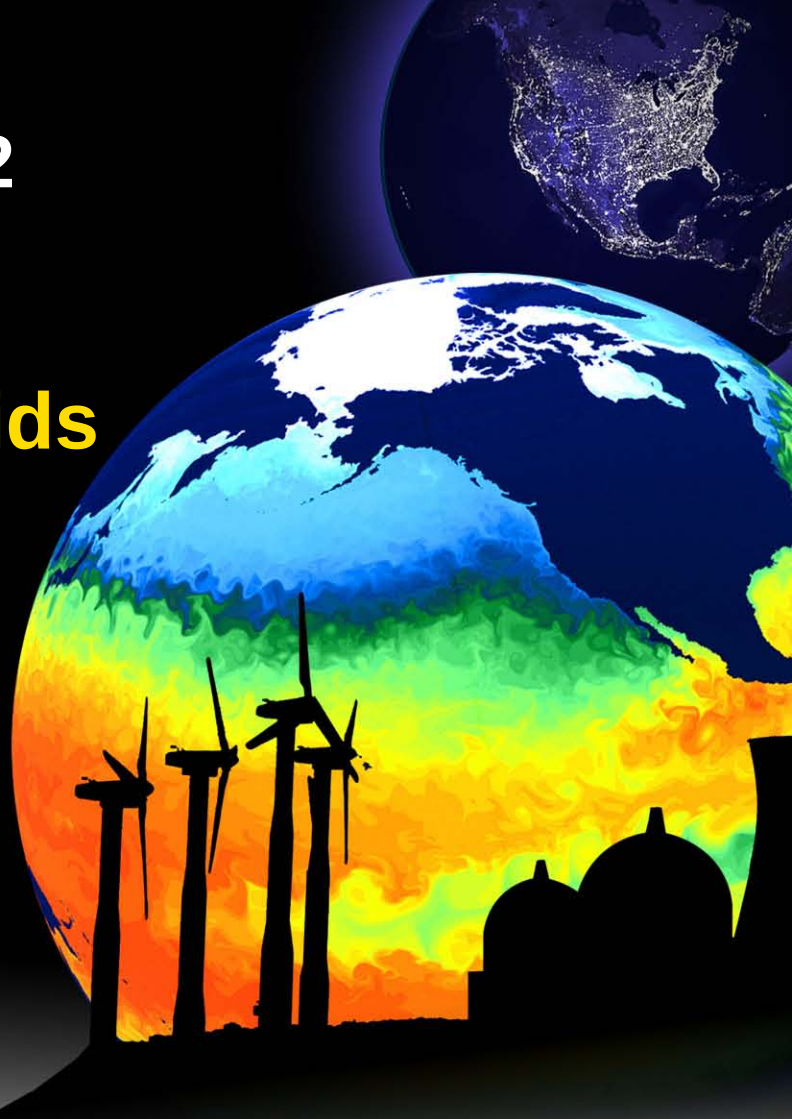
Center for Nonlinear Studies

Confirmed Invited Speakers

Stefan Boettcher
Emory
Vladimir Chernyak
Wayne State Univ.
Sue Coppersmith
Univ. of Wisconsin, Madison
David Gamarnik
Sloan School of Economics, MIT
Amir Globerson
Hebrew Univ.
Tom Hayes
Univ. of New Mexico
Koji Hukushima
Univ. of Tokyo
Shiro Ikeda
Inst. of Stat.Mechanics, Tokyo
Thomas Joerg
ENS, Paris
Werner Krauth
ENS, Paris
Florent Krzakala
ESPCI Paris
Martin Loebl
Charles Univ.
Jon Machta
Univ. of Massachusetts, Amherst
Alan Middleton
Univ. of Syracuse
Andrea Montanari
Stanford Univ.
Cris Moore
Univ. of New Mexico
Pablo Parrilo
EECS, MIT
Heiko Rieger
Univ. Saarlandes
Bart Selman
Cornell
Devavrat Shah
EECS, MIT
Alistair Sinclair
UC Berkeley
Sekhar Tatikonda
EE, Yale
Ricci-Tersenghi
La Sapienza, Rome
Massimo Vergassola
Pasteur Inst.
Pascal Vontobel
HP Research
Martin Wainwright
UC Berkeley
Johan Wastlund
Chalmers Univ.
Jonathan Yedidia
Mitsubishi Research
Riccardo Zecchina
Politecnico di Torino

LANL/LDRD DR, FY10-FY12

Optimization and Control Theory for Smart (Power) Grids



M. Chertkov (PI, T-4)
R. Bent (co-PI, D-4)

Aug 10, 2010
first year DR review

http:/cnls.lanl.gov/~chertkov/SmarterGrids/

Los Alamos NATIONAL LABORATORY EST. 1943

NNSA

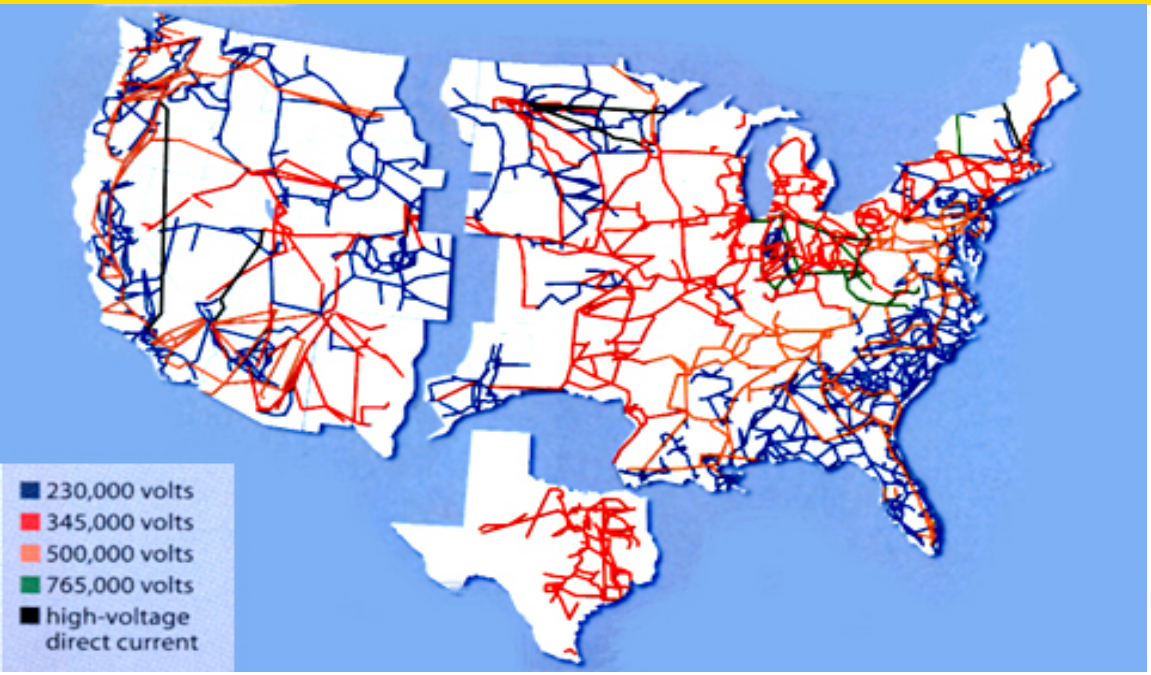
Optimization & Control Theory for Smart Grids

- So what? Impact.
  - savings: (a) 30b$ annually is the cost of power losses, 10% efficiency improvement=> 3b$ savings, (b) cost of 2003 blackout is 7-10b$, 80b$ is the total cost of blackouts annually in US
  - further challenges (more vulnerable, cost of not doing planning, control, mitigation)
- Grid is being redesigned [stimulus]

The research is timely.

-2T$ in 20 years (at least)

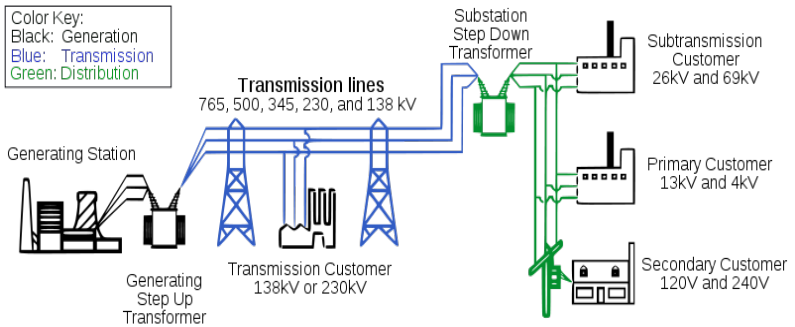
Optimization & Control Theory for Smart Grids



US power grid

Greatest Engineering Achievement of 20th century

will require smart revolution in 21st century



Optimization & Control Theory for Smart Grids

Our (LANL) *Road Map* for Smart Grids

New Systems

- Renewables
- PHEV & Storage
- Metering

Grid Stability

- distance to failure
- dynamic stability
- outages/rare events
- cascading
- signature detection

Grid Control

- load balancing
- queuing and scheduling
- optimal power flows
- feeder lines control
- distribution and switching with redundancy

Grid Design

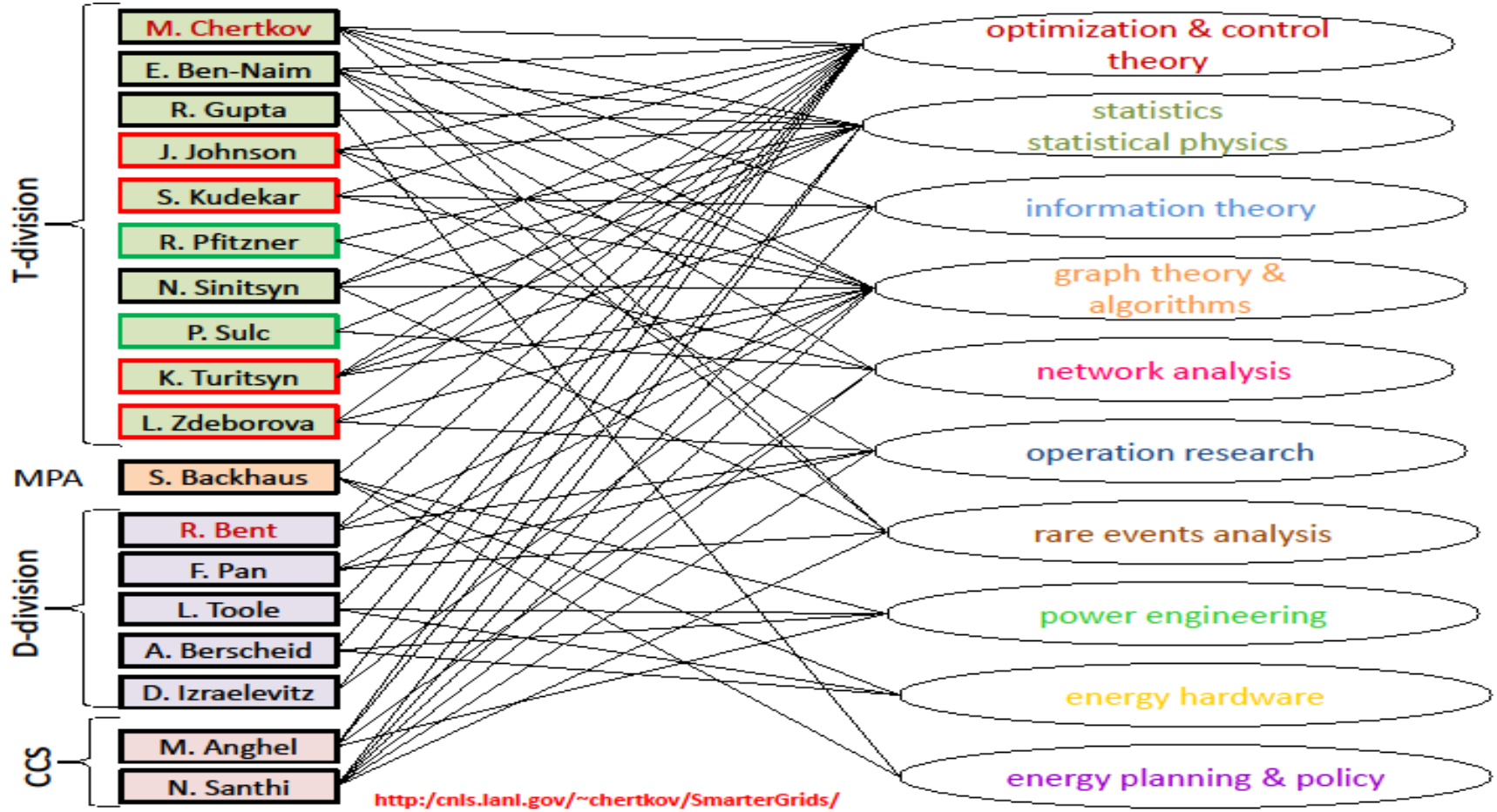
- placement of generations and storage
- intermittent wind as an integrated capacity
- accounting for outages and intermittency in planning

New Challenges

All of the above also requires scientific advances in

- Analysis & Control
- Stability/Reliability Metrics
- State Estimation
- Data Aggregation & Assimilation
- Middleware for the Grid
- Modeling Consumer Response

Optimization & Control Theory for Smart Grids



Optimization & Control Theory for Smart Grids

Publications so far (first 8 months of the project):

12. P. Sulc, **K. S. Turitsyn, S. Backhaus, and M. Chertkov** , Optimization of Reactive Power by Distributed Photovoltaic Generators, submitted to Proceedings of the IEEE, special issue on Smart Grid, arXiv:1008.0878

11. **F. Pan, R. Bent, A. Berscheid, and D. Izrealevitz** , Locating PHEV Exchange Stations in V2G, accepted IEEE SmartGridComm 2010

10. **K. S. Turitsyn, N. Sinitsyn, S. Backhaus, and M. Chertkov**, Robust Broadcast-Communication Control of Electric Vehicle Charging, arXiv:1006.0165, accepted IEEE SmartGridComm 2010

9. **K. S. Turitsyn, P. Sulc, S. Backhaus, and M. Chertkov** , Local Control of Reactive Power by Distributed Photovoltaic Generators, arXiv:1006.0160, accepted IEEE SmartGridComm 2010

8. **M. Chertkov, F. Pan and M. Stepanov** , Distance to Failure in Power Grids, LA-UR 10-02934

7. **K. S. Turitsyn** , Statistics of voltage drop in radial distribution circuits: a dynamic programming approach, arXiv:1006.0158, accepted to IEEE SIBIRCON 2010

6. **J. Johnson and M. Chertkov** , **A Majorization-Minimization Approach to Design of Power Transmission Networks**, arXiv:1004.2285, accepted 49th IEEE Conference on Decision and Control

5. **K. Turitsyn, P. Sulc, S. Backhaus and M. Chertkov**, Distributed control of reactive power flow in a radial distribution circuit with high photovoltaic penetration, arxiv:0912.3281 , selected for super-session at IEEE PES General Meeting 2010

4. **R. Bent, A. Berscheid, and G. L. Toole**, Transmission Network Expansion Planning with Simulation Optimization, Proceedings of the Twenty-Fourth AAAI Conference on Artificial Intelligence (AAAI 2010), July 2010, Atlanta, Georgia.

3. **L. Toole, M. Fair, A. Berscheid, and R. Bent** , **Electric Power Transmission Network Design for Wind Generation in the Western United States: Algorithms, Methodology and Analysis**, Proceedings of the 2010 IEEE Power Engineering Society Transmission and Distribution Conference and Exposition (IEEE TD 2010), April 2010, New Orleans, Louisiana.

2. **L. Zdeborova, S. Backhaus and M. Chertkov** , Message Passing for Integrating and Assessing Renewable Generation in a Redundant Power Grid, presented at HICSS-43, Jan. 2010, arXiv:0909.2358

1. **L. Zdeborova, A. Decelle and M. Chertkov** , Message Passing for Optimization and Control of Power Grid: Toy Model of Distribution with Ancillary Lines, arXiv:0904.0477, Phys. Rev. E **80** , 046112 (2009)

Tuesday, August 10, 2010

8:00-9:00. External Participants receive LANL badges. [Badge office -> CNLS]

9:00-9:20. Welcome/Opening Remarks: **Michael Chertkov** (T-4, LANL)

9:20-9:50. Intro to ``design of the grid'' part of the project & Transmission Network Expansion Planning with Simulation Optimization: **Russell Bent** (D-4, LANL)

9:50-10:15. A Majorization-Minimization Approach to Design of Power Transmission Networks : **Jason Johnson** (T-4/CNLS, LANL)

10:15-10:40. Locating PHEV Exchange Stations in V2G: **Feng Pan** (D-6, LANL)

10:40-11:10. Intro to ``control of the grid'' part of the project & Robust Broadcast-Communication Control of Electric Vehicle Charging : **Scott Backhaus** (MPA, LANL)

11:10-11:30. Break

11:30-11:55. Local Control of Reactive Power by Distributed Photovoltaic Generators: **Konstantin Turitsyn** (T-4/CNLS, LANL) [**Scott Backhaus** substituting]

11:30-11:55. Message Passing for Integrating and Assessing Renewable Generation in a Redundant Power Grid: **Lenka Zdeborova** (T-4/CNLS, LANL)

12:20-12:45. Algebraic Methods for Power Grid Analysis and Design : **Marian Anghel** (CCS-3, LANL)

12:45-13:15. Distance to Failure in Power Grids and wrap up of LANL part: **Michael Chertkov** (T-4/CNLS, LANL)

13:15-14:30. Lunch Break

14:30-15:10. Real-Time Embedded Optimization for the Smart Grid: **Steven Boyd** (Stanford University)

15:10-15:50. Efficient Algorithms for Renewable Energy Allocation to Delay Tolerant Consumers: **Michael Neely** (University of Southern California)

15:50-16:10. Break

16:10-16:50. Wind Integration -- By All Means Available: **Kameshwar Poolla** (University of California, Berkeley)

16:50-17:10. Multi-Commodity Flow Models for Dynamic Energy Management: **Matt Kraning** (Stanford University)

19:00-. Dinner [tentatively in Gabriels].

Wednesday, August 11, 2010

9:00-9:40. Do retail markets optimize electricity distribution costs? : **David Chassin** (PNNL)

9:40-10:20. Synchronization and Kron Reduction in Power Networks: **Francesco Bullo** (University of California, Santa Barbara)

10:20-10:40. Break

10:40-11:20. The Informational Value of Topological Models in Vulnerability Assessments for Electrical Networks : **Seth Blumsack** (Penn State University)

11:20-12:00. Verification of Global Access Policy in Large Scale Networks: **David Nicol** (University of Illinois)

12:00-13:30. Lunch Break

14:00-14:40. Modeling cascading failure with branching processes : **Ian Dobson** University of Wisconsin-Madison

14:40-15:20. Real time Pricing and the Stability of Wholesale electricity markets : **Sanjoy Mitter** (MIT)

15:20-16:00. Discussions & Final Remarks