Editorial
The Inaugural Issue of the IEEE Transactions on Control of Network Systems

I. A new beginning

This issue marks the beginning of the *IEEE Transactions on Control of Network Systems (TCNS)*. TCNS is envisioned to be a journal that cuts across multiple areas and it is financially and technically sponsored by the *IEEE Control Systems Society (CSS)* with technical co-sponsors the *IEEE Circuits and Systems Society*, the *IEEE Communications Society*, the *IEEE Computer Society*, and the *IEEE Robotics and Automation Society*.

A new field of science and engineering is coalescing around the study, engineering, and control of networks with very broad applicability to engineered systems, social science, economics, and biological systems. The term *network science* is often used to collectively describe these areas of research and the US National Research Council has even attempted a definition, defining it as "the study of network representations of physical, biological, and social phenomena leading to predictive models of these phenomena."

The broad scientific community that the sponsoring societies represent has made important methodological contributions to these emerging fields and has also been involved in a growing list of application areas. We strongly believe that this community, with its well known methodological strength, can and should play a *central role* to these developments. We aspire for TCNS to become the premier venue for related work.

II. The footprint

TCNS aims at establishing a large footprint covering all aspects of systems with interconnected components. The journal is primarily interested in problems related to the control of network systems but is also open to contributions concerning their design, study, engineering, optimization, and emerging behavior as these can inform and guide design and control. We plan to publish rigorous methodological/theory papers on network systems and application papers that have a significant degree of modeling or methodological novelty in some application area of network systems. Application areas of interest are many, spanning engineered systems, social science, economics, and biological systems.

In an effort to sketch TCNS's application footprint, we will attempt to provide a list – by no means all-inclusive – of different types of networks whose study, control, analysis, and optimization would be of interest to TCNS. Starting from more traditional and well-known networks to control researchers, this list includes:

1) **Networked control systems**, where the controlled system, actuators, and sensors are not necessarily co-located but connected over a communication network with its limited bandwidth, delays, and losses.
2) **Communication networks** include both wireline and wireless networks and have to be modeled, controlled, optimized, priced, simulated, and secured. Several problem areas are well established within the control community from routing, flow control, admission control, spread of viruses and malware, to performance evaluation, on-line optimization, inference of network structure, web analysis, and network economics.
3) **Sensor networks**, often wireless, have all characteristics of communication networks but with the addition of sensors which interact with the physical world. Again, this is an established area within the control systems community and has motivated important problems as in estimation, consensus, averaging, and decision making over networks.
4) **Cyber-physical systems** is a relatively recent term that encompasses systems with both physical and cyber components. In many cases, networking is a key to connecting the various system components and a plethora of problems can be posed, from abstract architectural issues to very practical problems in actual systems. The optimal deployment, control, performance evaluation, and security of these systems are problems that have attracted considerable interest.
5) **Networks of autonomous agents** include networks of robots, Unmanned Aerial Vehicles (UAVs), or other autonomous vehicles, and give rise to a myriad of related problems including swarming, consensus, cooperative control, motion planning, formation control, deployment, robustness, and bio-inspired control.
6) **Electric power networks or energy networks** can be used to describe the burgeoning research on the smart-grid and advanced energy systems within the control community and elsewhere. Such networks include the more traditional electric power networks but also new constructs such as micro-grids, fleets of plug-in hybrids interacting with the grid, and electricity demand response by cooperation among devices within a building or home.
7) **Transportation networks** is an established area of research but one where sensor networks, crowd-sourcing, smart parking, smart traffic lights, and vehicular communication networks are only now emerging with huge potential for revolutionary improvements.
8) **Biological networks**. The list of such networks is long and includes signal transduction networks, gene regula-

tion networks, protein interaction networks, metabolic networks, phylogenetic networks, networks of living organisms, and ecological networks which model consumer-resource interactions between groups of organisms. Control scientists are present in these areas, using for instance process control expertise in metabolic networks, or optimization techniques in predicting protein interactions, or collective decision making and learning in networks of organisms.

9) **Social and Economic networks** model interactions among humans (potentially through a communication network) for social or economic reasons. Research seeks to understand and control decision making (mostly distributed), behavior, phase transitions, resource allocation, and games over networks.

From this discussion, it is evident that the intended application footprint is large. Several methodological themes emerge, including: dynamics over networks, control over networks, network evolution, cooperative control, optimal (potentially dynamic) deployment, dynamic optimization, on-line optimization, estimation over networks, decision making over networks, games over networks, and simulation of networks.

The technical community TCNS aims at appealing to is known for its rigor. Rigor, therefore, is a key ingredient of papers we wish to publish and it is our goal to establish TCNS as the *premier destination for mathematically rigorous papers in network systems*.

While rigor is satisfying, it can be a double-edged sword. Take it to an extreme, and immediately the audience that could potentially appreciate and understand a paper shrinks. Therefore, and because we wish to make inroads into the whole spectrum of network systems applications, we plan to accept contributions that may not necessarily develop new theory or methods but make a *significant* modeling contribution, or *are first* to formulate and solve a new problem using techniques and ideas that have emerged out of the control systems and the broader technical community intersecting with TCNS. Such papers, in our view, have the potential to open new application areas to the technical community but also – and importantly – attract application domain experts. We are hoping that TCNS will help bring about a virtual "melting pot" and ground for synthesis of new ideas from the intellectual interaction between methodological/technical researchers and application domain experts.

We close this section with some comments on the complementary role of TCNS within the portfolio of CSS-sponsored publications. The *IEEE Transactions on Automatic Control* serves as the premier repository of new results in control theory, while the *IEEE Transactions on Control Systems Technology* covers more application-oriented papers. The *Control Systems Magazine*, on the other hand, in addition to covering control systems technology, publishes tutorials, essays, and reports on a variety of CSS and other activities. TCNS aims at providing a focused venue for rigorous work in network systems and becoming the premier journal for this emerging and growing area that extends well beyond the "boundaries" of the CSS.

III. TCNS EDITORIAL BOARD STRUCTURE AND SOME EARLY NUMBERS

We view the editorial board as "defining" the journal and we are excited to to have formed an absolutely first-rate group of *Senior Editors (SEs)* and *Associate Editors (AEs)*. They are well-recognized leaders in areas of interest to the journal. Inaugural TCNS SEs are: P.R. Kumar, Naomi Leonard, Steven Low, and Jeff Shamma. Authors submitting their papers are given the option to submit to any of the Editor-in-Chief (EiC), Deputy Editor-in-Chief (D-EiC), or SEs who then assign the paper to an AE. Our AEs take ownership of the papers they handle, are eponymous, and collaborate with the SEs and the EiC/D-EiC to arrive at editorial decisions.

We started accepting submissions in July of 2013 and we set a September 2013 deadline for submissions to be considered for inclusion in this inaugural issue. We received 120 such papers and selected 11 papers using a variety of criteria, including quality, strength of the reviews, recommendations by the AEs and SEs, and whether the work in the paper demonstrates the broad footprint of TCNS. While we are confident of the high-quality of all papers we selected, this does not necessarily imply that papers we have accepted for publication and we are currently scheduling for subsequent issues are inferior. We aim at maintaining very high standards for all papers we publish.

Early indications suggest that TCNS has generated quite a bit of interest in the research community. As of February 2014 we have received 194 submissions. A breakdown of decisions we have made appears in Fig. 1. A few remarks are in order. All "[1] Accepted without changes" decisions are made after a paper undergoes one round of revision. Initial decisions either recommend a minor revision (these are [2] decisions – conditionally accepted), or a major revision (these are [3] decisions – provisionally rejected), or reject the paper without encouraging the authors to revise and re-submit. The editorial board reviews all submissions and in some instances rejects papers without requesting external reviews (these are the [4I] decisions) either because it finds them out of scope or not containing a significant contribution. We will maintain this practice to avoid overburdening our reviewers which we consider as a key element to the success of the journal and a particularly scarce resource!

IV. THE PAPERS IN THIS ISSUE

The papers in this issue cover a number of topics of interest to TCNS and can be broadly organized into four main categories: (i) control and optimization of electric power networks, (ii) control of dynamic networks, (iii) resource allocation and routing in networks, and (iv) dynamic decision making in social networks.

In category (i) we have two representative papers. The paper by Caliskan and Tabuada studies the transient stability of electric power networks and derives conditions that ensure stability under the existence of losses in transmission lines. The paper by Low provides a comprehensive survey of work on the optimal power flow problem and presents advances on convex relaxations of this key optimization problem.

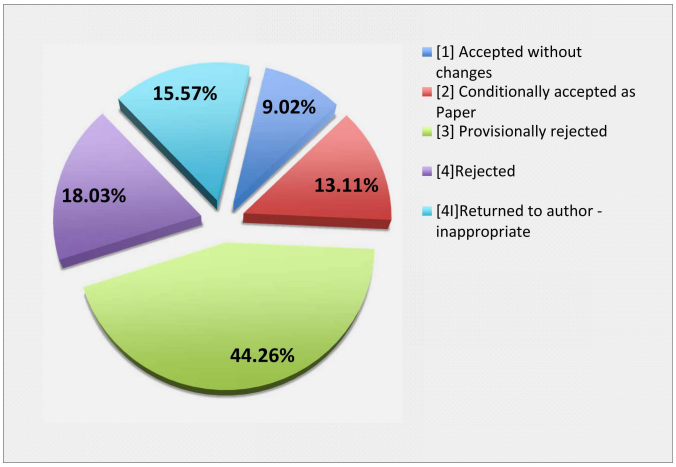

Fig. 1. Decisions as of February 2014.

In category (ii), the paper by Li et al. considers the control of transportation networks modeled by Partial Differential Equations. The paper by Pasqualetti et al. is motivated by applications in power systems, social networks, and the spread of epidemics. It focuses on how to select a set of control nodes in the network and design an appropriate control input for these nodes in order to drive the network to a target state. The paper by Madjidian and Mirkin considers the distributed coordination of a homogeneous group of autonomous agents and is motivated by some coordination problems arising in wind farms.

In category (iii) the paper by Beck et al. considers resource allocation problems in communication networks formulated as a network utility maximization problem. It develops a fast distributed algorithm to solve the dual of this problem. The paper by Karpovsky et al. considers wormhole routing in communication networks and develops techniques to prevent deadlocks which can occur in this setting. The paper by Cassandras et al. focuses on routing and energy allocation problems in wireless sensor networks under a realistic (nonlinear) model describing how batteries at the various nodes get depleted. Finally, the paper by Preciado et al. targets problems motivated by the spread of epidemics over networks. It develops strategies on how to optimally allocate preventive ("vaccines") and corrective ("antidotes") resources across the network.

Category (iv) papers consider dynamic decision making in networks formed by humans. The paper by Vassio et al. studies the evolution of opinions in a social network. It proposes a new metric of node centrality and develops a distributed algorithm for computing this metric for each node. Finally, the paper by Srivastava and Leonard considers the distributed decision making in a network of humans modeled by using a coupled drift diffusion model.

It is clear from this discussion that a number of dominant themes emerge including the control of networks, network dynamics, the emphasis on distributed control and optimization, and the importance of distributed resource allocation and decision making over networks. Several applications areas are represented by this collection: electric power networks, transportation networks, communication networks, sensor networks, networks of autonomous agents, and social networks.

We close this editorial by stating the obvious. This issue is simply a snapshot of an emerging and rapidly evolving area of research. We look forward for TCNS to establish itself as the premier venue for rigorous work in this broad arena of network systems. We count on your continued support and we welcome your submissions. Please follow the TCNS developments at http://sites.bu.edu/tcns/.

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