A Reference Model for a Networked Organization (Doctoral Consortium)

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ABSTRACT

This paper heralds a paradigm that serves as a reference model for organizations of networked agents. This paradigm suggests modular components that can be combined to form a network organization. For network centricity in this paradigm, I am introducing synergy and social capital as specific network effects that enhance performance at various levels of an organization and overall productivity.

Categories and Subject Descriptors

I.2.11 [**Distributed Artificial Intelligence**]: Multiagent Systems

General Terms

Management

Keywords

Agents Paradigm, Computational Models, Network Organization

1. INTRODUCTION

When the agents dwell inside an organization, they form repeated patterns of interactions that shape the structure of their network, which affect their performance features [7]. A paradigm is a term that capitulates representational power of a more ubiquitous perspective over its modifier. Agents in an open multi-agent system are self-governed by their own belief systems and have irrational behaviors. It is possible for an organization to exhibit specific features yet not be characterized by them. In a previous work [3], we explored applications that account for spontaneous exigencies in the agents' actions to benefit and shape an organization. We found that traditional organizational paradigms lack the representational power in modeling such spontaneous structure that is formed from frameless actions and connections. The agents in that case seem to collectively form large, semi-autonomous networked communities with the aim of automating command and control of distributed complex tasks that we term as *Network Organizations* (NO).

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Studies of traditional organizations were moved by a homologous structure formed from cooperative interactions among different agents to address networks as part of the intra-organizational structure [6]. Networks strengthen the social communication of an organization to access critical resources with other organizations on the network as well as to agilely adapt to environmental changes [8]. Such properties allow the NO to plastically transform its internal structure to cope with outside social and information demands which in turn influence behaviors of its agents [4].

2. UNDERSTANDING AN NO PARADIGM

An NO paradigm (NOP) guides us to model organizations of large firms working on complex, in scope or impact, problems. Examples are systems of river dam control, factory cells, electrical power grids, organized labor unions, and traffic control on land, sea, and space. As a paradigm, it does not functionally alter the operations to which it is applied. The paradigm can be understood in terms of the ways it permits arrangement of command and control regimes. A significant advancement was established in the network-centric warfare that stimulates self-organization and self-integrating coordination. Location ignorance is extended in NOP to permit temporal freedom, i.e., operations can be controlled asynchronously. Another extension for an NOP is to allow any credentialed network member node to exert influence on operations. In sum, an NOP provides a more ubiquitously open model that may include transparent entry and exit to the organization. At this high level, we summarize an NOP in the main components listed below. For more, refer to [1]:

- **Network profile**: $\langle \mathcal{N},\ R_{esource},\ \mathcal{P}\ \rangle$, where $\mathcal{N}$ is a set of agents profiles participating in an NO and $\mathcal{P}$ is a set of protocols to govern the activity of agents that include norms, rules, and roles.
- **Agent profile**: $\langle \vec{A}, \vec{S}, R, \vec{f}, P_{\vec{reference}}, A_{utonomy} \rangle$, where A is a set of an agent's allegiances, S is a set of skills including his capacities for different tasks, R is a set of an agent's relations with others in or out an NO, and f is a set of agent's initial fitness values for different types of tasks based on its previous experiences.
- **Problem profile**: $\langle C_{ontrol}, \vec{C_{oordination}}, G, P_{recedence}, I_{ndependence} \rangle$, where C_{ontrol} is for controlling participants and available roles, $C_{oordination}$ is a set of coordination rules for each agent based on its profile for a possible assignment, G is the goal of the problem profile, which includes a set of tasks and set of plans that

should be followed to achieve this goal, $P_{recedence}$ is the priority level of the problem domain, and $I_{ndependence}$ of a G in the problem-profile from other competing goals that can be executed at the same time.

- **Governance profile**: $\langle C, P, \mathcal{F}, A_u, O_{perf} \rangle$, where C is the organizational charter adapted from the network to generate goals presented by different problem domains. P stands for the pattern of connecting problem-profiles provided to satisfy the global charter. $\mathcal{F}$ is a set of fitness functions for the whole NO to help in evaluating its functioning over time to make sure it follows in a proper direction. A_u is the autonomy level of an NO, where with the higher level of autonomy, the more independently the NO operates. O_{Perf} is an optimal organizational performance to be compared with the current performance to measure the NO progress.
- **Institution profile**: $\langle Charter, Pattern, Regulation \rangle$, for a $Charter$ that is much bigger than C of NO to give a general idea of the institution and to link different NOs through $Pattern$. $Regulation$ are partially inherited from the network to include a set of roles, rule, and norm that is most likely inherited by its NOs.

3. NETWORK EFFECT ON AGENTS' PRODUCTIVITY

In a graph, values of links are driven from continual interactions among agents in an NO to calculate values of relations which help in measuring parts of the network effects.

3.1 Synergy

In an NO, there is a level of inter-agent compatibility in which the agents can work together effectively. Such a measure will affect the agents' performances and, as a result, the global output of an NO. As long as there are continual interactions between the agents inside the NO, we describe these levels as synergy [9]. When a part of these interactions are not active, their synergies will be reevaluated and it may affect the total synergy of their NO. The value of a pairwise synergy is proportional to the agents' capacities, which include their capabilities, willingnesses and availabilities, as well as their relations with each other.

3.2 Social Capital

Social capital in a link is measured from accumulation of positive values of social flow and trust plus abundance of communication over the common topic of NO. Work in progress will provide quantitative methods for operations in NOs to help us guide the organization toward accomplishing its objectives; a short description was presented in [5].

4. SUMMARY AND WORK IN PROGRESS

An NO can be a small team of two or more agents working on a common, quick goal that is possibly faster than human perceptual threshold (e.g., aerial coordination at high speeds) or a large collection of agents made up of thousands of people (i.e., possibly swarms) working on long term objectives that are possibly beyond a single human's cognitive capacity (e.g., detecting climate change). I have briefly introduced a paradigm to best model organizations dwelling on socially connected networks. This paradigm is a collection of principles, layouts, and interaction protocols that obviate the network nature of group activity as an organization. The salient properties that set an NOP apart from other organizational paradigms are: a. Openness, b. Evolving structure, c. Selfish allegiances and community social power, and d. Impromptu network topology.

Given the volatility of networks, an NOP will allow for rapid depiction and analysis of emerging and evolving networked organizations witnessed in our connected world. An NOP has introduced modular components capturing essential units to be modularly combined to define NOs. An NOP replicates many properties and features of virtual working groups. A specific salient phenomenon is how working together in networks affects their individual as well as collective productivities. Synergy and social capital are main types of network effects featured in our paradigm to enhanced performance of agents and the organization.

Our plans include analyses of naturally occurring network organizations that illustrate principles indicated in our proposed paradigm as well as designs for novel applications that illustrate flexibility of our modular paradigm. We have shown by a case study that the NO paradigm is applicable for modeling real world organizations [2]. An extended work will cover more details and applications that corroborate tenets of NOs in settings such as Net-centric warfare as well as grid-based disaster responses. Of particular interest are the potential issues arising from scaling NOs to medium and large organizations, and augmenting generic NO features with features that will be required for specific domains that are unforeseen at the moment.

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