

The Bio-Networking Architecture: A Biologically Inspired Approach to the Design of Scalable, Adaptive, and Survivable/Available Network Applications

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Abstract

In this paper, the authors propose and describe a new network architecture called the Bio-Networking Architecture. The Bio-Networking Architecture is inspired by the observation that the biological world has already developed mechanisms that are necessary for future network requirements such as self-organization, scalability, adaptation and evolution, security, and survivability. In the biological world, each individual entity (e.g., a bee in a bee colony) follows a simple set of behavior rules (e.g., migration, replication, reproduction, death, energy exchange, and relationship establishment with other entities), yet a group of entities (e.g., a bee colony) exhibits complex, emergent behavior and characteristics (e.g., self-organization, scalability, adaptation and evolution, security and survivability). The authors of this paper believe if a network is modeled after biological concepts and mechanisms, it may be able to achieve the desirable properties of self-organization, scalability, adaptation and evolution, security, and survivability.

In the Bio-Networking Architecture, network applications are implemented by a group of distributed, autonomous entities called the cyber-entities (analogous to a bee colony consisting of multiple bees). Each cyber-entity implements a functional component related to its service and also follows simple behavior rules similar to biological entities (such as migration, replication, reproduction, death, energy exchange, and relationship establishment with other cyber-entities). In the Bio-Networking Architecture, useful behaviors and characteristics emerge from the interaction of individual cyber-entities.

The innovative features of the Bio-Networking Architecture include:

- The Bio-Networking Architecture is the first attempt to apply key biological concepts and mechanisms (such as emergent behavior, adaptation, evolution, diversity, social networking, and energy) to the design of a broad and general class of network applications.
- The Bio-Networking Architecture enables the construction of complex network applications with the inherent properties of self-organization, scalability, adaptation, evolution, security, and survivability.
- Because the Bio-Networking Architecture adapts and evolves to accommodate short and long term changes in network conditions, system designers, administrators, and users are free from managing and tuning network applications.

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