Survivability of Multi-Agent Systems

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ABSTRACT

The survivability of a large scale Distributed Multi-Agent Systems (DMAS) functioning in dynamic and hostile environments is a significant design and run-time challenge. Delivering the correct proportion of performance, robustness and security is vital to the survivability of a complex adaptive system such as the DMAS. Using a combination of theoretical and empirical models, this thesis builds a survivability framework while addressing themes such as scalability, decentralization and autonomy in parallel.

Categories and Subject Descriptors

C.4 [**Performance of Systems**]: *Design studies, modeling techniques, performance attributes*

General Terms

Performance, Reliability, Experimentation

Keywords

Multi-Agent Systems, Survivability, Queueing Models

1. RESEARCH OBJECTIVE

While recognizing, resisting and recovering from stressful situations are the fundamental properties of survivable systems, quantifying these measures along various dimensions is vital to adaptivity design. One way to realize these properties is to formulate the threads of performance, robustness and security and to tackle threats along these dimensions. This thesis focuses on designing a scalable, decentralized and autonomous framework capable of performance and robustness adaptation for ensuring DMAS survivability.

We model a DMAS with a common system-wide functionality of planning such as in military logistics based on the systemic specifications of the capabilities and attributes of individual agents (TechSpecs). TechSpecs distributes knowledge about the capabilities and strategies of the system. Dynamic stresses range from heavy computational loads to infrastructure destruction. The DMAS consists of the application, infrastructure and physical layers as visualized in [2].

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2. SOLUTION METHODOLOGY

We propose an autonomous and scalable queueing theory-based methodology to control the performance of a hierarchical network of distributed agents [1]. Because of the need to achieve maximum overall utility during operation, the objective of the performance control framework is to identify the trade-offs between quality and performance and adaptively choose the operational settings to posture the MAS for better utility. By formulating the MAS as an open queueing network with multiple classes of traffic we evaluate the performance and subsequently the utility, from which we identify the control alternative for a localized, multi-tier zone.

The robustness of the network is characterized using the reliability of the network of nodes under random and targeted attacks by using a Markovian reliability model. The application can choose the objectives of reliability and performance for a price in a desirable proportion so as to maximize its domain-specific utility. A price negotiation algorithm is designed to ensure the convergence of QoS selection which is an iterative accept-reject process.

While decentralization is achieved through a pricing based mechanism, a building block approach can create a large-scale DMAS using autonomous small-scale clusters. The clusters adhere to the prices imposed by their superior and minimize cross-cluster interactions. The scalability strategy mandates small clusters that manage their QoS (and ultimately the survivability of the DMAS) through calculated reallocations within the cluster while making the performance and robustness trade-offs through the internal models.

3. CONCLUSIONS

The contribution of this work lies in architecting a multi-objective framework for a survivable DMAS with the desirable properties of scalability, autonomy and decentralization. To ensure the success of such a framework attention must be paid to convergence issues as well as chaos related complications that may arise. If supported by theoretical and empirical evaluation on a large scale, this research will result in a design template for survivable DMAS.

4. REFERENCES

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