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Getting DOD Linked- How to Build Netcentric Operations

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Over the past decade, conventional theory for large networks has undergone a radical revolution as evidenced by the popularity of books such as Albert-Laszlo Barabasi's Linked: The New Science of Networks. Under the old regime (strongly influenced by the work of the great mathematician Paul Erdos), networks were modeled as static, random, and passive entities. Today, we recognize large networks are actually dynamic, scale free, and competitive in nature. Why does this shift in network theory affect the DOD's goal for netcentric operations?

First, if indeed large enterprise networks such as integration of all of DOD's command and control systems are seen as dynamic, growing organisms, then we should rethink our current approach of a master, all encompassing architectural definition of the 'to be' state. Instead, we ought to capture the essential aspects of this 'to be' architecture with modest efforts and expect to evolve it frequently over time as the enterprise grows and changes. This empowers our architects to produce meaningful guides today without having to promise the omniscient vision for all time- something that is not only impossible but restraining progress in moving out today. It acknowledges and encourages a continuous refinement that is critical to a healthy roadmap of enterprise proportions.

Second, the realization that the network is not random is perhaps the biggest impact that can help us achieve netcentric operations today. Current theory states that any very large network is actually scale free or scale invariant- a term borrowed from the Nobel Prize winning work on phrase transitions done by Kenneth Wilson in 1982. In a random network, we would view the number of links per node of a network to follow a Poisson or Guassian distribution; there would be a 'peak' frequency of some 'average' connectivity as depicted in a classical Bell shaped distribution curve. Using this old model we find resiliency to be quite robust in a network such as the Internet as analysis would indicate up to 10% of the nodes could be taken out randomly and the functionality would basically remain intact. However, conventional wisdom tells us that hackers can bring down the network with a much smaller fraction of nodes being attacked. Though they probably haven't studies the new network theory, they empirically understand that not all nodes are equal- in fact some are enormously more important than others. These major hubs are the lifeline of the large network and if attacked can cripple the overall effectiveness of a network very rapidly. The new theory of large networks predicts exactly this as being a byproduct of what is known as 'scale free' networks. In a scale free network, there is no classical peak of a Bell curve. Instead there is a power law relationship: at one end there is an asymptotic approach for a very large number of nodes to have few links and another asymptotic probability that a very few nodes will have an enormous number of links. This predicts not only the existence of hubs with large connectivity characteristics, but also leads to arguments that the real power of a large network is controlled by the presences of these highly connected hubs. How can this help DOD?

Take the holy grail of data interoperability across the numerous DID legacy systems in the field today. The new power law theory would argue that an enterprise data strategy must recognize a balance between communities of interest (COI) data standards that have modest richness of detail but modest system participation against loosely coupled data standards that have modest richness of details but a very large number of system participation. For example, the Air Force has the

TADIL J data standard that contains 3000 pages of message descriptions that richly capture the needs of airborne missions. The Army uses JVMF message standards where one message type can have over a quadrillion legal variants to capture many needs of the Army's missions. Both of these are very rich in detail, are highly valued by their respective COI, but have limited number of systems outside of that COI that can afford to invest in such a complex standard. And there are many other 'big' standards evolved out of different COIs, each with greater complexity and value to their members. However, conventional wisdom in the DOD is to gather all the COIs together and try to mandate a single, enterprise standard to solve the data interoperability issue. First, no community is willing to adopt another community's standard since they are all optimized for such different missions. So we tend towards a superset or union of all the big data standards to propose a 'mother of all standards' in which everyone's richness (and complexity) is included. The problem is there is no one that could ever implement and test such an enormous standard. In fact we do not know of anyone who has fully implemented and tested even a single COI standard such as TADIL J and JVMF! However, using the new network theory of power laws, we would move to balance these COI standards with a loose coupler that connects with every other COI standard using a very light weight set of data elements that capture only the most critical elements. This does not attempt to compete with the richness of any one standard, but is simple enough that all communities could easily adopt it as part of their implementation. But how do we choose what's most important? One way is instead of taking the union of data needs, we take the opposite approach and look at the intersection of needs across communities. This has the appealing characteristic of scalability since as we add more systems to interoperate, the intersection of common data element types gets smaller! This will scale to enterprise proportions. Further, this intersection highlights data elements so pervasive that they truly are of enterprise value- and contain tremendous value per data element. We see that not all data elements are created equal, so why do we impose strategies that tell programs to implements them as if they were all of equal value? The new theory says that focus on what is most important and the return on investment will be immediate and overwhelming. This is yet another instance of the 80/20 Pareto rule! Do we have any existing examples that this data strategy of COI and loosely coupled standards will work? Yes ! (see Cursor on Target paper).

Finally, the assumption that the network is passive leads us to believe that a master planner is behind the scenes deciding how the overall network will be created. Reality is quite the opposite. We see large networks as constantly changing, with competing entities that are rewarded and punished by their 'fitness' to survive in the environment. As an example on the Internet, search engines have always been one of the cornerstones to tap into the power of this large network. Historically, we see search engines come and go as new algorithms, user feedback, and market push Yahoo, Alta Vista, Netscape, and others to the top and then to the bottom of the fitness pile. Late comers like Google can shoot to dominance if their 'fitness' is proven superior by the users. With millions of 'tests' a day, users validate their choices on a continual basis. Market forces are critical to evolving a healthy large scale network. Yet in the DOD, we can't help but want to pick 'winners' and 'losers', often well before the market has had a chance with real experiences to validate these choices. Instead we need to provide a benign environment where users can have not

just the 'DOD' approved solution, but other innovative competitors that encourage rapid refinement and adaptation to evolving user needs. Then as the market speaks, DOD must be nimble enough to allow choices to change. This is such a superior approach to improve performance-starved needs, that any other approach is doomed to stagnate in comparison. Does this mean we should always encourage diversity and competition? What about the implied costs, maintenance, interoperability, etc. of such an approach? In general, if the diversity of solutions does not differentiate themselves in performance because all are 'good enough' then it makes sense to standardize and possibly pick a standard for cots, maintenance, and interoperability reasons. However, if the mission need it addresses is performance driven, then standardization is ill-advised.

The examples discussed are not all inclusive, but rather representative of alternative strategies the DOD should consider based on the new network theory that evolved over the past decade/ These ideas have made radical transformations in marketing, medicine, biology, etc. Isn't it time we let the network theory help transform DOD's netcentric realization?

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