# Federation Among Remote Military Data Stores In DIL Environments

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***Abstract*—The abstract goes here.**

## I. Introduction

Transportable computing and some degree of network connectivity have been a necessary component of US military operations at least since the advent of the personal computer in the 1980s. Subsequent ubiquity of laptop computers and, more recently, hand held devices such as the smart phone have exacerbated the problem by allowing the need for data and the locus of computing power to be increasingly distributed and fragmented.

Consequently, there exists a significant and growing problem related to the decentralization of computing in the United States military. Due to the increasing distribution of computing power and data storage, there is now an acknowledged need to implement some form of federation [**?**] in order to maintain data concurrency. This is especially true in theaters of operation that are characterized as austere environments and for which communications are assumed to be disconnected, intermittent, or limited (DIL), and where connections to a centralized data store are impractical or impossible.

## II. Problem Space

United States involvement in military operations over the past fifteen years has been in operationally challenging environments. Lack of existing infrastructure to provide necessary operational support has been a primary challenge to sustaining long-term presence necessary to achieve our national security goals. We focus on the challenges associated with fighting in an asymmetrical conflict while operating in an environment in which the transmission of electronic data is challenging at best.

### *A. Motivation*

Is this answered in the Introduction? If not (or possibly even, if) elaborate here on the distribution (diffusion) of computing and storage. Also, comment on the commonality of the need for federation as a service to a) protect and manage bandwidth as an Organizational resource, and b) prevent independent implementation by multiple systems, which would result in redundant and potentially conflicting services. We view bandwidth as a resource and treat it similar to ammunition and food.

### *B. Questions*

Here is what we intend to address:

- Can we guarantee eventual consistency of data, if even statistically?
- In what sort of time can we expect to achieve consistency?
  - I think it should approach $O(log(n))$, maybe with some constant, $K$, based on the likelihood that small-world networks will develop. $O(Klog(n))$
  - Elapsed time, based on number of time steps and the average duration of each step.

## III. Model Design

A description of the model goes here.

Can we make a cogent case for using the inverse square of the distance law of gravitational attraction to accurately model both bandwidth and the probability of connectivity within the constraints of our graph model, taking distance, $d$, as the graph distance between any two given nodes, $n_i$ and $n_j$? Possibly we follow this basic model but apply some constant to correct for accuracy. Certainly it does seem to be the case (on first inspection) that both bandwidth and connectivity should follow some inverse power law.

### *A. Bandwidth*

Bandwidth is inversely proportional to the distance of some node, $k$, to the root of the graph.

### *B. Connectivity*

The probability of connectivity goes inversely with the distance of some node, $k$, to the root of the graph.

### *C. Directionality*

While the traditional flow of information in a military hierarchy follows a top-down model, we implement an undirected graph. We feel this is in keeping with the stated specific desire that each soldier be a sensor on the network [**?**]. A direct result of this is that information will naturally flow not only up and down the traditional chain of command, but also laterally within a structural organization and even across formations. We will further see how the occasional lateral flow of information facilitates our desired end state of achieving consistency of data across the network by creating temporary ad hoc small-world networks within the hierarchical military structure.

### D. Shortcuts

We intentionally allow the occasional introduction of shortcuts on our graph. These shortcuts model the transit of information over non-traditional routes within the network. Shortcuts are an important part of this network model in that they intermittently create small-world type situations within an otherwise hierarchical network model. Talk about why small-world networks are important for shortening the diameter of the graph.

*1) Lateral Movement of Data:* Data at rest on computing devices in transit between Companies or Battalions could constitute an instance of an unintended consequence of an increasingly distributed computing environment and result in a lateral transfer of information.

*2) Hierarchical Movement of Data:* The establishment of temporary connectivity from one echelon to another, which bypasses the standard chain of command could result in a hierarchical movement of data. Such situation may exist if, for example, a Company Commander required a Sat-Com link to a Division asset.

## IV. Related Work

Possibilities for additional, related work include:

- Individual datum may have different levels of importance, and consequently there may be the need to address QoS issues on the network.
- Security has been summarily ignored for the sake of this discussion, but must be implemented in a way that satisfies the needs of the military organization.

## V. Conclusion

The conclusion goes here.

The following is just a collection of citations that may (or may not) be used in this paper. I have collected them here in order to ensure they not get misplaced. [**?**] [**?**] [**?**] [**?**] [**?**] [**?**] [**?**] [**?**] [**?**]

## References