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Vendor Network Mapping Capability

Follow-On Project

Final Report

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Foreword

The Vendor Network Mapping Capability (VNMC) project was an effort sponsored by the Defense Logistics Agency (DLA) Weapon System Sustainment Program (WSSP) Research & Development Office to pilot novel approaches for creating network maps of DLA suppliers and analyzing relevant risks associated with them. This effort was a continuation of a previous successful effort, Vendor Network Linkage Analysis (VNLA), which was a feasibility study to determine whether a network mapping and risk analysis was possible. These efforts, which are meant to help DLA develop additional supply chain risk management capabilities, are aimed directly at assessing and mitigating the risk of DLA obtaining potentially counterfeit, nonconforming, or otherwise malicious components.

During the pilot effort of VNMC, a variety of tasks were completed including, but not limited to, (1) setting dataset best practices, (2) developing analytic approaches for manipulating and analyzing network data, (3) building unique network visualizations, (4) producing/user testing enterprise Qlik Sense dashboards, (5) developing technical recommendations for implementation, and (6) assessing ICT suppliers and differences between manufacturers/distributors. These activities were performed in conjunction with WSSP R&D leadership and Technical Quality stakeholders in DLA HQ J34 and the Counterfeit Detection and Avoidance Program (CDAP) located at DLA Land & Maritime.

In addition to these activities, a follow-on effort was sponsored in 2019 to refresh the Agency's understanding of related capabilities and update the business case for this program. A renewed analysis of industrial capabilities found that D&B's Tier-N offering remains the top third-party data option. An in-house analysis of related capabilities found that some supplier risk assessment tools exist and a burgeoning Vendor Network Mapping (VNM) section built into Business Decision Analytics (BDA) has laid the foundation for DLA to move forward with operationalizing this capability. Additionally, recent guidance from the Director in his 2018-2026 Strategic Plan specifically mentions that 'SCRM is fundamental to the Agency's ability to meet its mission' and calls out implementation of VNMC (or a similar capability) as a means to partnering with reputable vendors, a major strategic focus area.

This Vendor Network Mapping Capability Follow-On Final Report is a wholly separate addendum to the overall VNMC Final Report containing only findings and updates relevant to this follow-on effort and analysis. Information from previous phases are included where pertinent for context, however the findings and recommendations stemming from this work have been incorporated into the overall VNMC Final Report which should be considered the authoritative text on the project.

Executive Summary – VNMC Follow-On Findings

The Vendor Network Mapping Capability (VNMC) Follow-On project was sponsored to provide additional research and analysis to the previous VNMC pilot to meet three primary objectives: (1) research the current state of industry and available commercial options for vendor mapping data, (2) research the current state of DLA and government capabilities to assess whether any capabilities meet the goals of a vendor mapping capability, and (3) revisit the benefit cost analysis to determine an approximation of the cost of developing a capability or procuring data from a commercial source.

An analysis of commercial 'vendor mapping' or 'multi-tier supply chain' data capabilities revealed that several new offerings have emerged, but most do not offer critical multi-tier data and as such are of limited use for vendor mapping purposes. Panjiva appears to have a promising dataset, but sample data could not be obtained to certify its applicability and the veracity of the company's claims. Similarly, previously researched company Beroe remains highly rated but has similarly unproven data claims. Several top offerings from previous research were analyzed, but their ratings remain wholly unchanged due to a lack of development or modification. The Tier-N offering from Dun & Bradstreet, although unchanged from previous phases, continues to be the highest-rated data package and the only analyzed offering with proven multi-tier datasets. Tier-N datasets were purchased for DLA evaluation in previous phases and are well-documented in the data exploration sections.

Analysis of DLA and government capabilities within Supply Chain Security groups found that limited relevant capabilities exist in whole or in part. This research found that relevant thought capital exists in the form of a research paper *Clustering Algorithm Identification of Supply Chain Vulnerabilities* written by Lieutenant Commander Michael Kidd (USN) during his time at DLA, and also in the information repositories hosted by the Defense Technical Information Center (DTIC). However, the only production-ready environment and applicable tool exists in the aptly named Vendor Network Mapping (VNM) tool built within the Business Decision Analytics (BDA) suite. Although the current version supports only the analysis of vendor fraud networks, its foundation using Qlik Sense for visualizations is promising. The recommendation for integrating VNMC into production has also been updated based on the development of this tool. It is now recommended that J6 explore integrating/updating VNMC capabilities into this tool and utilizing a Sankey Diagram for analysis in conjunction with supply tier data from a third-party source.

The Benefit Cost Analysis for this project has become less relevant in recent months, since the Director mandated that both Business Decision Analytics and Vendor Network Mapping be integrated into the enterprise's acquisition strategy moving forward. The current capability can be upgraded by acquiring commercial data to load vendor supply tier data as needed and utilize J6 support for any required integration or modification. Data acquiring from D&B during previous phases roughly estimates the per-supplier data acquisition cost to be approximately two-thousand dollars each, but an economy of scale can be expected in negotiations with a data provider. Overall, the major benefits of a VNMC solution cannot be assessed quantitatively since the goal of this supply chain risk management tool would be to reduce risk, and not cost. Regardless, rough quantitative estimates for workload reduction and a number of qualitative benefits were assessed in the initial phases of the project.

Executive Summary – Data Provider Evaluation

A major component of the original Vendor Network Linkage Analysis (VNLA) research included an analysis of data & capability providers offering some form of supplier analysis including linkage and/or relationship information. This original research set out a 14-criteria evaluation framework for assessing industry capabilities based on:

1. Data Delivery Format
2. Link/Relationship Data
3. Link/Relationship Data Format
4. Parent/Subsidiary Data
5. Parent/Subsidiary Data Format
6. Link/Node Attribute Data
7. Link/Node Attribute Data Format
8. Scope/Data Coverage (Tier 1 DLA; International)
9. Scalability/Lead Time
10. Update Frequency
11. Interfacing Options
12. Market Intelligence Data
13. Available Use Cases
14. DoD Client

Utilizing this structured approach, sixteen unique offerings were evaluated along with DLA's use of Traceability Data in the original VNLA research. Each offering was rated on the strength of their attributes using a weighted scale (i.e. most important criteria weighted more heavily) and relatively ranked. The top offering across both assessments (for VNLA originally, and within the VNMC updated research) is the Dun & Bradstreet Tier-N capability.

The Tier-N offering appears to be the only 'true' capability including proprietary data, although it is somewhat burdened by the requirement to obfuscate company details beyond Tier 1 when the information was not sourced publicly. This strength of the offering (i.e. having proprietary, non-public data) also hampers its ultimate effectiveness. However, as shown in the VNMC pilot (and documented within this report), the data is still useful for identifying supply choke points, areas of foreign influence, and potential single sources of supply among competing bidders.

Executive Summary – DLA & Government Capability Assessment

A major task of VNMC was to analyze internal DLA and government capabilities to identify those with functions that are the same, or similar to, the intention of a Vendor Network Mapping Capability. Contacts were made within DLA and government supply chain security groups to identify any capabilities for analyzing the supply chain and/or networks of high-importance vendors. More specifically, points of contacts were asked to please respond with any information directly relating to the following functions:

- **Vendor Risk Analysis** (i.e. credit risks, fraud risks, etc.)
- **Vendor Network Mapping / Supply Chain Mapping** (any data relating one company to another (e.g. a known connection between an OEM providing components to a distributor)
- **Vendor Performance Issues** (i.e. potential fraud, failed testing, late delivery, etc.)

Several related capabilities and/or sources of thought capital were identified including:

1. **Vendor Network Mapping** – A subset of Business Decision Analytics, this section of the production-ready tool utilizes data from Defense Criminal Investigative Service to provide a platform for exploring known fraud rings and relationships.
2. **Enterprise Geospatial Information System** – A functional capability for incorporating geospatial analysis and real-time feeds for producing highly actionable dashboards. This robust system provides a means for incorporating custom sources of relevant supply chain data with mapping visualizations to meet specific logistics objectives and/or mitigations.
3. **Clustering Algorithm Identification of Supply Chain Vulnerabilities** – This research paper authored by Lieutenant Commander Michael Kidd, USN details his approach for utilizing social network analysis tools and publicly available supply linkage data to explore large networks.
4. **Defense Technical Information Center Repository –** The DTIC information repository is CAC-accessible information sharing platform making more than half of all DTIC information available to users. This platform can be used to perform background research and/or find best practices on supply chain security topics.

The most related capability to VNMC is the Vendor Network Mapping developed within Business Decision Analytics. Although this tool is currently used to analyze known fraud networks (as opposed to overall supply chain networks), the visualization framework built using Qlik Sense provides a way-forward for VNMC data such as that used in the pilot from D&B Tier-N.

In addition to being production ready and in-use, this tool provides a low-cost alternative to developing a new standalone capability and reduced deployment time. Although it would need some repurposing to accept full supply chain data and does not currently support Sankey diagrams (AKA flow diagrams), the development of this tool in 2018-2019 changes the recommendation for deploying VNMC. The most direct route to a VNMC-type production capability is through Business Decision Analytics and this specific capability.

Executive Summary – Business Case Analysis

A Business Case Analysis (BCA) was performed to assess the benefits and costs associated with the production implementation of a Vendor Network Mapping Capability at DLA through the J6 Front Door process. While exact estimates are difficult to obtain, it was found that DLA has several integration options (including leveraging J6 and enterprise visualization tools) that can minimize the cost to integrate such a capability. Additionally, based on data costs from the pilot, it can be expected that data costs could require about two-thousand dollars per vendor supply chain mapped, with potential economies of scale depending on the supplier volume. Toward that end, an analysis of vendor 'coverage' for FSG 59 – Electrical and Electronic Equipment was performed. This analysis found that DLA can procure data for a number of specific suppliers to cover areas of interest – for example the Top 100 suppliers in FSG 59 by quantity of components provided would account for more than two-thirds of all components acquired within that supply group.

	FSG 59 Procurement Value	**FSG 59 Procurement Quantity**	**FSG 59 Procurement Count**
Top 100 Suppliers	47.0%	66.8%	56.3%
Top 150 Suppliers	55.8%	75.4%	64.4%
Top 200 Suppliers	62.1%	81.0%	69.7%

However, it should be noted that the largest suppliers of components to DLA (by any metric) tend to be the most trusted. Therefore, the supply chain security strategy should ideally combine a mixture of enterprise coverage (i.e. understand the majority of the supply base) and special targeting of trouble suppliers (i.e. understand where risks may exist for suspicious and/or special case suppliers).

Overall, the intangible (or unquantifiable) benefits of the project are numerous and the importance of this effort was noted by the Director in his 2018-2026 Plan and Supply Chain Security Strategy. The Director guided DLA to work on integrating Vendor Network Mapping into DLA acquisition strategies, showing the importance of a well-protected supply chain.

Guidance supporting the VNMC implementation solution at DLA to help address and mitigate supply chain risks is also elaborated within (but not limited to) the following documents; **(1)** DoD Manual 4140.01 Volume 11, **(2)** DoD Instruction 4140.67, **(3)** DoD Instruction 5200.44, **(4)** DoD Instruction 5000.02, **(5)** National Defense Authorization Act of 2018 – Section 806 and Section 807, and **(6)** DLA Director's Strategic Plan 2018-2026**.**

Although VNMC and other supply chain risk management efforts are not strictly cost saving capabilities, the consequences they prevent can be conservatively estimated in terms of labor savings to provide a baseline for consideration. Cost Avoidances for pre-award, re-procurement, disposition, test centers, and fraud counsel were estimated to be approximately $460,000 assuming twenty percent improvements overall.

Executive Summary – Recommended Implementation Plan

The Vendor Network Mapping Capability (VNMC) project was a Weapons System Support Program (WSSP) R&D pilot to test the effectiveness of utilizing Tier-N data and visualization capabilities to assess supplier network risks and the relationships between vendors. As part of the way-forward for this network risk assessment capability, DLA will be required to make several decisions about the scope of the enterprise solution in order to move forward with a J6 Front Door Request. The four major production components for which decisions must be made include (1) Data Source/Volume, (2) Data Refresh Rate, (3) Visualization Capability, and (4) Technical Architecture. The advantages and disadvantages of various options for each major production component are described within this Implementation Plan document/section. However, the recommended enterprise options from each major production component (and supporting rationale) are summarized below:

Data Volume Recommendation: It is recommended that DLA utilize **Data for Several Supply Classes** as its Data Volume. A slightly larger dataset of network risk data covering several related federal supply classes would allow DLA to understand the efficacy of this type of data on a broader scale while protecting the most at-risk component classes. The number of Tier 1 suppliers this option would support could cover the existing QSLD suppliers while also giving DLA the opportunity to address suppliers in higher risk supply classes that are being addressed by SCRM efforts such as the expansion of traceability documentation collection by CDAP. Finally, the data volume would be a relatively large increase from the pilot effort and provide higher-level connection insights at what is expected to be a reasonable cost.

Data Refresh Rate Recommendation: It is recommended that DLA utilize **Monthly Updates** for its Data Refresh Rate. Monthly data refreshes are frequent enough to be relatively distinct from other options by providing data within a more business relevant timeline to DLA. This monthly refresh rate would allow DLA to receive new information and relevant risk rating modifications within the period allowed for typical contracting actions which lead to an award.

Visualization Capability Recommendation: It is recommended that DLA utilize **J6 to integrate and develop VNMC** via existing Qlik Sense dashboards for its Visualization Capability. Existing Qlik dashboards, including the VNM dashboard within the BDA capability, serves a similar purpose and may be an appropriate avenue for uploading VNMC pilot dashboards and supplying third-party data. However, note that a Sankey Diagram or other extension for viewing the flow diagrams is highly recommended.

Technical Architecture Recommendation: It is recommended that DLA utilize **Data Storage and Visualization in EDW with EBS Connection to Records Management** for its Technical Architecture. Building VNMC within the EDW and providing a connection to EBS Records Management will harness the based capabilities of the EDW while also providing a mechanism for saving analysis views and metrics directly within the enterprise system of record. This option would utilize the existing capabilities available within the EDW while providing a method for connecting Technical Quality resources with a way to access and save validation of their risk assessments directly to the system of record.

1.0 VNMC Introduction

DLA is DOD's source of supply for nearly 85 percent of spare parts, supporting more than 2,430 weapon systems, and nearly all consumable items (fuel, food, construction material, etc.). With over 9,000 contracts processed daily to meet this demand, DLA is especially vulnerable to the increasing trend of suppliers providing counterfeits, non-conformance, and malicious items.

In response to these risks, both the government and DLA have made Supply Chain Risk Management (SCRM) a priority. In the DLA Strategic Plan 2018-2026, addressing (Obj. 1.3) and mitigating risk (5.4) are listed as major priorities for the enterprise. Specifically, the Plan outlines that DLA should "Strengthen risk management to ensure secure, agile, and resilient combat logistics support" with a goal of ensuring "readiness and lethality across the end-to-end supply chain," by reducing risk in areas such as counterfeiting.

Additionally, the United States Congress, in the FY18 National Defense Authorization Act (NDAA) has laid out specific instructions for the Department of Defense with regard to assessing the network impacts of bad actors in Section 807.b.2 by mandating that,

> "…The Secretary of Defense shall establish a process for enhancing scrutiny of acquisition decisions in order to improve the integration of supply chain risk management into the overall acquisition decision cycle [by including the following:]… Development or integration of tools to support commercial due-diligence, business intelligence, or otherwise analyze and monitor commercial activity to understand business relationships with entities determined to be threats to the United States."

DLA currently lacks sufficient information to understand or assess a primary supplier's Tier 2 and Tier 3 supply chain partners. This information is especially relevant given that many primary (Tier 1) suppliers for at-risk electronic components are wholesalers or distributors instead of trusted Original Equipment Manufacturers (OEM). The fact that so many business partners are not OEMs has led to an increased risk that components may have been unknowingly compromised by a bad actor further up the supply chain (Tier 2, Tier 3, etc.). These bad actors may consist of hostile Nation States, counterfeiters, or negligent suppliers to name a few examples. Potentially defective or malicious components poise significant risk to DLA's mission and the proper operation of critical weapon systems.

VNMC was designed with the goal of providing DLA resources across various functional areas with additional risk information which can be used to proactively mitigate the risk of nonconforming or potentially counterfeit components from entering the DLA supply chain. VNMC will allow DLA users to understand more about its direct suppliers and address the challenges posed by an increasing threat of malicious components. By utilizing third party supplier network data, DLA will have enhanced visibility into the supply chains of its current suppliers and an understanding of specific risks posed by their supply networks, which will greatly surpass what is possible with current DLA data limitations. Users will be able to utilize VNMC to better understand potentially impacted suppliers when nonconforming or potentially counterfeit components are discovered.

VNMC functionality will focus on combining network analysis tools, easy-to-use visual dashboards, and both internal and external DLA supplier information to provide a comprehensive supply chain risk assessment capability to DLA.

2.0 Data Provider Evaluation

A major component of the original Vendor Network Linkage Analysis (VNLA) research included an analysis of data & capability providers offering some form of supplier analysis including linkage and/or relationship information. This original research identified several relevant offerings and has been recently updated to explore changes in the original offerings and to add in new companies with similar capabilities.

Although many companies exist which offer multi-tier analysis and/or mapping as a service, these offerings are out of scope for this research since they do not provide a scalable (or economically viable) option for DLA. Instead, only companies offering vendor tier datasets are considered as the primary points of interest and research. Ideal datasets should include data for suppliers of interest to DLA and should have scalable discovery and update functionality to enable wider surveillance of suppliers of interest without manual intervention.

Most importantly, appropriate datasets should include multiple tiers of supply and connections between companies with known business connections at any level. This type of data does not refer to corporate subsidiary data (which is generally publicly available), but rather should include proprietary and generally harder to obtain transactional business data (i.e. companies that have performed some sort of business together). In this case, ideal datasets will include companies who have purchased primary use items from each other. For example, we are most interested in how components have flowed from an original manufacturer down to DLA through tiers of supply.

Note that the research findings from the original Vendor Network Linkage Analysis (VNLA) project are included within this document, as they were not originally part of the VNMC report but take on new relevance given the update of data providers. Additionally, the most highly rated companies from this initial phase of research were re-evaluated to determine whether new offerings existed or modifications should be made to their assessments. Research on this front concluded that some offerings should be excluded due to a lack of supporting documentation (i.e. it was difficult to determine whether the offerings still exist) while others remained wholly unchanged from previous analysis (i.e. no new capabilities have been developed since their original research).

2.1 Evaluation Framework

As laid out in the original Vendor Network Linkage Analysis (VNLA) research, a 14-criteria evaluation framework was adopted for rating data provider capabilities. This framework of criteria was developed with DLA's Vendor Mapping needs in mind and was ordered to show the most important criterion first and least important last. This methodology ensures that the offerings can be given weighted scores and comparatively ranked. This approach is recommended in this scenario since two key criteria (Data Delivery Format and Link/Relationship Data) are crucially important, while other characteristics hold less value. This framework was used to rate companies during VNLA and within the more recent follow-on data provider update. The 14 criteria are shown in Table 1.

Table 1. Data Provider Evaluation Criteria

Evaluation Reference	Definition
1. Data Delivery Format	The format of data obtained from the data provider.
2. Link/Relationship Data	The extent to which the data provider has node/link relationship data
3. Link/Relationship Data Format	The format which the data provider has link/relationship data – mass extracts of unstructured data, prepared network linkage data ready for visualization, etc.
4. Parent/Subsidiary Data	The extent to which data provider has information on parent subsidiary relationships
5.Parent/Subsidiary Data Format	The format which the data provider has link/relationship data – mass extracts of unstructured data, prepared network linkage data ready for visualization, etc.
6. Link/Node Attribute Data	Whether the data provider has supplier risk, company identifiers, or relationship strength
7. Link/Node Attribute Data Format	The format which the data provider has risk/node attribute data – mass extracts of unstructured data, prepared data ready for visualization, etc.
8. Scope/Data Coverage (Tier 1 DLA; International)	The extent to which the data provider has the capability to provide necessary international and domestic data to map DLA Tier 1 suppliers.
9. Scalability/Lead Time	The timescale which a data provider can scale their solution and provide network data
10. Update Frequency	The frequency of which the data provider regularly updates its network data.
11. Interfacing Options	Which interfacing options the data provider can offer – automatic updates, batch processing, real-time pings, etc.
12. Market Intelligence Data	Whether the data provider has market intelligence data available as an option.
13. Available Use Cases	The provider has use cases related specifically to network mapping using their data.
14. DoD Client	The provider has an existing or previous Department of Defense client.

In addition to these basic definitions, each criterion was given detailed rating guidelines to further differentiate the strengths of each offering. In most cases, criterion were rating by assigning 'Harvey Balls', which represent an offering's strength in a certain area from 'no capability' (represented by an empty or white circle) to 'full capability' (represented by a full or completely black circle. In most cases, there were degrees of fit, where a half, quarter, or third of a ball (for example) may apply instead. In some specific cases, where there are qualitative differences but no 'ranked' preference, letter assignments were used instead. The first criterion, 'Data Format', for example rates providers by whether they offer data in 'database' (represented by 'D') or 'report' (represented by 'R') format. Since neither format is quantifiably better, these ratings differentiate the offerings rather than rate their strength. The full list of criteria and their detailed explanations are shown below.

Criterion 1: Data Format

D: Data is capable of being delivered in the form of a tabular database.

R: Data is delivered in the form of a report. This data is delivered in a text brief, and requires further labor by analysts to extract necessary data and convert it to an ingestible format.

N/A: Not applicable.

Criterion 2: Link/Relationship Data


Can provide links between multiple tiers in a supply chain/capable of comprehensive mapping.


Can provide 1 or 2 tiers past tier 1 / not completely comprehensive.


Cannot provide visibility past tier 1 of a supply chain.

Criterion 3: Link/Relationship Data Format


Structured, tabular, format ready for ingestion into mapping tool.


Text report or unstructured in need of analyst manipulation.


Dump of data/unstructured.

Criterion 4: Corporate Structure Data

- Can provide comprehensive Corporate Structure data.
- Can provide partial Corporate Structure data.
- Cannot provide Corporate Structure relationship data.

Criterion 5: Corporate Structure Data Format

- Structured, tabular, format ready for ingestion into mapping tool.
- Text report or unstructured in need of analyst manipulation.
- Dump of data/unstructured.

Criterion 6: Link/Node Attribute Data

A: Validated supply chain risk index/score

B. Descriptive data (i.e. DUNS or CAGE #)

C: Relationship strength (i.e. one time small purchase or recurring large procurements)

- Can provide A, B, and C.
- Can provide only B *and* C.
- Can only provide B *or* C.
- Cannot provide any attribute data.

Criterion 7: Link/Node Attribute Data Format

 Structured, tabular, format ready for ingestion into mapping tool.

 Text report or unstructured in need of analyst manipulation.

 Dump of data/unstructured.

Criterion 8: Scope/Data Coverage

 Can provide necessary international and domestic data. All or large majority of DLA T1 suppliers can be mapped.

 Can provide some international and domestic data. Some but not all of DLA's T1 suppliers can be mapped).

 Can provide data on all or some domestic DLA T1 suppliers – cannot provide international data.

 Can provide data on some domestic DLA T1 suppliers.

Criterion 9: Scalability/Lead time

F: Fixed - Can return networks in a fixed amount of time regardless of volume of T1 suppliers provided/ Does not compound.

S: Step - Receives suppliers in batches and turns around in a reasonable amount of time/ Is compounding.

L: Takes longer to turn around data/ Is compounding (requires greater analysis and cleansing) (i.e. does surveys or heavily sources from data aggregated from various sources).

Criterion 10: Database Update Frequency

 Updated Automatically/Daily.

 Updated Monthly.

 Updated Quarterly-Annually.

Criterion 11: Interface Options (No option quantitatively more beneficial)

R: Provides real-time pings.

A: Provides automatic updates.

B: Provides batch updates.

Criterion 12: Market Intelligence

● Offers comprehensive market intelligence information as a service, with real-time data feed or database of risk information available.

◑ Offers some market intelligence information on ad hoc basis with no real-time data feed or database subscription available.

○ Does not offer any market intelligence information.

Criterion 13: Use Cases

● Can provide a relevant Supplier Network Mapping use case.

◑ Can provide a related use case (Social Network mapping, other supply chain), but cannot provide a Vendor Network Mapping use case.

○ Cannot provide a related or relevant use case.

Criterion 14: DoD Client

● Currently has working account with DLA.

◑ Has previously worked with DLA or is currently working with another DoD agency.

○ Has never worked with DoD.

2.2 VNLA Data Provider Evaluation

Based on the criteria outlined above, ten of the most relevant industry offerings (and DLA's own internal traceability documentation) were researched and rated during VNLA to determine an appropriate data provider for piloting a capability. DLA's internal traceability documentation was analyzed as a starting point/baseline and an alternative to acquiring third party data. The other ten companies evaluated included:

- Dun & Bradstreet
- Deloitte
- Beroe
- Achilles
- Experian
- LexisNexis
- Thompson Reuters
- Bureau van Dijk
- Maplecroft
- CVM

The results of this research found that Dun & Bradstreet's 'Tier-N' solution was the most mature offering in this area, with a very efficient 'discovery' process which would reduce the lead time over competitors, and the most comprehensive set of vendors and their linkages. Most vendors had some form of business hierarchy (i.e. subsidiary, global parent, etc.) data, but not actionable business relationship data (e.g. linkages between disparate business partners who exchange goods).

This was a major area of differentiation for Dun & Bradstreet over other options. Additionally, other businesses offering supplier risk data often listed Dun & Bradstreet as a data partner or as a source from which those other vendors can provide metrics. The resulting Data Provider Evaluation Results are in Table 2 and the detailed supplier evaluations are included below. Note that these evaluations and ratings were current as of November 2016. Any rating changes for companies included in the VNMC evaluation will be noted in Section 2.3 VNMC Data Provider Evaluation.

Table 2. VNLA Data Provider Evaluation Ratings

	Data Delivery Format	Link/Relationship Data	Link/Relationship Data Format	Parent/Subsidiary Data	Parent/Subsidiary Format	Link/Node Attribute Data	Link/Node Attribute Format	Scope/Data Coverage	Scalability/Lead Time	Database Update Frequency	Interface Options	Market Intelligence	Use Cases	DoD Client	
Dun & Bradstreet	D	●	●	●	●	●	●	●	F	○	R/A/ B	●	●	●	
Deloitte	D	●	●	●	●	●	●	◕	S	●	R/A/ B	●	●	●	
Beroe	D	●	●	●	●	●	●	◕	S	○	R/A/ B	◑	◑	○	
Achilles	R	◑	●	◑	●	◕	●	○	L	○	R/A/ B	◑	●	○	
Experian	R	◑	◑	●	◑	◕	◑	●	L	●	R	◑	◑	○	
LexisNexis	R	○	N/A	●	◑	◔	◑	N/A	N/A	N/A	N/A	●	○	○	
Thomson Reuters	R	○	N/A	●	◑	◕	◑	N/A	N/A	N/A	N/A	●	○	○	
Bureau van Dijk	R	○	N/A	●	◑	◔	◑	N/A	N/A	N/A	N/A	◑	○	○	
Maplecroft	D	○	N/A	○	N/A	◔	●	N/A	N/A	N/A	N/A	○	○	○	
CVM	R	○	N/A	○	N/A	◔	●	N/A	N/A	N/A	N/A	◑	○	○	
DLA Trace Data	N/A	◑	○	○	N/A	◔	○	◕	L	○	N/A	○	○	N/A	

2.2.1 Dun & Bradstreet

Company Description: Dun and Bradstreet (D&B) provides commercial data to businesses including credit history, business-to-business sales and marketing, counterparty risk exposure, supply chain management, lead scoring and social identity matching. D&B's database contains information on more than 235 million companies across 200 countries worldwide.

D&B's patented DUNS Right Data quality process allows customers to enrich their files with third-party data to gain a complete view of supplier risk refresh data frequently to maintain the accuracy and completeness of supplier information. D&B has a large D-U-N-S database which it can use to track linkage between companies. With this numbering system D&B has the ability to consume a great deal of data and distill it down to one single company. By using the D-U-N-S number to track companies, D&B can automatically update clients when a company is consumed by another company or involved in questionable dealings. D&B utilizes shipment data, bills of material, trade tape data, and data which they buy or acquire from private companies. D&B mines and analyzes this data to create links, using commodity codes to track companies clients would like tracked.

Applicability: D&B can provide end to end network linkage data, as well as attribute and subsidiary data, all in an ingestible format and in a scalable 3-week period. D&B can also provide real-time updates and pings.

Description

- Data Intelligence firm offering Tier-N solution with fully ingestible supply chain linkage and network risk data.
- Supports Tableau-based interactive dashboards, scorecards, highly formatted reports, ad hoc query, thresholds and alerts, and automated report distribution.
- Currently used by DLA for procurement intelligence.

Pros

- DLA has existing subscription with D&B.
- Claims 3 week network discovery lead time regardless of volume.
- Pre-built and validated comprehensive link-node network maps including attribute data.

Cons

- May prove to be a more expensive provider.
- Some portions of network data may be un-attributable (no identifiable data).
- May not be able to map every Tier 1 supplier down to raw materials suppliers.

Table 3. D&B Detailed Evaluation

Evaluation Reference	Definition
1. Data Delivery Format	Sample data provided by D&B was delivered in an excel data set.
2. Link/Relationship Data	Yes – D&B can provide node/link linkage data and provide sub-supplier tier information, no mining or interviewing/surveying will be necessary.
3. Link/Relationship Data Format	The data would come in the form of completed networks.
4. Parent/Subsidiary Data	Yes – D&B can provide comprehensive parent-subsidiary data of DLA's supply chain.
5.Parent/Subsidiary Data Format	The data would come in the form of completed networks.
6. Link/Node Attribute Data	D&B can provide risk data (risk scores and indices) and attribute data including addresses risk indices in a dashboard and in the links and nodes.
7. Link/Node Attribute Data Format	Data can come prepared for visualization or can be delivered in the form of a dashboard or link-node network maps.
8. Scope/Data Coverage (Tier 1 DLA; International)	D&B has full capability to map DLA Tier 1 suppliers, including international companies. They have the largest network of 950 million companies.
9. Scalability/Lead Time	D&B can scale their solution and accurately produce network maps in 3 weeks no matter how many tier one suppliers VNLA provides them.
10. Update Frequency	D&B updates data every quarter.
11. Interfacing Options	D&B can offer automatic updates on a quarterly basis, batch processing, real-time pings.
12. Market Intelligence Data	D&B did state that they have a comprehensive Market Intelligence database.
13. Available Use Cases	Yes – D&B can likely provide a somewhat related use case.
14. DoD Client	Yes – D&B has a working account with DLA.

2.2.2 Deloitte

Company Description: Deloitte is a multinational professional services firm headquartered in the United States. Deloitte is one of the largest accounting firms and also provides audit, tax, consulting, enterprise risk and financial advisory services.

Applicability: Deloitte has worked with DLA on many projects, most relevant of which includes a plethora of Industrial Base studies aimed at understanding the supply chain and potential vulnerabilities for DLA components. Through these efforts, Deloitte has shown a capability to perform network research and develop thorough network maps for vendors and products. Although Deloitte has not been providing network mapping data broadly as a service, representatives have indicated that Deloitte has that capability.

Description

- Management consulting company offering supply chain network mapping capability using proprietary database and data scraped from various sources.
- Existing database includes network maps for a subset of DLA Tier 1 suppliers, unstructured data from web scraping is cross-referenced, cleansed, and assigned confidence scores.

Pros

- Data that may otherwise be unattainable is available (extent unknown).
- Existing DLA supply chain network mapping efforts; demonstrated network mapping capability.
- Socialized solution with other DLA stakeholders.

Cons

- Unclear how mature existing proprietary database is with relation to network maps.
- Current approach requires relatively increased manual intervention during discovery process.
- Unclear how scalable the provider is or how long delivery of all of DLA's Tier 1 supplier chains would take.

Table 4. Deloitte Detailed Evaluation

Evaluation Reference	Definition
1. Data Delivery Format	Data can be delivered in a data table format, but this would be a new delivery mechanism for Deloitte at DLA. Previous network mapping data has been presented in report format.
2. Link/Relationship Data	Deloitte has shown through work with DLA that they have data for multiple tiers of supply for certain suppliers.
3. Link/Relationship Data Format	Data is stored in link-node format.
4. Parent/Subsidiary Data	Deloitte has corporate structure data (organizational structure) available.
5.Parent/Subsidiary Data Format	Deloitte's parent/subsidiary data is in a tabular structured format.
6. Link/Node Attribute Data	Deloitte has noted they have descriptive data and some measures of relationship strength. It was also noted that risk scores and indices can be built based on client need.
7. Link/Node Attribute Data Format	The link/node attribute data available is stored in a tabular structured format.
8. Scope/Data Coverage (Tier 1 DLA; International)	Deloitte has said they have wide domestic and international data coverage, but do not have network mapping data for DLA's entire universe of Tier 1 suppliers.
9. Scalability/Lead Time	Deloitte has said their network discovery process involves analysts working with scraped data from algorithms; process would scale linearly with additional supplier networks.
10. Update Frequency	Deloitte has said network maps can be updated as often as needed, although it is unclear whether this means there are automatic updates/refreshes.
11. Interfacing Options	"Deloitte can push DLA the data however desired and refreshed whenever desired."
12. Market Intelligence Data	Deloitte offers Market Intelligence as a service.
13. Available Use Cases	Deloitte's IB studies can be used as Network Mapping use cases.
14. DoD Client	Yes, Deloitte is currently working for DLA.

2.2.3 Beroe

Company Description: Beroe is a procurement intelligence company which specializes in customized market research. Sixty percent of Beroe's data comes from import-export data. Beroe representatives stated that they can provide network linkage data by combining different sources of data. This means extracting useful information from import-export data and a variety of proprietary subscriptions and then combing through that data to draw conclusions and links between companies. Beroe representatives stated that they can tailor this data to be provided to DLA in any format desired. Beroe offers curated alerts of supplier risk and market risk.

Applicability: Beroe, unlike many supply chain data providers possesses a readily available extensive database. Therefore, Beroe does not rely on self-reported surveys from suppliers to gather linkage data, a practice which AFS deems often inefficient and inaccurate. The one possible drawback of working with Beroe would be the intensive labor and aggregation of data necessary for them to create links. Their method may indicate that they provide lengthy lead times. Additionally, the method they described indicates that scalability is unlikely, and lead times will be based on the number of DLA Tier 1 suppliers VNLA provides to Beroe. The company could not provide a network discovery timeline but stated that they would be willing to work with DLA on a pilot basis to determine whether they will be able to provide the data DLA requires and determine how long it would take.

Description

- US-based business Market Intelligence company catered to procurement.
- Able to provide link-node data for all tier one suppliers through the analysis of sizable proprietary database and subscriptions.
- Claims to have the capability to provide data in any format necessary.

Pros

- Offers link-node and attribute data without the use of surveys.
- 60% of data from proprietary database, 40% of data from other sources.
- Offers suppler risk, market risk, and curated alerts.

Cons

- Suspected lengthy lead time based on available data.
- Manually intensive data aggregation.
- Little experience in specific supplier network mapping.

Table 5. Beroe Detailed Evaluation

Evaluation Reference	Definition
1. Data Delivery Format	Data format – Beroe claims they can deliver in any major format requested.
2. Link/Relationship Data	Likely – Beroe believes they can provide comprehensive linkage data but would like to move ahead on a pilot basis to determine whether they can provide the data DLA needs to perform VNLA.
3. Link/Relationship Data Format	Excel is the main format but Beroe has indicated that they can provide data in any format we need and the data would be structured and ready to ingest.
4. Parent/Subsidiary Data	The extent to which data provider has information on parent subsidiary relationships.
5.Parent/Subsidiary Data Format	The format which the data provider has link/relationship data – mass extracts of unstructured data, prepared network linkage data ready for visualization, etc.
6. Link/Node Attribute Data	Beroe can provide risk information, company identifiers, and may be able relationship strength.
7. Link/Node Attribute Data Format	Beroe would provide data in a ready to ingest, structured format.
8. Scope/Data Coverage (Tier 1 DLA; International)	Beroe can provide domestic and international data necessary to complete the mapping of DLA's tier 1 suppliers – but they are not completely confident, and therefore, cannot be given a full score.
9. Scalability/Lead Time	Unknown – Beroe has indicated that they would like to determine lead time through a pilot basis.
10. Update Frequency	Beroe can update its data quarterly.
11. Interfacing Options	Beroe claims to offer real-time pings, as well as batch and automatic updates.
12. Market Intelligence Data	Yes – Beroe is an up and coming player in the Market Intelligence field, with a growing database.
13. Available Use Cases	No – Beroe cannot provide use cases related to network mapping.
14. DoD Client	Beroe is not an existing or previous DoD client.

2.2.4 Achilles

Company Description: Achilles Supply Chain Mapping allows companies to gain visibility of their extended supply chains and view supplier information beyond first tier suppliers. Their process: Once the first tier supplier's data has been uploaded into the Achilles Supply Chain Mapping System, buyers or category managers access the system and start the supplier invitation process by linking products for which they wish to receive a supply chain map to the listed suppliers. This triggers an automated email to suppliers requesting registration in the Achilles Supply Chain Mapping Program, as well as information related to the components of the products they sell and the suppliers they are sourced from. First tier suppliers register in the system and provide basic company information, confirmation they supply the products selected by the buyer and information about the components/ingredients they need to source in order to supply that particular product, as well as the suppliers they are sourced from. This process is repeated until the end of the chain is reached. Once the data is in the system, buyers can start to navigate the data using different filters to create customizable reports of their various supply chain maps.

Applicability: Achilles does not have a large proprietary database with the necessary linkage data. Achilles utilizes a solely self-survey system, which will be time consuming, and may be unreliable in yielding accurate results. Those are the cons assuming that supplies further down the chain respond to surveys, and there is no certainty that they will comply, as the survey is not mandatory.

Description

- UK-based Supply Chain Services consultancy offering supply chain mapping and data gathering through self-reported surveys with suppliers and manufacturers.
- Survey data covers interdependencies and risk points in the supply chain, areas of convergence, and potential single points of failure, supplier clusters across high-risk regions, and the impact of major events or incidents on global production.
- Offers easily ingestible data as well as user-friendly interface.

Pros

- Basic user-friendly supply chain visualizations, dashboards, and alerts.
- Available link-node data.
- Ease of data ingestion.

Cons

- No existing database - all of the data to produce network maps is sourced from self-reported surveys to previously identified suppliers.
- Lengthy network discovery lead time.
- Sixty percent response rate to surveys.

Table 6. Achilles Detailed Evaluation

Evaluation Reference	Definition
1. Data Delivery Format	Achilles can provide data in several ready-to-ingest formats
2. Link/Relationship Data	Through self-reported surveys Achilles can provide multiple tiers of linkage data.
3. Link/Relationship Data Format	If accurate and comprehensive data is retrieved, Achilles can provide prepared network linkage data ready for visualization, mapped out, and in a dashboard through their basic visualization tool.
4. Parent/Subsidiary Data	Through self-reported surveys Achilles can provide parent/subsidiary data.
5.Parent/Subsidiary Data Format	If accurate and comprehensive data is retrieved, Achilles can provide prepared network linkage data ready for visualization, mapped out, and in a dashboard through their basic visualization tool.
6. Link/Node Attribute Data	If all suppliers reply accurately to self-reported surveys Achilles will be able to provide risk indices, descriptive data, and relationship strength.
7. Link/Node Attribute Data Format	If accurate and comprehensive data is retrieved, Achilles can provide prepared network linkage data ready for visualization, mapped out, and in a dashboard through their basic visualization tool.
8. Scope/Data Coverage (Tier 1 DLA; International)	If all suppliers in the DLA supply chain reply accurately to Achilles, then the company can map DLA Tier 1 suppliers, including international companies.
9. Scalability/Lead Time	Several months – Achilles will need to survey each supplier in the chain with automatic emails.
10. Update Frequency	Achilles can update their data quarterly basis given that suppliers reply to follow up surveys.
11. Interfacing Options	Batch processing, real-time alerts, automatic updates, geographic map, chart view of links.
12. Market Intelligence Data	Yes – Achilles is also a provider of market intelligence, but the database is limited.
13. Available Use Cases	Yes – Achilles has mapped out Nestlé's supply chain and can provide a use case.
14. DoD Client	No record of such available publicly.

2.2.5 Experian

Company Description: Experian PLC is a global information services group with operations in 40 countries. Experian representatives stated that they would be able to provide linkage data, including links between companies, subsidiaries, and different company branches. Experian can also provide commercial credit scores, all historical trade information available and current trade lines. However, Experian can only provide this information in the form of text reports in brief format. Although these text reports are filterable and word searchable they would require hours of further work by an analyst. Experian offers both international and domestic data. Experian can provide risk classes for each company and an account monitoring service which boasts 47 different triggers clients can choose from, including alerts for new trade lines and changes in credit scores. Experian also offers market intelligence data through their Business IQ Platform, which is also the platform offering linkage data. There is a free trial available for Business IQ.

Applicability: Experian was unable to provide a use case or sample data to VNLA. Experian was also unable to provide an estimated lead time or scalability options. Although Experian can provide linkage data, their data comes in the form of text briefs requiring much more filtering to be completed by analysts at DLA.

Description

- Credit data company with significant coverage of non-credit domestic and international business data.
- Has linkage data that includes commercial credit scores, historical trade information, and current trade lines.
- Business IQ platform provides a monitoring service. Alerts if any selected risk factor is triggered. Factors include new trade lines for a business and changes in credit scores among other things.

Pros

- Link-node data available.
- Extensive coverage of domestic and international business data.
- Attribute data available.

Cons

- Data not ingestible - text briefs would require further extraction by analysts.
- Scalability is not an option.
- Long lead times expected.

Table 7. Experian Detailed Evaluation

Evaluation Reference	Definition
1. Data Delivery Format	Experian delivers data only in text-brief format.
2. Link/Relationship Data	Experian has substantial credit data and transactional data between domestic and international businesses and claims to be able to create linkage data
3. Link/Relationship Data Format	Experian can provide filterable text reports and on occasion can provide batch excel files.
4. Parent/Subsidiary Data	Experian claims they can link subsidiaries to the parent companies as well as companies to other companies they are doing business with. Experian uses commercial credit scores, all historical trade information available, and current trade lines.
5.Parent/Subsidiary Data Format	Experian can provide filterable text reports and on occasion can provide batch excel files.
6. Link/Node Attribute Data	Yes – Experian can assign various risk indices to suppliers.
7. Link/Node Attribute Data Format	Experian can provide filterable text reports and on occasion can provide batch excel files.
8. Scope/Data Coverage (Tier 1 DLA; International)	Extensive coverage of domestic and international business data.
9. Scalability/Lead Time	Custom reports can be built stepwise. Batch reports in excel form may have improved scalability/lead time.
10. Update Frequency	The database is updated daily in real time.
11. Interfacing Options	Account monitoring service “47 different triggers you can choose from.” Can get alerts if there is a new trade line for a business, change in credit scores among various other options.
12. Market Intelligence Data	Experian offers a market intelligence capability within their Intelliview software
13. Available Use Cases	According to Experian representative these do exist, but use cases never received.
14. DoD Client	No.

2.2.6 LexisNexis

Company Description: Lexis Nexis is a corporation providing computer-assisted legal research as well as business research and risk management services. Through meetings with LexisNexis representatives, it was found that while Lexis Nexis offers several solutions catered towards supply chain management and analysis – it would be unlikely that they could provide linkage data. The VNLA team also learned that Lexis Nexis does collect data of business between companies, but mainly through mining or aggregation public sources. The Lexis Nexis representatives also explained that they would be able to provide the capability to search through news reports, both proprietary and public. The representatives explained that they can also provide financial, political, legal, environmental, societal, and technological risk data. On September 8th LexisNexis representatives responded to the VNLA project team that they would not be able to collect and provide linkage data to DLA.

Applicability: It may be helpful to note that Lexis Nexis does have other capabilities, as stated above, which may be helpful to DLA in future endeavors. However, Lexis Nexis representatives have explicitly stated that they do not have linkage data available for DLA.

Description

- LexisNexis cannot offer Linkage Data.
- Lexis Diligence can provide business transaction data between companies.
- LexisNexis can provide risk data about financial, political, legal, environmental, societal, and technological risks.

Pros

- Able to provide multi-type risk assessments.
- Established data provider with large database.
- Can provide some parent-subsidiary information and attribute data which can be useful through mining.

Cons

- Cannot provide link-node data.
- Data only delivered in text format.
- Data must be searched and collected manually by user.

Table 8. LexisNexis Detailed Evaluation

Evaluation Reference	Definition
1. Data Delivery Format	Lexis can only provide data in a report format.
2. Link/Relationship Data	No – Lexis Nexis cannot provide network linkage data.
3. Link/Relationship Data Format	N/A
4. Parent/Subsidiary Data	Yes – LexisNexis can provide comprehensive parent/subsidiary data.
5.Parent/Subsidiary Data Format	Data is in a text brief format – extraction of relevant data into a digestible format would require further labor by analysts.
6. Link/Node Attribute Data	Lexis can likely provide some risk indices and company identifier data.
7. Link/Node Attribute Data Format	Data is in a report format - not ready for network analysis. Extraction would require further analyst labor.
8. Scope/Data Coverage (Tier 1 DLA; International)	N/A – Lexis cannot provide linkage data about any of DLA's tier 1 suppliers.
9. Scalability/Lead Time	N/A – Lexis cannot provide network linkage data.
10. Update Frequency	N/A – Lexis cannot provide network linkage data.
11. Interfacing Options	If LexisNexis is provided with all necessary linkage data they can provide a tool named "SmartWatch" - a risk-monitoring and alerting tool. Leverages market intelligence to assess supplier's current risk levels.
12. Market Intelligence Data	Yes – Lexis offers a Market Intelligence service called LexisNexis Newsdesk.
13. Available Use Cases	N/A – Lexis cannot provide network linkage data.
14. DoD Client	No.

2.2.7 Thomson Reuters Special Services (TRSS)

Company Description: Thomson Reuters Special Services (TRSS) is a subsidiary of Thomson Reuters which provides customized solutions to select clients; utilizing proprietary integrated services, open source information, Thomson Reuters' products and global business data. TRSS provides advanced algorithms to connect the dots within disparate data sets and leverages Thomson Reuters' best practices, flexible applications & thought leadership. TRSS analysts have a number of years' experience using these sources to supplement investigations and research to include both domestic and international activities.

TRSS demonstrated their EIKON capabilities which offers mergers and acquisitions data, company data, real time research, and market intelligence. TRSS cannot provide the required linkage data, but can provide market intelligence, business data, and financial data. However, all of their reports are provided in the form of data briefs. TRSS is unable to convert financial information or disruption warnings into data indicators or elements. This is important because for the nature of this project data will be feeding directly into a tool or network automatically. TRSS's subscriptions are text based briefs in long text form, which would have to then be reviewed by an analyst.

Applicability: TRSS cannot provide linkage data and can only deliver attribute and parent/subsidiary data in text brief forms which would require DLA analyst intervention. TRSS does have market intelligence data available.

Description

- Customized solutions utilize proprietary integrated services, open source information, Thomson Reuters' products and global business data.
- Provides market intelligence, business data, financial information, and disruption data in the form of text briefs.
- Cannot provide network linkage data.

Pros

- Can provide business data, market intelligence, and financial information.
- Has a large database with potential parent-subsidiary data.
- Established data provider with notable clients.

Cons

- Does not provide linkage data or risk indicators/attribute data.
- Unable to convert text briefs into data indicators or elements.
- Unlikely to have business data about niche fields.

Table 9. Thompson Reuters Detailed Evaluation

Evaluation Reference	Definition
1. Data Delivery Format	Thomson Reuters can only provide data in report format.
2. Link/Relationship Data	No – TRSS can provide business information about individual suppliers, but no links can be made.
3. Link/Relationship Data Format	N/A
4. Parent/Subsidiary Data	Yes – TRSS can provide comprehensive parent/subsidiary data.
5.Parent/Subsidiary Data Format	TRSS data is delivered only in the form of data briefs.
6. Link/Node Attribute Data	TRSS can provide basic business information and hierarchy, and mergers and acquisitions data, but cannot provide much in the way of risk indices.
7. Link/Node Attribute Data Format	TRSS data comes in the form of data briefs and they are unable to convert financial information or disruption warnings into data indicators or elements.
8. Scope/Data Coverage (Tier 1 DLA; International)	N/A – TRSS Cannot provide linkage data. TRSS will be able to provide business data and limited risk data on the Tier 1 DLA suppliers. Data on further tiers which are international is likely but not certain.
9. Scalability/Lead Time	N/A – TRSS cannot provide network linkage data.
10. Update Frequency	N/A – TRSS cannot provide network linkage data.
11. Interfacing Options	N/A – TRSS cannot provide network linkage data.
12. Market Intelligence Data	TRSS can provide a great deal of market intelligence including M&A & business hierarchies.
13. Available Use Cases	No – supply chain mapping is not a common practice for TRSS, and they therefore cannot provide an example. They do, however, have social network mapping examples.
14. DoD Client	No

2.2.8 Bureau van Dijk

Company Description: BvD provides many risk assessment services sourced from business financials derived from intelligence they own on private companies throughout the world. BvD sources its data from annual file reports and works with local corporate registries to pull data into the system. The company then standardizes the annual file reports and other reports and information they gather.

BvD stated that they can provide legal registered addresses, shareholders, parent-subsidiary companies, subsidiary locations, business activities, percentages of ownership, and any enforcement actions placed on individuals or companies. Currently BvD's clients include the CIA, Bank of Canada, IMF, and the World Bank.

Applicability: BvD does offer some procurement data and has the capability to locate high risk targets. However, the BvD team does not have information regarding business relations or transactional supply chain data. Furthermore, the data which BvD can provide (market intelligence, attribute data, and parent-subsidiary data) is delivered only in the form of text briefs/reports and would require further extraction or analysis to be converted into an ingestible format.

Description

- Provider of business information with a specialty in private company data.
- Combines private company data with software such as Orbis, among other things.
- Data offered includes financial strength indicators, news linked to companies, and detailed company ownership.

Pros

- Flexible alert system – ratings updated daily.
- Attribute data available.
- Offers market intelligence.

Cons

- Data delivered in text format, requiring further analysis and extraction.
- Link-node data not available.
- Lengthy network discovery lead time.

Table 10. Bureau van Dijk Detailed Evaluation

Evaluation Reference	Definition
1. Data Delivery Format	BvD can only offer text-brief format reports.
2. Link/Relationship Data	No link data available, "There is no information as to who is doing business with who". Relational data includes parent companies.
3. Link/Relationship Data Format	Data is in a report format/Not ready for network analysis. Data is tagged and is searchable.
4. Parent/Subsidiary Data	Shareholders, parent companies, subsidiary locations, and percentage of ownership data available.
5.Parent/Subsidiary Data Format	Data is in a report format/Not ready for network analysis. Data is tagged and is searchable.
6. Link/Node Attribute Data	Risk scores, legal registered addresses, shareholders, subsidiary locations, enforcement actions placed on companies.
7. Link/Node Attribute Data Format	Data is in a report format/Not ready for network analysis. Data is tagged and is searchable.
8. Scope/Data Coverage (Tier 1 DLA; International)	N/A – BvD cannot offer network link data.
9. Scalability/Lead Time	N/A – BvD cannot offer network link data. However, attribute and parent-subsidiary data is only available through manually-accessed platforms.
10. Update Frequency	N/A – BvD cannot offer network link data.
11. Interfacing Options	N/A – BvD cannot offer network link data.
12. Market Intelligence Data	Yes – BvD offers independent industry market research.
13. Available Use Cases	None specifically on network mapping. Use Case involving supply chain risk.
14. DoD Client	No

2.2.9 Maplecroft

Company Description: Maplecroft offers supply chain risk data through client tailored solutions. Maplecroft does not offer linkage/network data. Once provided with a comprehensive list of suppliers in a supply chain, Maplecroft can provide inherent risk information regarding the countries in which each company is located. Maplecroft also offers six other measured risk factors which clients can choose from including political risk, labor risk, and humanitarian risk.

Maplecroft does not offer a market intelligence solution. Their services are confined to risk information. They offer a dashboard in Excel which is easy to use and offer .csv data which is easily ingestible into a map. These risk indices can be updated on an annual or quarterly basis. Alerts are not "real-time" alerts, but rather provided every quarter.

Applicability: Maplecroft does not offer linkage data, but is a provider of risk information. Should DLA locate network linkage data without risk indices, Maplecroft could be a viable option to add detail to an already created map.

Description

- Risk data provider categorizes and ranks company risk. Inherent risk based on geographical location as well as six other risk factors.
- Receives supplier names and addresses from clients and returns information about the risks associated with each supplier and the country in which they are located.
- Delivers risk data in user-friendly risk score/index interface in excel.

Pros

- User-friendly interface.
- Easily ingestible .csv risk scores.
- Seemingly reliable and comprehensive risk information.

Cons

- Does not provide network linkage data.
- Does not provide attribute data beyond basic risk indicators such as political or geographic risk.
- Cannot provide parent-subsidiary data.

Table 11. Maplecroft Detailed Evaluation

Evaluation Reference	Definition
1. Data Delivery Format	Maplecroft's risk scores and indices can be delivered in any major data format.
2. Link/Relationship Data	No – Maplecroft cannot provide linkage data, they mainly provide inherent risk data in a 0-10 scale.
3. Link/Relationship Data Format	N/A – Maplecroft cannot provide linkage data.
4. Parent/Subsidiary Data	No – Maplecroft cannot provide parent/subsidiary data.
5.Parent/Subsidiary Data Format	N/A – Maplecroft cannot provide linkage data.
6. Link/Node Attribute Data	Maplecroft can only provide inherent country risk information and also allows clients to choose from up to 6 other categories of risk including political risk, etc.
7. Link/Node Attribute Data Format	The risk scores/indices are delivered in a structured ingestible format or in a dashboard imbedded in excel.
8. Scope/Data Coverage (Tier 1 DLA; International)	N/A – Regarding risk data - Maplecroft will likely be able to provide domestic and international risk data on all Tier 1 suppliers but will need to be provided names and address of all other tier suppliers.
9. Scalability/Lead Time	N/A – Regarding risk data – they can provide risk indices immediately if provided with supplier info.
10. Update Frequency	N/A – Regarding risk data- Updates only occur annually; and for some risk categories, quarterly.
11. Interfacing Options	N/A – Maplecroft cannot provide linkage data
12. Market Intelligence Data	No – Maplecroft does not offer market intelligence.
13. Available Use Cases	No – Maplecroft has risk indices, not supply chain mapping data.
14. DoD Client	No – Maplecroft is not an existing or previous Department of Defense client.

2.2.10 CVM

Company Description: CVM offers one of the largest proprietary databases on the market. Representatives explained that CVM offers risk management solutions catered to client needs, acting as a consulting firm. However, they explained, they lack the capability to provide linkage/network information necessary to map out the supply chain. After speaking with our team, CVM investigated their capabilities to determine whether they would be able to tailor a solution to VNLA's mission. CVM reported that they would be unable to assist VNLA in determining network linkage. It may be helpful to note that CVM is able to provide attribute data.

Applicability: CVM has explicitly reported that they are unable to provide linkage data, but has company attribute data and other risk management data available for a wide swath of companies.

Description

- Provider of supplier risk data solution.
- Unable to cater a solution to VNLA needs - cannot provide linkage data.
- Offers a large proprietary database capable of providing attribute data and market intelligence.

Pros

- Easily digestible risk data.
- Large proprietary database.
- Customizes solutions to clients' needs.

Cons

- Does not provide linkage data.
- Unable to cater a solution to VNLA needs.
- Unable to provide comprehensive attribute or parent-subsidiary data.

Table 12. CVM Detailed Evaluation

Evaluation Reference	Definition
1. Data Delivery Format	CVM can only provide data in a text-brief format.
2. Link/Relationship Data	CVM cannot provide any tiers of network data.
3. Link/Relationship Data Format	N/A – CVM cannot provide any tiers of network data.
4. Parent/Subsidiary Data	CVM cannot provide the parent-subsidiary data required by DLA.
5.Parent/Subsidiary Data Format	N/A – CVM cannot provide the parent-subsidiary data required by DLA.
6. Link/Node Attribute Data	CVM can only provide basic description data after they are provided with company names.
7. Link/Node Attribute Data Format	The data can be delivered in a structured data in .xlsx format.
8. Scope/Data Coverage (Tier 1 DLA; International)	CVM cannot provide linkage data for any of DLA's tier 1 suppliers.
9. Scalability/Lead Time	N/A – CVM cannot provide any tiers of network data.
10. Update Frequency	N/A – CVM cannot provide any tiers of network data.
11. Interfacing Options	N/A – CVM cannot provide any tiers of network data.
12. Market Intelligence Data	Yes – CVM does offer a market intelligence solution, but it is not comprehensive.
13. Available Use Cases	No – CVM does not provide linkage data and thus does not have available use cases.
14. DoD Client	No – CVM does not have an existing or previous Department of Defense client.

2.2.11 DLA Traceability Data

Company Description: The Counterfeit Detection and Avoidance Program (CDAP) is a key component of DLA's efforts to reduce and mitigate the risk of counterfeit or fraudulent parts from entering the DoD supply chain. For components in Federal Stock Class 5962, DLA currently requests additional proof and documentation of authenticity referred to as 'traceability documentation'. This documentation is primarily intended to ensure that vendors provide parts that were manufactured by an approved original equipment manufacturer, whether they are being sold by a vendor or OEM themselves.

Applicability: The extent of data received from traceability documentation is currently limited to that information obtained on Form 918, which can be accessed from DLA's CDAP webpage linked here. This data is only requested by DLA for suppliers of FSC 5962 parts, a high-risk but fairly small portion of DLA procurements.

Description

- Defense Logistics Agency collects traceability data for suppliers providing parts in Federal Supply Class 5962.
- FSC 5962 includes Electronic Microcircuits and is one of the highest risk part classes at DLA.
- Traceability data is self-reported by suppliers and often contains errors, causing delays and back-and-forth communications with suppliers.

Pros

- The only relational data currently available within DLA for OEM-Dealer relationships.
- Data is available for FSC 5962, one of DLA's highest risk part classes.
- Requirement can be expanded to other part classes as existing contracting clauses currently retain this right for DLA.

Cons

- Data is very limited in scope, roughly 3,000 records maximum.
- Data is not currently stored in a centralized database (Records Management only).
- Data may be inaccurate or incomplete due to supplier self-reporting methods.

Table 13. DLA Traceability Data Detailed Evaluation

Evaluation Reference	Definition
1. Data Delivery Format	N/A – data is already within DLA systems.
2. Link/Relationship Data	Trace data only exists for FSC 5962. At best, any relationship data is only one entity-to-entity link between suppliers/manufacturers/distributors.
3. Link/Relationship Data Format	Data is stored in disparate locations in Records Management.
4. Parent/Subsidiary Data	Parent subsidiary data is not available.
5.Parent/Subsidiary Data Format	N/A – data not available
6. Link/Node Attribute Data	Company name, address, and CAGE is available.
7. Link/Node Attribute Data Format	Data is stored in disparate locations in Records Management.
8. Scope/Data Coverage (Tier 1 DLA; International)	Data is only collected for FSC 5962 (Electronic Microcircuits).
9. Scalability/Lead Time	Data must be manually aggregated and entered by DLA resources.
10. Update Frequency	Database is updated when new procurements are made, therefore data for any individual company is very infrequently updated.
11. Interfacing Options	N/A – data is already within DLA systems.
12. Market Intelligence Data	No market intelligence data is collected or exists previously.
13. Available Use Cases	No network mapping use cases exist.
14. DoD Client	N/A – Is part of DLA.

2.3 VNMC Data Provider Evaluation

Following-up on this previous research, the industrial base was searched for differentiated supplier tier data offerings or related capabilities. Once again, some companies including Dun & Bradstreet, Beroe, Achilles, and Experian offered information on their capabilities and are included within the ratings due to their relevance. Additional research has found that each of these companies maintains offerings, but none have significantly modified their offerings or approaches in a way that affects or changes their existing ratings. For these reasons, their ratings remain consistent with those in the VNLA table.

Note: The detailed rating explanations for companies appearing in both the previous research and this current updated are listed below once again for convenience of viewing and comparison to other companies. As previously described, no new functionality affecting these ratings was found.

Other companies from the previous ratings which are no longer included fell off due to a lack of relevance (i.e. did not have strongly related offerings) or did not respond to information requests.

The full list of companies reviewed/evaluated during this follow-on include:

- Dun & Bradstreet
- Panjiva
- Beroe
- Insideview
- Infogroup
- HG Insights
- Cortera
- Ernst & Young
- Achilles
- Experian

The results of this research found that Dun & Bradstreet's 'Tier-N' solution remains the most mature offering, despite a lack of significant changes or additional features since the last evaluation. Many of the close competitors suffer from a lack of scalability, inability to provide directly relevant data samples, and are unproven at scale.

A common theme seen previously and repeating within this evaluation is that of companies offering a type of 'supply chain analysis as a service'. This type of analysis and data collection is extremely manually intensive and is the primary reason D&B's Tier-N offering remains unique and applicable to DLA's wide swath of potential suppliers.

The resulting Data Provider Evaluation Results are in Table 14 and the detailed supplier evaluations are included below.

Table 14. VNMC Data Provider Evaluation Ratings

	Data Delivery Format	Link/Relationship Data	Link/Relationship Data Format	Parent/Subsidiary Data	Parent/Subsidiary Format	Link/Node Attribute Data	Link/Node Attribute Format	Scope/Data Coverage	Scalability/Lead Time	Database Update Frequency	Interface Options	Market Intelligence	Use Cases	DoD Client	
Dun & Bradstreet	D	●	●	●	●	●	●	●	F	○	R/A/B	●	●	●	
Panjiva	D/R	●	●	●	●	◔	●	●	S	●	A/B	◑	◑	●	S&P Global panjiva
Beroe	D	●	●	●	●	●	●	◕	S	○	R/A/B	◑	◑	○	BEROE
Insideview	D	◑	●	●	●	◔	●	●	F	●	R/A/B	◑	◑	○	InsideView
Infogroup	D/R	◑	●	●	●	◔	●	◔	S	●	R/A/B	○	○	○	infogroup
HG Insights	D	○	●	●	●	◕	●	◕	S	◑	A/B	●	○	○	HG Insights
Cortera	D	○	●	●	●	◔	●	◔	L	◑	B	●	○	○	CORTERA
Ernst & Young	R	◑	◑	●	●	◔	●	◕	L	●	R/A/B	◑	◑	●	EY
Achilles	R	◑	●	◑	●	◕	●	○	L	○	R/A/B	◑	●	○	Achilles
Experian	R	◑	◑	●	◑	◕	◑	●	L	●	R	◑	◑	○	

2.3.1 Dun & Bradstreet

Company Description: Dun and Bradstreet (D&B) provides commercial data to businesses including credit history, business-to-business sales and marketing, counterparty risk exposure, supply chain management, lead scoring and social identity matching. D&B's database contains information on more than 235 million companies across 200 countries worldwide.

D&B's patented DUNS Right Data quality process allows customers to enrich their files with third-party data to gain a complete view of supplier risk refresh data frequently to maintain the accuracy and completeness of supplier information. D&B has a large D-U-N-S database which it can use to track linkage between companies. With this numbering system D&B has the ability to consume a great deal of data and distill it down to one single company. By using the D-U-N-S number to track companies, D&B can automatically update clients when a company is consumed by another company or involved in questionable dealings. D&B utilizes shipment data, bills of material, trade tape data, and data which they buy or acquire from private companies. D&B mines and analyzes this data to create links, using commodity codes to track companies clients would like tracked.

Applicability: D&B can provide end to end network linkage data, as well as attribute and subsidiary data, all in an ingestible format and in a scalable 3-week period. D&B can also provide real-time updates and pings.

Description

- Data Intelligence firm offering Tier-N solution with fully ingestible supply chain linkage and network risk data.
- Supports Tableau-based interactive dashboards, scorecards, highly formatted reports, ad hoc query, thresholds and alerts, and automated report distribution.
- Currently used by DLA for procurement intelligence.

Pros

- DLA has existing subscription with D&B for different data types.
- 3-week network discovery lead time regardless of volume.
- Pre-built and validated comprehensive link-node network maps including attribute data.

Cons

- May prove to be a more expensive provider.
- Some portions of network data may be un-attributable (no identifiable data).
- May not be able to map every Tier 1 supplier down to raw materials suppliers.

Table 15. D&B Detailed Evaluation

Evaluation Reference	Definition
1. Data Delivery Format	Sample data provided by D&B was delivered in an excel data set.
2. Link/Relationship Data	Yes – D&B can provide node/link linkage data and provide sub-supplier tier information, no mining or interviewing/surveying will be necessary.
3. Link/Relationship Data Format	The data would come in the form of completed networks.
4. Parent/Subsidiary Data	Yes – D&B can provide comprehensive parent-subsidiary data of DLA's supply chain.
5.Parent/Subsidiary Data Format	The data would come in the form of completed networks.
6. Link/Node Attribute Data	D&B can provide risk data (risk scores and indices) and attribute data including addresses risk indices in a dashboard and in the links and nodes.
7. Link/Node Attribute Data Format	Data can come prepared for visualization or can be delivered in the form of a dashboard or link-node network maps.
8. Scope/Data Coverage (Tier 1 DLA; International)	D&B has full capability to map DLA Tier 1 suppliers, including international companies. They have the largest network of 950 million companies.
9. Scalability/Lead Time	D&B can scale their solution and accurately produce network maps in 3 weeks no matter how many tier one suppliers VNLA provides them.
10. Update Frequency	D&B updates data every quarter.
11. Interfacing Options	D&B can offer automatic updates on a quarterly basis, batch processing, real-time pings.
12. Market Intelligence Data	D&B did state that they have a comprehensive Market Intelligence database.
13. Available Use Cases	Yes – D&B can likely provide a somewhat related use case.
14. DoD Client	Yes – D&B has a working account with DLA.

2.3.2 Panjiva

Company Description: Panjiva integrates financial and industry data, research and news into tools that help track performance, generate alpha, identify investment ideas, understand competitive and industry dynamics, perform valuation and assess credit risk. With quick access to information on over 8 million companies in over 190 countries, Panjiva's sophisticated AI-based network analysis identifies unusual activity across over 1 billion shipment records. Panjiva technology gives immediate insight into the companies involved at every node of international supply chains. From manufacturers and buyers to shipping and logistics, Panjiva allows customers to better assess trade around the globe.

Applicability: Can provide easily ingestible data (financial, business, market intelligence data) for use in procurement system, capability to produce supply chain network maps including risk information, offers supply chain visualization software and dashboards created with the purpose of proactively identifying risks.

Description

- Panjiva integrates financial and industry data, research and news into tools that help track performance, generate alpha, identify investment ideas, understand competitive and industry dynamics, perform valuation and assess credit risk
- Panjiva technology gives immediate insight into the companies involved at every node of international supply chains.

Pros

- Can provide information past tier 1 suppliers and customers
- Can provide a risk model based on type of product (Panjiva provides shipment data, company data, and location data)
- Panjiva’s artificial intelligence platform can pinpoint the signatures of illegal activity across the entire supply chain

Cons

- Can not provide a direct risk index score, but can provide an overall supply chain risk model
- Does not offer a full market intelligence database subscription

Table 16. Panjiva Detailed Evaluation

Evaluation Reference	Definition
1. Data Delivery Format	Data is capable of being delivered in the form of a tabular database. / Data is delivered in the form of a report. This data is delivered in a text brief and requires further labor by analysts to extract necessary data and convert it to an ingestible format.
2. Link/Relationship Data	Can provide links between multiple tiers in a supply chain/capable of comprehensive mapping.
3. Link/Relationship Data Format	Structured, tabular, format ready for ingestion into mapping tool.
4. Parent/Subsidiary Data	Can provide comprehensive Corporate Structure data.
5.Parent/Subsidiary Data Format	Structured, tabular, format ready for ingestion into mapping tool.
6. Link/Node Attribute Data	Can provide descriptive data and relationship strength (one-time purchase or a recurring large procurement)
7. Link/Node Attribute Data Format	Structured, tabular, format ready for ingestion into mapping tool.
8. Scope/Data Coverage (Tier 1 DLA; International)	Can provide necessary international and domestic data. All or large majority of DLA T1 suppliers can be mapped.
9. Scalability/Lead Time	Step - Receives suppliers in batches and turns around in a reasonable amount of time/ Is compounding.
10. Update Frequency	Updated Automatically/Daily.
11. Interfacing Options	Provides batch updates.
12. Market Intelligence Data	Offers some market intelligence information on ad hoc basis with no real-time data feed or database subscription available.
13. Available Use Cases	Can provide a related use case (Social Network mapping, other supply chain), but cannot provide a Vendor Network Mapping use case.
14. DoD Client	Yes

2.3.3 Beroe

Company Description: Beroe is a procurement intelligence company which specializes in customized market research. Sixty percent of Beroe's data comes from import-export data. Beroe representatives stated that they can provide network linkage data by combining different sources of data. This means extracting useful information from import-export data and a variety of proprietary subscriptions and then combing through that data to draw conclusions and links between companies. Beroe representatives stated that they can tailor this data to be provided to DLA in any format desired. Beroe offers curated alerts of supplier risk and market risk.

Applicability: Beroe, unlike many supply chain data providers possesses a readily available extensive database. Therefore, Beroe does not rely on self-reported surveys from suppliers to gather linkage data, a practice which AFS deems often inefficient and inaccurate. The one possible drawback of working with Beroe would be the intensive labor and aggregation of data necessary for them to create links. Their method may indicate that they provide lengthy lead times. Additionally, the method they described indicates that scalability is unlikely, and lead times will be based on the number of DLA Tier 1 suppliers VNLA provides to Beroe. The company could not provide a network discovery timeline but stated that they would be willing to work with DLA on a pilot basis to determine whether they will be able to provide the data DLA requires and determine how long it would take.

Description

- US-based business Market Intelligence company catered to procurement.
- Able to provide link-node data for all tier one suppliers through the analysis of sizable proprietary database and subscriptions.
- Claims to have the capability to provide data in any format necessary.

Pros

- Offers link-node and attribute data without the use of surveys.
- 60% of data from proprietary database, 40% of data from other sources.
- Offers suppler risk, market risk, and curated alerts.

Cons

- Suspected lengthy lead time based on available data.
- Manually intensive data aggregation.
- Little experience in specific supplier network mapping.

Table 17. Beroe Detailed Evaluation

Evaluation Reference	Definition
1. Data Delivery Format	Data format – Beroe claims they can deliver in any major format requested.
2. Link/Relationship Data	Likely – Beroe believes they can provide comprehensive linkage data but would like to move ahead on a pilot basis to determine whether they can provide the data DLA needs to perform VNLA.
3. Link/Relationship Data Format	Excel is the main format but Beroe has indicated that they can provide data in any format we need and the data would be structured and ready to ingest.
4. Parent/Subsidiary Data	The extent to which data provider has information on parent subsidiary relationships.
5.Parent/Subsidiary Data Format	The format which the data provider has link/relationship data – mass extracts of unstructured data, prepared network linkage data ready for visualization, etc.
6. Link/Node Attribute Data	Beroe can provide risk information, company identifiers, and may be able relationship strength.
7. Link/Node Attribute Data Format	Beroe would provide data in a ready to ingest, structured format.
8. Scope/Data Coverage (Tier 1 DLA; International)	Beroe can provide domestic and international data necessary to complete the mapping of DLA's tier 1 suppliers – but they are not completely confident, and therefore, cannot be given a full score.
9. Scalability/Lead Time	Unknown – Beroe has indicated that they would like to determine lead time through a pilot basis.
10. Update Frequency	Beroe can update its data quarterly.
11. Interfacing Options	Beroe claims to offer real-time pings, as well as batch and automatic updates.
12. Market Intelligence Data	Yes – Beroe is an up and coming player in the Market Intelligence field, with a growing database.
13. Available Use Cases	No – Beroe cannot provide use cases related to network mapping.
14. DoD Client	Beroe is not an existing or previous DoD client.

2.3.4 Insideview

Company Description: Insideview fuels go-to-market strategies as they know how to adjust and optimize in real time. Insideview Insights delivers targeting intelligence and real-time data about more than 13 million companies and 30 million contacts around the world. Insights are provided from 40,000+ news and social media sources as well as a comprehensive view of corporate connections. Targeting intelligence is aggregated and validated using a proprietary methodology of data science and artificial intelligence to deliver the most reliable, relevant business-to-business data and market information.

Applicability: Includes market intelligence, business, and financial data; does not provide network linkage map, focus is on B2B customers and leads

Description

- Real-time data about more than 13 million companies and 30 million contacts around the world
- Insights from 40,000+ news and social media sources
- A comprehensive view of your personal and professional connections
- Targeting Intelligence is aggregated and validated using a proprietary methodology of data science and artificial intelligence to deliver the most reliable, relevant business-to-business data and intelligence.

Pros

- Can provide data is a structured format
- Can provide complete corporate structure data
- Can provide international and domestic data – a large majority of the DLA tier 1 suppliers can be mapped

Cons

- Can not provide completely comprehensive mapping of tiers in supply chain
- Can not provide a validated risk index/score or provide relationship strength information

Table 18. Insideview Detailed Evaluation

Evaluation Reference	Definition
1. Data Delivery Format	Data is capable of being delivered in the form of a tabular database.
2. Link/Relationship Data	Can provide 1 or 2 tiers past tier 1 / not completely comprehensive.
3. Link/Relationship Data Format	Structured, tabular, format ready for ingestion into mapping tool.
4. Parent/Subsidiary Data	Can provide comprehensive Corporate Structure data.
5.Parent/Subsidiary Data Format	Structured, tabular, format ready for ingestion into mapping tool.
6. Link/Node Attribute Data	Can provide descriptive data, but not a validated risk score/index or relationship strength.
7. Link/Node Attribute Data Format	Structured, tabular, format ready for ingestion into mapping tool.
8. Scope/Data Coverage (Tier 1 DLA; International)	Can provide necessary international and domestic data. All or large majority of DLA T1 suppliers can be mapped.
9. Scalability/Lead Time	Fixed - Can return networks in a fixed amount of time regardless of volume of T1 suppliers provided/ Does not compound.
10. Update Frequency	Updated automatically/daily (ADHOC)
11. Interfacing Options	Provides real-time pings, automatic updates, and batch updates.
12. Market Intelligence Data	Offers some market intelligence information on ad hoc basis with no real-time data feed or database subscription available.
13. Available Use Cases	Can provide a related use case (Social Network mapping, other supply chain), but cannot provide a Vendor Network Mapping use case. (Has worked with commercial Accenture ide before).
14. DoD Client	Has never worked with DoD

2.3.5 Infogroup

Company Description: Infogroup's data is comprised of 16 million U.S. businesses and 300 million customer profiles. Solutions are powered by proprietary business and consumer databases and supplemented by client and third-party data. 300+ data technicians make up the databases in the Omaha data factory to capture, validate, and enhance data. Infogroup utilizes all types of data collection methods including crawling, phone surveys, third-party surveys, and crowdsourcing.

Applicability: B2B and direct consumer demographic prospecting leads, business, consumer, and financial data, does not provide network linkage map

Description

- Contains automated database synchronization. (constant risk factors updates such as: change of address, moved, UCC filing, liens and judgements, transaction dates)
- Runs counts and calculate statistics on database segments.
- Infogroup provides on demand targeted delivery; it has the ability to search the database and pull lists as you need them.

Pros

- Access to compiled data at scale with API access (3000+ sources to create business databases and independently validate raw data)
- Has built historical business databases over time to enable trend analysis and sales pipeline insight
- Conducts call center interviews to gather constant and updated information on the businesses assessed

Cons

- Does not have access to trade data or financing information of the businesses assessed
- Does not have supply chain mapping capabilities

Table 19. Infogroup Detailed Evaluation

Evaluation Reference	Definition
1. Data Delivery Format	Data is capable of being delivered in the form of a tabular database. Data is also provided via xml, json, csv and reports as well.
2. Link/Relationship Data	Can provide 1 or 2 tiers past tier 1 / not completely comprehensive.
3. Link/Relationship Data Format	Structured, tabular, format ready for ingestion into mapping tool.
4. Parent/Subsidiary Data	Can provide comprehensive Corporate Structure data.
5.Parent/Subsidiary Data Format	Structured, tabular, format ready for ingestion into mapping tool.
6. Link/Node Attribute Data	Can provide descriptive data and relationship strength information. Infogroup has their own unique ID identification system.
7. Link/Node Attribute Data Format	Structured, tabular, format ready for ingestion into mapping tool.
8. Scope/Data Coverage (Tier 1 DLA; International)	Can provide data on all or some domestic DLA T1 suppliers – cannot provide international data.
9. Scalability/Lead Time	Receives suppliers in batches and turns around in a reasonable amount of time/ Is compounding.
10. Update Frequency	Updated automatically/daily.
11. Interfacing Options	Provides real-time pings, automatic updates, and batch updates.
12. Market Intelligence Data	Infogroup does not have a market intelligence database.
13. Available Use Cases	Cannot provide a related or relevant use case.
14. DoD Client	Has previously worked with DLA or is currently working with another DoD agency.

2.3.6 HG Insights

Company Description: HG Insights platform provides an unprecedented view into global industries, markets, and companies allowing you to identify the most valuable opportunities and build strategies to maximize your revenue and accelerate growth. HG Insights uses a data integrity engine to gather target industry and corporate data. It's Data-as-a-Service offering to access HG Insights' team of analysts for custom modeling & analysis provides custom matching with your company data, advanced cohort analysis, and bespoke account intelligence. HG Insights data-science driven approach allows you to see which technologies companies are using to run their business and who they interact with.

Applicability: Company financial information, market intelligence data, and business data can all be provided, offers visualization software and dashboards, cannot provide network linkage data.

Description

- Provides data that shows which specific technologies are being leveraged in the supply-chain
- Data is linked to Dun & Bradstreet which provides corporate linkage
- Has the capability to identify emerging vendors and products

Pros

- Data can be delivered in a structured and timely manner
- Cleans the data before sending it over, creates spend projection models and industry classifications by putting subsidiaries in the proper categories

Cons

- Can not provide a validated supply chain risk index or score
- Cannot provide visibility past tier 1 of a supply chain.
- Supplier Data is only refreshed every month

Table 20. HG Insights Detailed Evaluation

Evaluation Reference	Definition
1. Data Delivery Format	Data delivery can be done via HG's online platform or within tools such as Salesforce or Marketo. Data delivery can also be done offline via flat files.
2. Link/Relationship Data	Cannot provide visibility past tier 1 of a supply chain.
3. Link/Relationship Data Format	Structured, tabular, format ready for ingestion into mapping tool.
4. Parent/Subsidiary Data	Data is mapped to Dun and Bradstreet dataset which provides corporate linkage.
5.Parent/Subsidiary Data Format	Can provide comprehensive Corporate Structure data.
6. Link/Node Attribute Data	Can not provide a validated supply chain risk score, can provide a DUNS number but not a CAGE ID, and can provide relationship strength on 700,000 entities
7. Link/Node Attribute Data Format	Structured, tabular, format ready for ingestion into mapping tool.
8. Scope/Data Coverage (Tier 1 DLA; International)	Install and spend information is tracked on a wide variety of companies across the globe with coverage into DLA related companies
9. Scalability/Lead Time	Step - Receives suppliers in batches and turns around in a reasonable amount of time/ is compounding.
10. Update Frequency	Data is refreshed monthly
11. Interfacing Options	UI access to generate target lists of companies and associated data points, account matching, monthly file delivery
12. Market Intelligence Data	Yes – HG Insights has a market intelligence database. HG tracks technology usage at companies - what software/hardware systems are in use - that can provide a view to market intelligence.
13. Available Use Cases	Cannot provide a related or relevant use case.
14. DoD Client	Has never worked with DoD.

2.3.7 Cortera

Company Description: The Cortera network delivers deep dive views into risk, including business purchasing and payment behaviors with industry-specific segmentation. Innovative features such as self-service batch appends, robust APIs and scorecard wizards present data-driven insights in a variety of easy, intuitive formats. Cortera customers can access data on-the-fly for individual companies through the website or get a monthly dashboard analyzing their entire customer and prospect files. Cortera Pulse monitors your customers and sends you a daily alert on changing purchase behavior, payment behavior, risk scores, financial news, and public record filings. Cortera aggregates data from thousands of sources, provides unique business data insights into your customers, and delivers predictive analytics into the future risk of your customers.

Applicability: Can provide easily ingestible data (financial, business, market intelligence data) for use in procurement system, offers supply chain visualization software and dashboards created with the purpose of proactively identifying risks. Although Cortera does not provide a network linkage map, it monitors seven major supply chain industries to track purchase, payment and financial trends: Apparel, Building Supplies, Construction, Food & Beverage, Industrial Supplies, Manufacturing Materials, and Transportation.

Description

- Delivers deep dive views into risk, including business purchasing and payment behaviors with industry-specific segmentation.
- Provides features such as self-service batch appends, robust APIs and scorecard wizards presenting data-driven insights in a variety of easy, intuitive formats

Pros

- Combines public records with contributed data, creating risk profiles for companies
- Generates custom fraud reports, spending behavior, and fraud detection
- Partnered with Lexis Nexus database to perform customer due diligence

Cons

- Does not provide network coverage and cannot provide visibility past tier 1 of supply chain
- Cannot provide international data, only North America and Canada
- Takes longer to turn around data in terms of compounding, requiring greater analysis and cleansing

Table 21. Cortera Detailed Evaluation

Evaluation Reference	Definition
1. Data Delivery Format	Data is capable of being delivered in the form of a tabular database.
2. Link/Relationship Data	Cannot provide visibility past tier 1 of a supply chain
3. Link/Relationship Data Format	Structured, tabular, format ready for ingestion into mapping tool.
4. Parent/Subsidiary Data	Can provide comprehensive Corporate Structure data.
5.Parent/Subsidiary Data Format	Structured, tabular, format ready for ingestion into mapping tool.
6. Link/Node Attribute Data	Can provide relationship strength (one-time purchase or recurring large procurements)
7. Link/Node Attribute Data Format	Structured, tabular, format ready for ingestion into mapping tool.
8. Scope/Data Coverage (Tier 1 DLA; International)	Can provide data on all or some domestic DLA T1 suppliers – cannot provide international data.
9. Scalability/Lead Time	Takes longer to turn around data/ Is compounding (requires greater analysis and cleansing) (i.e. does surveys or heavily sources from data aggregated from various sources).
10. Update Frequency	Updated monthly
11. Interfacing Options	Provides batch updates
12. Market Intelligence Data	Offers comprehensive market intelligence information as a service, with real-time data feed or database of risk information available.
13. Available Use Cases	Cannot provide a related or relevant use case.
14. DoD Client	Has never worked with DoD.

2.3.8 Ernst & Young

Company Description: Ernst & Young is a large multinational company providing advisory, assurance, tax and transaction services across a wide portfolio of technical areas. Ernst & Young's advisory practice includes a supply chain & operations area offering consulting services related to risk management, supply chain operations, and other manufacturing-related areas.

Applicability: As part of the Supply Chain Smart Map solution, Ernst & Young uses a Supply Chain Strategic Analyzer, a proprietary software platform for supply chain intelligence. With this advanced diagnostic tool, one can analyze the entire breadth of a supply chain to better align with business priorities. Smart Maps provide insights through quantitative analytics, standardizing, and qualitative performance assessments. These insights can help identify the critical areas to increase performance and achieve a full supply chain potential. B2B and direct consumer demographic prospecting leads, business, consumer, and financial data, does not provide network linkage map.

Description

- Accelerate performance insights and decision-making with end-to-end supply chain dashboards
- Uses Smart Maps to provide insights through quantitative analytics, standardizing, and qualitative performance assessments
- Cover entire breadth of end-to-end supply chain and digital capabilities and align capabilities with supply chain priorities

Pros

- Smart Maps offering provides holistic supply chain management
- Can provide basic user-friendly supply chain visualizations, dashboards, some alerts related to market risk, and an optimization tool
- Offers supply chain visualization software and dashboards created with the purpose of proactively identifying potential supply chain risks

Cons

- No existing database - all the data to produce network maps is sourced from self-reported surveys to previously identified suppliers or from third party aggregated databases of information
- Data to feed Supply Chain Smart Maps appears to be required from client source.
- Manually intensive data aggregation
- Cannot provide a validated supply chain risk index or score
- Does not offer a full market intelligence database subscription

Table 22. Ernst & Young Detailed Evaluation

Evaluation Reference	Definition
1. Data Delivery Format	Data is delivered in the form of a report. This data is delivered in a text brief and requires further labor by analysts to extract necessary data and convert it to an ingestible format.
2. Link/Relationship Data	Unclear whether data is provided by EY or required from client and client supply chain. Can expect public subsidiary information available.
3. Link/Relationship Data Format	Text report or unstructured in need of analyst manipulation.
4. Parent/Subsidiary Data	It is expected they can provide comprehensive corporate structure data.
5.Parent/Subsidiary Data Format	It is expected they can provide structured, tabular, format ready for ingestion into mapping tool.
6. Link/Node Attribute Data	Can only provide some form of complimentary company matching information on CAGE/DUNS.
7. Link/Node Attribute Data Format	Structured, tabular, format ready for ingestion into mapping tool.
8. Scope/Data Coverage (Tier 1 DLA; International)	Can provide some international and domestic data, but this data is limited to that available by client matched to public records.
9. Scalability/Lead Time	Takes longer to turn around data/ Is compounding (requires greater analysis and cleansing) (i.e. does surveys or heavily sources from data aggregated from various sources).
10. Update Frequency	It is expected that basic available data or subscription-based data is updated automatically, while other data is quarterly.
11. Interfacing Options	It is expected that they can accommodate any type of data update method including real-time, automatic, or batch updates.
12. Market Intelligence Data	Offers some market intelligence information on ad hoc basis with no real-time data feed or database subscription available.
13. Available Use Cases	Can provide a related use case (Social Network mapping, other supply chain), but cannot provide a Vendor Network Mapping use case.
14. DoD Client	Currently has working account with DLA.

2.3.9 Achilles

Company Description: Achilles Supply Chain Mapping allows companies to gain visibility of their extended supply chains and view supplier information beyond first tier suppliers. Their process: Once the first tier supplier's data has been uploaded into the Achilles Supply Chain Mapping System, buyers or category managers access the system and start the supplier invitation process by linking products for which they wish to receive a supply chain map to the listed suppliers. This triggers an automated email to suppliers requesting registration in the Achilles Supply Chain Mapping Program, as well as information related to the components of the products they sell and the suppliers they are sourced from. First tier suppliers register in the system and provide basic company information, confirmation they supply the products selected by the buyer and information about the components/ingredients they need to source in order to supply that particular product, as well as the suppliers they are sourced from. This process is repeated until the end of the chain is reached. Once the data is in the system, buyers can start to navigate the data using different filters to create customizable reports of their various supply chain maps.

Applicability: Achilles does not have a large proprietary database with the necessary linkage data. Achilles utilizes a solely self-survey system, which will be time consuming, and may be unreliable in yielding accurate results. Those are the cons assuming that supplies further down the chain respond to surveys, and there is no certainty that they will comply, as the survey is not mandatory.

Description

- UK-based Supply Chain Services consultancy offering supply chain mapping and data gathering through self-reported surveys with suppliers and manufacturers.
- Survey data covers interdependencies and risk points in the supply chain, areas of convergence, and potential single points of failure, supplier clusters across high-risk regions, and the impact of major events or incidents on global production.
- Offers easily ingestible data as well as user-friendly interface.

Pros

- Basic user-friendly supply chain visualizations, dashboards, and alerts.
- Available link-node data.
- Ease of data ingestion.

Cons

- No existing database - all of the data to produce network maps is sourced from self-reported surveys to previously identified suppliers.
- Lengthy network discovery lead time.
- Sixty percent response rate to surveys.

Table 23. Achilles Detailed Evaluation

Evaluation Reference	Definition
1. Data Delivery Format	Achilles can provide data in several ready-to-ingest formats
2. Link/Relationship Data	Through self-reported surveys Achilles can provide multiple tiers of linkage data.
3. Link/Relationship Data Format	If accurate and comprehensive data is retrieved, Achilles can provide prepared network linkage data ready for visualization, mapped out, and in a dashboard through their basic visualization tool.
4. Parent/Subsidiary Data	Through self-reported surveys Achilles can provide parent/subsidiary data.
5.Parent/Subsidiary Data Format	If accurate and comprehensive data is retrieved, Achilles can provide prepared network linkage data ready for visualization, mapped out, and in a dashboard through their basic visualization tool.
6. Link/Node Attribute Data	If all suppliers reply accurately to self-reported surveys Achilles will be able to provide risk indices, descriptive data, and relationship strength.
7. Link/Node Attribute Data Format	If accurate and comprehensive data is retrieved, Achilles can provide prepared network linkage data ready for visualization, mapped out, and in a dashboard through their basic visualization tool.
8. Scope/Data Coverage (Tier 1 DLA; International)	If all suppliers in the DLA supply chain reply accurately to Achilles, then the company can map DLA Tier 1 suppliers, including international companies.
9. Scalability/Lead Time	Several months – Achilles will need to survey each supplier in the chain with automatic emails.
10. Update Frequency	Achilles can update their data quarterly basis given that suppliers reply to follow up surveys.
11. Interfacing Options	Batch processing, real-time alerts, automatic updates, geographic map, chart view of links.
12. Market Intelligence Data	Yes – Achilles is also a provider of market intelligence, but the database is limited.
13. Available Use Cases	Yes – Achilles has mapped out Nestlé's supply chain and can provide a use case.
14. DoD Client	No record of such available publicly.

2.3.10 Experian

Company Description: Experian PLC is a global information services group with operations in 40 countries. Experian representatives stated that they would be able to provide linkage data, including links between companies, subsidiaries, and different company branches. Experian can also provide commercial credit scores, all historical trade information available and current trade lines. However, Experian can only provide this information in the form of text reports in brief format. Although these text reports are filterable and word searchable they would require hours of further work by an analyst. Experian offers both international and domestic data. Experian can provide risk classes for each company and an account monitoring service which boasts 47 different triggers clients can choose from, including alerts for new trade lines and changes in credit scores. Experian also offers market intelligence data through their Business IQ Platform, which is also the platform offering linkage data. There is a free trial available for Business IQ.

Applicability: Experian was unable to provide a use case or sample data to VNLA. Experian was also unable to provide an estimated lead time or scalability options. Although Experian can provide linkage data, their data comes in the form of text briefs requiring much more filtering to be completed by analysts at DLA.

Description

- Credit data company with significant coverage of non-credit domestic and international business data.
- Has linkage data that includes commercial credit scores, historical trade information, and current trade lines.
- Business IQ platform provides a monitoring service. Alerts if any selected risk factor is triggered. Factors include new trade lines for a business and changes in credit scores among other things.

Pros

- Link-node data available.
- Extensive coverage of domestic and international business data.
- Attribute data available.

Cons

- Data not ingestible - text briefs would require further extraction by analysts.
- Scalability is not an option.
- Long lead times expected.

Table 24. Experian Detailed Evaluation

Evaluation Reference	Definition
1. Data Delivery Format	Experian delivers data only in text-brief format.
2. Link/Relationship Data	Experian has substantial credit data and transactional data between domestic and international businesses and claims to be able to create linkage data
3. Link/Relationship Data Format	Experian can provide filterable text reports and on occasion can provide batch excel files.
4. Parent/Subsidiary Data	Experian claims they can link subsidiaries to the parent companies as well as companies to other companies they are doing business with. Experian uses commercial credit scores, all historical trade information available, and current trade lines.
5.Parent/Subsidiary Data Format	Experian can provide filterable text reports and on occasion can provide batch excel files.
6. Link/Node Attribute Data	Yes – Experian can assign various risk indices to suppliers.
7. Link/Node Attribute Data Format	Experian can provide filterable text reports and on occasion can provide batch excel files.
8. Scope/Data Coverage (Tier 1 DLA; International)	Extensive coverage of domestic and international business data.
9. Scalability/Lead Time	Custom reports can be built stepwise. Batch reports in excel form may have improved scalability/lead time.
10. Update Frequency	The database is updated daily in real time.
11. Interfacing Options	Account monitoring service “47 different triggers you can choose from.” Can get alerts if there is a new trade line for a business, change in credit scores among various other options.
12. Market Intelligence Data	Experian offers a market intelligence capability within their Intelliview software
13. Available Use Cases	According to Experian representative these do exist, but use cases never received.
14. DoD Client	No.

3.0 DLA & Government Capability Assessment

Aside from updating the industrial base survey and research related to external data providers, a major task of VNMC was to analyze internal DLA and government capabilities to identify those with functions that are the same, or similar to the intention of a Vendor Network Mapping Capability. Contacts were made within DLA and government supply chain security groups to identify any capabilities for analyzing the supply chain and/or networks of high-importance vendors. More specifically, points of contacts were asked to please respond with any information directly relating to the following functions:

- **Vendor Risk Analysis** (i.e. credit risks, fraud risks, etc.)
- **Vendor Network Mapping / Supply Chain Mapping** (any data relating one company to another (e.g. a known connection between an OEM providing components to a distributor)
- **Vendor Performance Issues** (i.e. potential fraud, failed testing, late delivery, etc.)

Supply Chain Security and enhanced procedures for assessing supplier risk and/or quality have been of increased importance for DLA in recent years. This dedication to increased supply chain security is outlined in Appendix 1 of the Director's 2018-2026 Strategic Plan: Supply Chain Security Strategy.

3.1 Vendor Network Mapping

In recent years, DLA has operationalized a capability called Business Decision Analytics (BDA) to provide procurement specialists, tech quality resources, and others with a vast array of actionable supplier data, item data, and pricing information. Among the many pieces of functionality within this suite of tools is a relatively new capability called Vendor Network Mapping (VNM). VNM was developed in partnership with the Defense Criminal Investigative Service (DCIS) as a way to analyze networks of suspicious or known nefarious 'bad actors'. Specifically, this tool was built to ingest data linking corporate entities together who have certain pieces of data in common. Among the criteria for the tool include any suppliers or companies who are likely 'matches' (i.e. operating within the same fraud network and/or the same bad actor(s) continuing to operate) based on the following:

- D&B Universal Numbering System (DUNS) Number
- Internet Protocol (IP) Address
- Street Address
- Company Owner Name
- Excluded Parties List System (EPLS) Name
- Contact Information

Starting with a machine learning-based tool, likely matches are generated. Next, the likely matches are reviewed by DLA Fraud Counsel and determined a 'strength' which further defines the

'likelihood' of a correct or strong match existing. There are three levels of strength (High, Medium, and Low), and these levels generally correlate with the strength of the variables used to identify them as matches. Individual overrides of this system may be possible for specific threat networks, but in general the strength is allocated as follows:

- **High Strength:** Match on DUNS Number and/or Mailing Address
- **Medium Strength:** Match on Owner Names and/or IP Address
- **Low Strength:** Match on EPLS Name

This capability ingests the linkage data consisting of entity nodes and relationship links. It then transforms this data into a visual representation of the fraud networks, showing nodes as dots, linkages as lines, and the strength of a connection (i.e. a line between nodes or dots) by the color of that connection. Other relevant information for the companies included in the visualization are shown including the information used to make the match. Notional examples of the capability are shown below with fake/obfuscated data used to show the functionality.

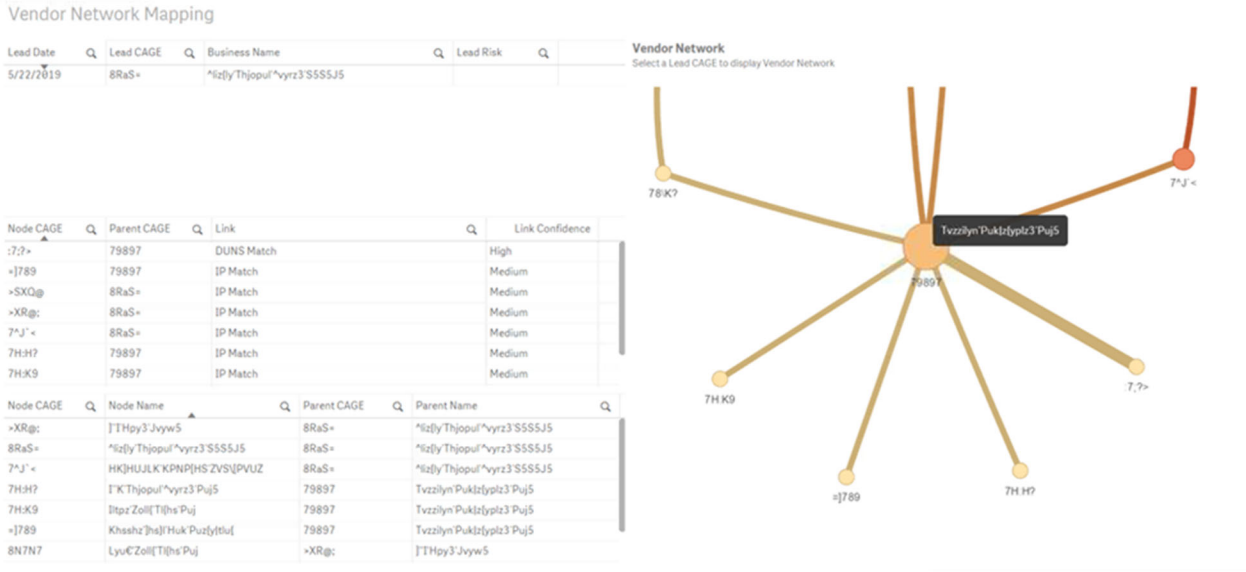


Figure 1. Example view of Vendor Network Linkage Capability

An additional feature of the Vendor Network Mapping capability is that it is built using the J6 Enterprise visualization tool, Qlik Sense. This visualization tool is widely available to all DLA employees for exploratory data analysis and provides a higher level of familiarity to end users than if the tool was developing using a different or more esoteric application. Additionally, by being directly integrated into production Business Decision Analytics, this tool is immediately available to those with a business need and can be augmented in the future to accept new linkage data and evolve over time. This ability to 'evolve as new threats emerge' is specifically cited by the Director in his Supply Chain Security plan, as are his plans to 'integrate Business Decision Analytics and Vendor Network Mapping into acquisition strategies' in the future.

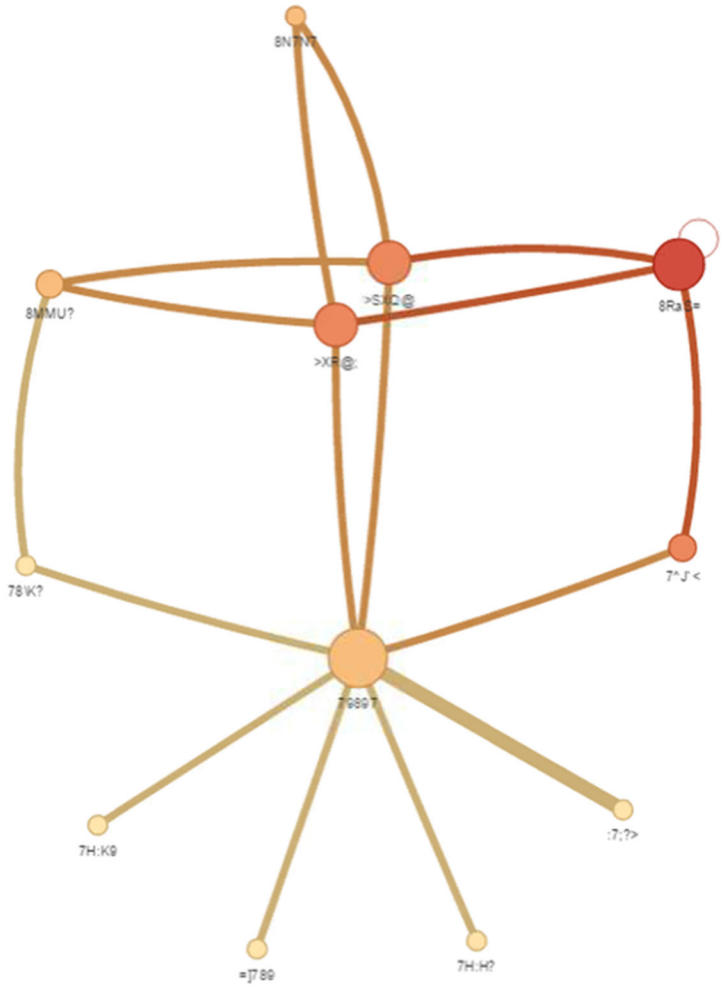


Figure 2. Sample Visualization of Fraud Network in VNM

3.2 Enterprise Geospatial Information System

The Enterprise Geospatial Information System (eGIS) is a platform focused on providing self-service analysis and awareness to DLA users that is capable of incorporating real-time data feeds and geospatial analysis of assets. Although this capability does not directly provide supply chain linkage information or mapping, it provides a robust location-based capability that may be adapted in the future to accept such supply chain linkage data and operationalize it.

As described in a capability briefing, eGIS is 'designed as a Platform as a Service (PaaS) within DLA AZURE Cloud and Enterprise GIS – Software as a Service (SaaS) using ESRI ArcGIS Technologies.' This capability provides a means for exchanging data with external partners and provides dashboarding functionality that is being used to monitor DLA Energy locations to respond to severe weather events, medical emergencies, part shortages, and other logistics operations.

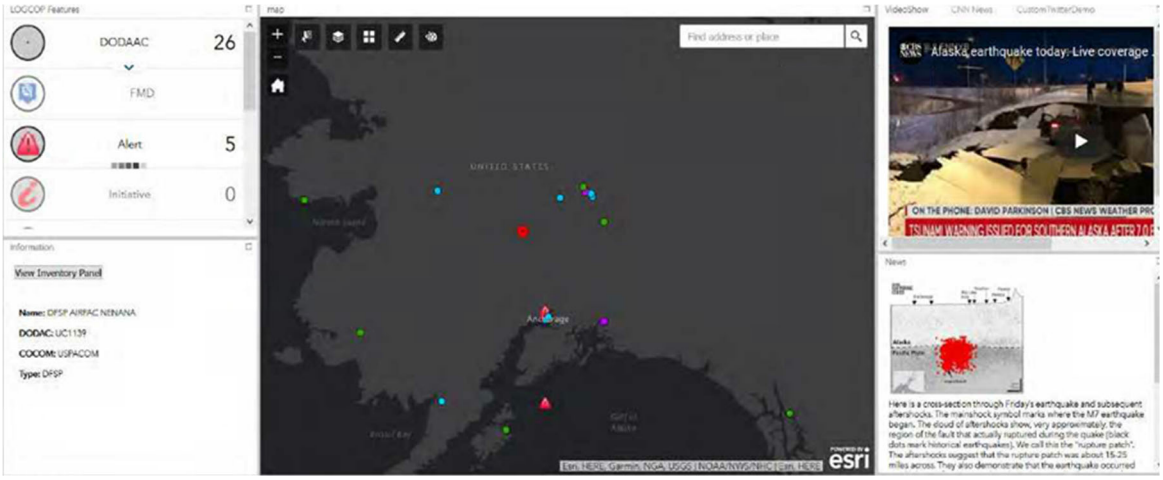


Figure 3. Sample View of eGIS for Severe Weather Events

Despite a current lack of supply chain data or supplier linkage data, eGIS provides another production ready visualization option for incorporating supply tier data. This tool's ability to ingest real-time data feeds and/or other media types may prove useful in combination with other information such as vendor risk and/or delivery data.

3.3 Clustering Algorithm Identification of Supply Chain Vulnerabilities

Another capability closely related to the goals of VNMC is an algorithm/approach for identifying supply chain vulnerabilities as presented by ***Lieutenant Commander Michael Kidd (US Navy).*** LCDR Kidd developed this research paper and approach as an Action Officer on the Navy National Account Manager Team as part of his work with DLA.

LCDR Kidd's paper focuses on exploring the use of social network software NodeXL to present a cost-effective approach to identifying structural and geographic supply network risks. Utilizing publicly available data indicating supply relationships via academic access to Mergent Online, LCDR Kidd explores the networks of two of DLA's primary vendors, 3M Corporation and Rockwell Collins. His initial exploratory efforts are similar to the findings within this report, including identification of the exponential growth of supply networks by supply tier, as shown in Figure 4.

LCDR Kidd produces several useful suggestions in his paper, including the need to directly target suppliers and/or supply chains of interest and investing in SCRM tools directed at those areas. Similarly, he notes that there are unique challenges in collecting useful data for this analysis and that,

> "Employment of commercial services or partnership with research universities are likely to provide transparency in the most expeditious manner. Such an

approach would leverage existing DoD expertise with a more developed civilian supply surveillance infrastructure."

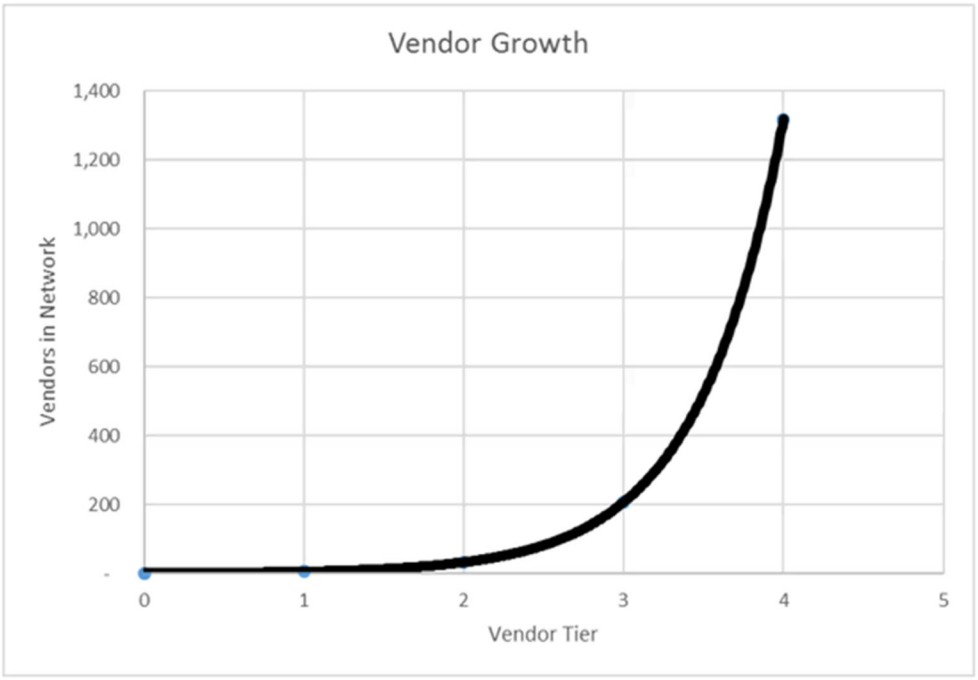


Figure 4. Growth of Vendor Networks by Supply Tier

Although similar approaches can be utilized to analyze supply networks using the tools highlighted in this paper, the resulting visualizations are somewhat difficult to follow and lack exploratory capabilities. Additionally, the data available via Mergent Online is sourced using only public filing information and may provide reduced or little information for smaller vendors. A request for more information was not returned by Mergent Online for the purposes of this paper.

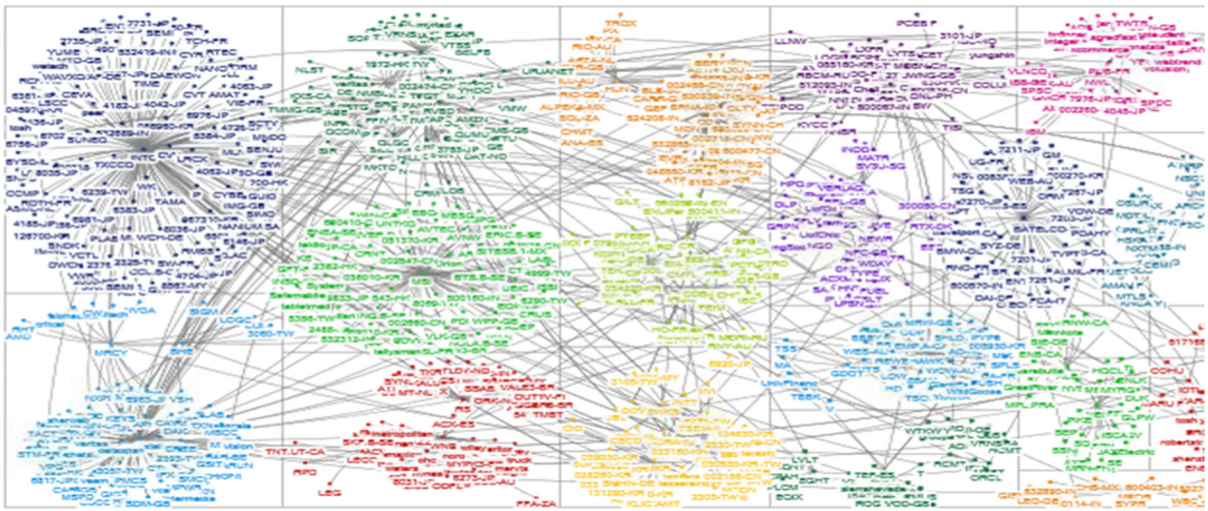


Figure 5. Sample Visualization using NodeXL

3.4 Defense Technical Information Center Repository

While not strictly a single capability or asset, the Defense Technical Information Center (DTIC) provides access to research and guidance that may be relevant to DLA decision makers on a variety of topics including supply chain security and resilience. As listed on their webpage (discover.dtic.mil/about/), DTIC's mission is,

> "to aggregate and fuse science and technology data to rapidly, accurately, and reliably deliver the knowledge needed to develop the next generation of technologies to support our Warfighters and help assure national security."

Other major capabilities provided by DTIC include supporting DoD efforts:

> "to mitigate new and emerging threat capabilities… by:
>
> - Preserving and disseminating the research that led to the technologies our warfighters use today;
> - Delivering the tools and collections that empower the research and engineering enterprise to accelerate the development of technologies that will help maintain our nation's technical superiority;
> - Stimulating innovation by providing access to DoD-funded research and digital data to the public and industry; and
> - Maximizing the value of each dollar the DoD spends through the analysis of funding, work-in-progress, and Independent Research and Development (IR&D) data to identify gaps, challenges and way forward."

More than half of DTIC's information is available via a Common Access Card login and their R&E Gateway. A survey of potentially related information included the following pieces of thought capitol:

1. ***Exploratory Analysis of Supply Chains in the Defense Industrial Base***
    a. https://apps.dtic.mil/dtic/tr/fulltext/u2/a560124.pdf

2. ***Logistics as a Competitive Warfighting Advantage***
    a. https://apps.dtic.mil/dtic/tr/fulltext/u2/1020304.pdf

3. ***Supply Chain Attack Framework and Attack Patterns***
    a. https://apps.dtic.mil/dtic/tr/fulltext/u2/a610495.pdf

Although it does not provide a relevant production-ready capability, the Defense Technical Information Center should be searched and reference periodically by DLA decision makers and Supply Chain Security officers to ensure that specific topics of interest are sufficiently researched and best practices and/or findings from related research can be utilized within DLA.

4.0 Recommended Implementation Plan Changes

During the original Vendor Network Mapping Capability pilot, recommendations were made regarding four major production components: (1) Data Sources/Volume, (2) Data Refresh Rate, (3) Visualization Capability, and (4) Technical Architecture. Each major area was discussed along with recommendations and rationales for each choice. After completion of the VNMC follow-on effort, new developments within DLA have been discovered which alter the recommended Visualization Capability provided during this previous assessment. All other recommendations, however, remain consistent.

The previous recommendation was to "either **utilize J6** or **contract through the WSSP** for the Visualization Capability depending on the scope of data available and program goals."

The new recommendation is to "utilize **J6 to adapt existing dashboards** and screens within Business Decision Analytics and their Vendor Network Mapping dashboards to provide desired VNMC functionality."

This new recommendation is founded upon the recent development of a Vendor Network Mapping dashboard within the production Business Decision Analytics suite. The BDA suite is a production capability providing acquisition specialists, technical quality users, and others with actionable enterprise data. The development of a Vendor Network Mapping dashboard, as described in previous sections, provides an enterprise location for loading linkage data. Although this dashboard is currently used to analyze known fraud networks, VNMC pilot dashboards can be loaded to this area and ingest commercial linkage data.

An additional consideration for utilizing this approach is that a more user-friendly visualization view may be required to provide actionable results. The existing visualization type does not easily show tiers of supply chains and it is recommended that a Sankey Diagram (also known as a flow diagram) be utilized as demonstrated in the VNMC pilot. This specific type of visualization is not currently supported by standard Qlik Sense views and may require that a custom extension be utilized. Note that using this type of visualization is key to functional analysis of multi-tier data and commercial third-party data should not be acquired before setting up this type of view. Without such a visualization, it may be difficult or impossible to properly use ingested data in an actionable manner.

In lieu of providing a complete transcript of recommendations from the VNMC Final Report, only modified sections (based on this new development) are copied in subsequent sections for reference.

4.1 Visualization Capability

One of Vendor Network Mapping Capability's (VNMC) largest impacts and value adds to DLA will originate from its ability to quickly and accurately display supply network risk data in an easy-to-use format. Ideally, such a capability will be intuitive enough to be fully integrated into DLA end users' day to day decision-making processes and help increase their efficiency and reduce related time to award activities. A good capability would also be one that is directly tailored to primary users' needs with minimal extraneous complexity or additional analytical work on the user's end. Finally, such a capability should be supported by DLA's existing framework and software rollouts to ensure that the tool is up-to-date and has continued technical support. The following options cover various options DLA has for how to operationalize network relationship data and network risk data with visualization tools.

4.1.1 J6-Produced Qlik Sense Dashboards

4.1.1.1 Description: Qlik Sense is currently being deployed as DLA's enterprise visualization tool. As part of this effort J6 Information Operations is collecting use cases across a variety of process areas and attempting to produce re-useable assets for DLA employees. DLA has the option to leverage its existing access to Qlik Sense Enterprise to have J6 resources create VNMC analysis views within this tool. Additionally, J6 can choose to modify and/or update existing Qlik Sense dashboards (including the VNMC tool within BDA) to load VNMC pilot dashboards and data.

4.1.1.2 Advantages – J6-Produced Qlik Sense Dashboards

DLA may utilize the widespread rollout of Qlik Sense as an enterprise view over the next several months as a method for developing network risk analysis dashboards. Advantages of utilizing this type of visualization capability for VNMC include:

- **Internal DLA Support for Qlik Sense** – Qlik Sense has been chosen as DLA's enterprise visualization tool and will be the focus of internal training and support over the duration of the product's rollout. By removing the various disparate data visualization tools previously used across the enterprise, there will be a large emphasis on understanding how to use the tool and share information across DLA. This emphasis will also likely mean that internal support for the tool's functionality and development will be available through traditional Help Desk means.
- **DLA Custom Visualizations** – The use of Qlik Sense would give DLA a robust and customizable dashboard and reporting tool and let the enterprise tailor distinct views for relevant users. As a result of the J6 effort to collect and build re-usable dashboard views, appropriate Technical Quality views may be developed which could ingest network data.
- **Internal Data Access and Sharing** – By utilizing DLA's enterprise tool, resources will be able to leverage any accessible data stored in the Enterprise Data Warehouse and will more easily be able to share customized views or analysis results within the network. The internal nature of the data storage and manipulation capabilities will also prove an extra level of data and network security.
- **Existing Avenue for Production Deployment** - Given that multiple Qlik Sense dashboards are currently in enterprise use, J6 can modify and/or update these dashboards to incorporate views developed during the VNMC pilot and to add new data as needed.

4.1.1.3 Disadvantages – J6-Produced Qlik Sense Dashboards

By choosing to develop a Qlik Sense dashboard internally, DLA will require separate internal sources of expertise for all functional aspects of network risk analysis. Disadvantages of utilizing this type of visualization capability for VNMC include:

- **DLA Qlik Subject Matter Experts Required** – One trade-off of utilizing the J6 capability is that DLA would need to dedicate subject matter experts within J6 Information Operations to the development and maintenance of custom Qlik Sense dashboards for network analysis. If such users are not available, or otherwise occupied by the enterprise-wide rollout, DLA may have to look externally for this help or spend the time and resources to train another employee.
- **Lack of Vendor Network and Risk Analysis Expertise –** While a Network Risk Analysis dashboard may be developed internally by J6, this does not guarantee that DLA will have the SCRM subject matter experts required to understand the nuances to analyzing network risk nor the project background to create relevant dashboard views.

4.1.2 Visualization Capability – Recommendation: J6 Developed Qlik Sense Dashboards

4.1.2.1 Summary: One of Vendor Network Mapping Capability's (VNMC) largest impacts and value adds to DLA will originate from its ability to quickly and accurately display supply network risk data in an easy-to-use format. Ideally, such a capability will be intuitive enough to be fully integrated into DLA end users' day to day decision-making processes and help increase their efficiency and reduce related time to award activities. A good capability would also be one that is directly tailored to primary users' needs with minimal extraneous complexity or additional analytical work on the user's end. For these reasons, it is recommended that DLA build the Vendor Network Mapping Capability via the **existing Business Decision Analytics dashboards**, and specifically the Vendor Network Mapping pages built for fraud network analysis. However, it is recommended **that J6 explore the possibility of utilizing a Sankey/Flow Diagram** for vastly improved user interaction and functionality.

4.1.2.2 Recommendation: It is recommended that DLA utilize **J6 to Develop Qlik Sense Dashboards** for its Visualization Capability. In the case that limited (or internal-only) data is available for this program, it may be the most cost-effective option to use those visualizations already developed during the VNMC pilot and any new dashboards developed by J6 as a starting point. Additionally, modifications can be made to existing production dashboards, including the VNM dashboard created for this purpose, to enable VNMC functionality. Over time, more J6 resources will be skilled with the chosen visualization tool and this may make in-house development more readily achievable. However, if there is a lack of in-house availability and/or a larger set of available data (such as third-party Tier-N data), it may be advantageous to utilize the skillsets of subject matter experts to rapidly develop new visualizations.

4.1.2.3 Rationale for Exclusion of Other Options: The other Visualization Capability options and a rationale for why they were not recommended is included below:

- **No Visualizations** – Work conducted during both the feasibility phase (VNLA) and pilot phase (VNMC) of this effort have concluded that network data is best analyzed and summarized utilizing visualization tools. The underlying network (node-link) data is dissimilar from traditional relational databases and does not lend itself to normal querying. It is highly recommended that DLA utilize some form of visualization approach for VNMC to be successful.
- **Web-Based Third-Party Tableau Dashboards –** The web-based Tableau dashboards provided as part of the pilot VNMC effort were useful as a quick first look, but ultimately not customized to the types of analyses that DLA end users would want. For example, certain boilerplate analysis variables were included which are not relevant to DLA as a business such as 'Congo risk', or the risk a company is doing business or sourcing materials from the Congo. Additionally, DLA J6 Information Operations is attempting to move away from disparate data visualization tools and licenses, instead hoping to move all DLA visualizations to Qlik Sense. Another deterrent for this option is the fact that it is hosted on the web and as such would be hosting data that is sensitive to DLA externally.

5.0 Business Case Analysis

Traditional Business Case Analyses (or Benefit-Cost Analyses) aim to quantify the cost of building or procuring a capability against the expected financial benefit to be gained by implementing such an activity. However, when analyzing the impact of Supply Chain Security (SCS) or Supply Chain Risk Management (SCRM) capabilities, the overall impact of a capability can be hard to estimate. This is due to the fact that instances of fraud, supply chain disruption, or disaster are practically impossible to predict. Additionally, most supply chain security capabilities, including VNMC, are risk reduction capabilities as opposed to cost reduction capabilities. Despite this fact, Supply Chain Security capabilities are nonetheless an important part of enterprise supply chain operations and can have a significant impact when used to identify potential fraud and mitigate the risk of supply chain disruptions. DLA's Director recognizes the importance of SCS and SCRM capabilities and has outlined his plan for approaching these topics in his Supply Chain Security Strategy (an Appendix to the Director's 2018-2026 Plan). In this document, Director Williams states that,

> *"DLA's mission is to sustain Warfighter readiness and lethality by delivering proactive global logistics in peace and war. Maintaining and effective supply chain security posture through Supply Chain Risk Management (SCRM) is fundamental to the Agency's ability to meet it's mission. It is within the threat spectrum captured above that DLA must innovate to strengthen operational resiliency in support of the Warfighter. DLA must continuously identify, assess, report, and mitigate threats, vulnerabilities, and disruptions to its Global Supply Chain. DLA's end state is to establish an enterprise architecture that comprehensively addresses supply chain security challenges. An architecture that evolves as new threats emerge, one that endures the test of time and provides uninterrupted support to the Warfighter."*

The Director is also aware of the pilot VNMC effort that has been demonstrated and has mandated the program's integration into production use within his Strategic Focus #3, 'Partner with Reputable Vendors.' In this section of guidance, the Director lists actions that will enable DLA to better prevent counterfeit and non-conforming parts, including instruction to:

> ***"Integrate Business Decision Analytics and Vendor Network Mapping into acquisition strategies"***

This guidance is an important step in the right direction, but a production-ready application will still require decision-makers to weigh the potential cost of third-party data and a balance of cost versus coverage (i.e. how many suppliers do we acquire multi-tier data for?) when negotiating with suppliers. Although no cost estimates were provided by researched companies during this effort, a rough order of magnitude estimate for multi-tier (3 tiers from DLA) data can be expected to cost around two-thousand dollars per vendor's supply chain. This estimate is based off of the cost to license data during VNMC pilot phases, however economies of scale likely exist and will have to be discussed in more detail with vendor companies. Additionally, the cost of integrating a solution into DLA's production environments will carry some cost, although options such as leveraging J6 to perform integration and enhancement work may help drastically mitigate those costs as well. In an effort to better assist decision makers in their acquisition strategies for third party data, an

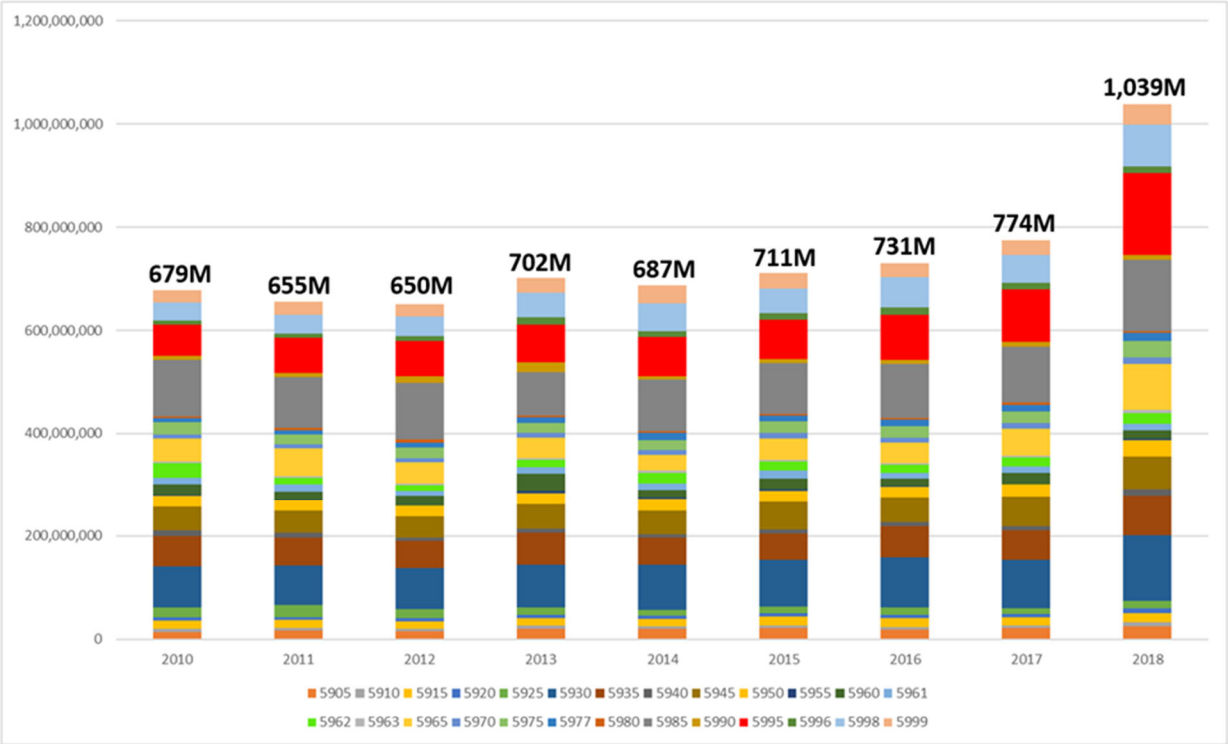
analysis of relevant stock is provided below. This analysis summarizes the impact of procuring data for 100 DLA suppliers of FSG 59 (Electrical and Electronic Components), split into coverage by dollar amount, item quantity, and number of awards.

5.1 Analysis of Relevant Stock

The Vendor Network Mapping Capability is a risk reduction capability, not a cost saving capability. As such, it is difficult to estimate the dollar value of the cost avoidance provided by reducing the risk of a given supply chain disruption or fraud activity. Instead, it may help to understand the value of assets expected to be protected in some form or function by the development of such a risk reduction capability. This section will provide an analysis of eight complete calendar years' (from calendar year 2010 through 2018) worth of some of DLA's most at-risk components, those in Federal Stock Group (FSG) 59 – Electrical and Electronic Components.

Federal Supply Group 59 includes twenty-six Federal Supply Classes, with FSC 5985 (Antennas, Waveguides, and Related Equipment), FSC 5930 (Switches), and FSC 5995 (Cable, Cord, and Wire Assemblies) representing over thirty-eight percent of all expenditures in this group. Overall, spending within this group has increased significantly in recent years, going from $774 million in 2017 to more than $1B in 2018. A summary of expenditures for each calendar year, broken down by FSC, is shown below.

Table 25. Sum of FSG 59 Supply Classes (CY10-18)



Some supply classes, such as FSC 5961 (Semiconductor Devices and Associated Hardware) and FSC 5962 (Electronic Microcircuits) have special protections in place already, but these components only represent about four percent of DLA's expenditures in this class and may still require additional supply chain intelligence to ensure safeguarding.

One example demonstrating the importance of protecting FSC 5962 found that a single microcircuit NSN supports one hundred and fifty-eight different weapons systems. This specific NSN has a Weapons System Essentiality Code of '1', indicating that failure of this component could compromise the integrity of the entire weapons system. A single counterfeit or non-conforming microcircuit can potentially impact the reliability of critical weapon systems, as well as personnel safety. A further consideration with this example is that the part in question costs about one hundred dollars per unit. This demonstrates that strictly analyzing FSC importance by per-unit cost is not an acceptable metric. In an effort to address this fact, procurement data from FSG 59 was further analyzed by supplier and their overall coverage of the supply group by three measures: total value of awards, total quantity of components, and total number of awards.

If supply chain data is to be procured (or collected internally by DLA), it will be useful to understand what coverage can be expected from obtaining this data for a specific number of suppliers. As such, a summary analysis of the available eight-years' worth of procurement data was developed, showing overall coverage by the 'Top X' number of suppliers and the percentage of total procurement value, procurement quantity, and procurement count.

Table 26. Coverage of FSG 59 by Top Suppliers by Metric

	FSG 59 Procurement Value	**FSG 59 Procurement Quantity**	**FSG 59 Procurement Count**
Top 50 Suppliers	33.6%	52.3%	42.7%
Top 100 Suppliers	47.0%	66.8%	56.3%
Top 150 Suppliers	55.8%	75.4%	64.4%
Top 200 Suppliers	62.1%	81.0%	69.7%
Top 250 Suppliers	67.4%	84.8%	73.6%

As shown above, the top 100 suppliers in each discrete category (value, quantity, and award count) represent approximately half or more of all DLA coverage in that area for FSG 59. This means that by understanding supply chain risks for the top 100 suppliers within each category, DLA can mitigate that risk for roughly half or more of all components obtained. Additionally, by examining component quantity specifically, we can see that 250 suppliers provide roughly 85 percent of all the components obtained by DLA. However, it should be noted that the largest suppliers of components to DLA (by any metric) tend to be the most trusted. Therefore, the supply chain security strategy should ideally combine a mixture of enterprise coverage (i.e. understand the majority of the supply base) and special targeting of trouble suppliers (i.e. understand where risks may exist for suspicious and/or special case suppliers). Additionally, programs such as the DLA

Land & Maritime Counterfeit Detection and Avoidance Program can be put in place to add extra layers of protection for specific part classes – in this case FSC 5962, Electronic Microcircuits.

In total, awards under FSG 59 have been made to approximately 6,000 unique companies over the past eight calendar years. However, roughly 2,000 of those suppliers averaged fewer than one award per year. DLA decision-makers are urged to collaborate with functional users to blend together a data acquisition strategy that balances coverage and suspect (or unproven) component providers. Analyses such as the one presented here today should focus on what aspects leaders believe are most important to invest in. In this instance, these three metrics provide the following rough benefits:

1. **Procurement Value:** Understand what total value of actual components (and potential re-procurements) DLA is protecting by understanding risk in the supply base of components.

2. **Procurement Quantity**: Understand the physical number of systems, readiness, and availability of weapons systems by understanding risk in the supply base of components.

3. **Procurement Count:** Understand the potential burden of reviewing individual procurements or of re-procuring components, based on risk in the supply base of components.

By hosting discussions with end-users and procurement specialists, decision-makers can determine what data analysis approach makes the most sense for DLA as a whole. It is recommended that a more thorough analysis be conducted based on metrics (and suppliers) of interest, and that this information guide decisions related to the third-party data acquired as a mitigation strategy. This approach can also help DLA determine which suppliers (if any) data should be collected for internally and how risk can best be mitigated moving forward, whether by risk assessment capabilities or new procurement requirements.

Appendix A - Glossary of Terms

AFS – Accenture Federal Services
BCA - Business Case Analysis
BDA – Business Decision Analytics
CAGE – Commercial and Government Entity
CDAP - Counterfeit Detection and Avoidance Program
CMUPS - Counterfeit Mitigation Unauthorized Product Substitution
DARPA - Defense Advanced Research Projects Agency
D&B – Dun & Bradstreet
DCIS – Defense Criminal Investigative Services
DLA - Defense Logistics Agency
DMEA - Defense Microelectronics Activity
DoD - Department of Defense
DTIC - Defense Technical Information Center
DUNS – Data Universal Number System
EBS – Enterprise Business Systems
ECC - Enterprise Central Component
EDW – Enterprise Data Warehouse
FAQ – Frequently Asked Questions
FSC - Federal Supply Class
FSG - Federal Supply Group
GAO – Government Accountability Office
HANA - High-Performance Analytic Appliance
ICT - Information and Communication Technology
IT - Information Technology
KO - Contracting Officer (Procurement)
LBD - Logic-Bearing Device
MDA - Missile Defense Agency
NAICS – North American Industry Classification System
NDAA - National Defense Authorization Act
NIIN - National Item Identification Number
NIPRNet - Non-Classified Internet Protocol Router Network
NPGS - Naval Postgraduate School
NSA - National Security Agency
NSS - National Security Systems
ODASD(SE) - Office of the Deputy Assistant Secretary of Defense for Systems Engineering
OEM – Original Equipment Manufacturers
OSD - Office of the Secretary of Defense
PDF – Portable Document Format
PTC - Product Test Center
QSLD – Qualified Suppliers List of Distributors
R&D – Research and Development
SCRI - Supply Chain Risk Indices
SCRM - Supply Chain Risk Management
SCS – Supply Chain Security

SER – Supplier Evaluation Risk
SIC – Standard Industrial Classification
SME – Subject Matter Expert
SRM - Supplier Relationship Management
SSIC – Supplier Stability Index Code
TAPO - Trusted Access Program Office
TQ – Technical Quality
USN – United States Navy
VNLA – Vendor Network Linkage Analysis
VNM – Vendor Network Mapping
VNMC - Vendor Network Mapping Capability
WSSP - Weapons System Sustainment Program