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AFITC 2019

Data Driven Business and Logistics Mission Resilience: PEO BES Interoperability Analysis

Dr Vivian L Martin, MITRE

Jim Barker, MITRE

Jim Dalton, MITRE

Michael Ahern, MITRE

Adia Foster, MITRE

Alex Brannon, MITRE

Collaboration team:

Connie Baggett, AFLCMC/HIQC

Austin Bartolo, AFLCMC/HIG

Jennifer Branton, AFLCMC/HICE

Keyania Brown, AFLCMC/HIBE

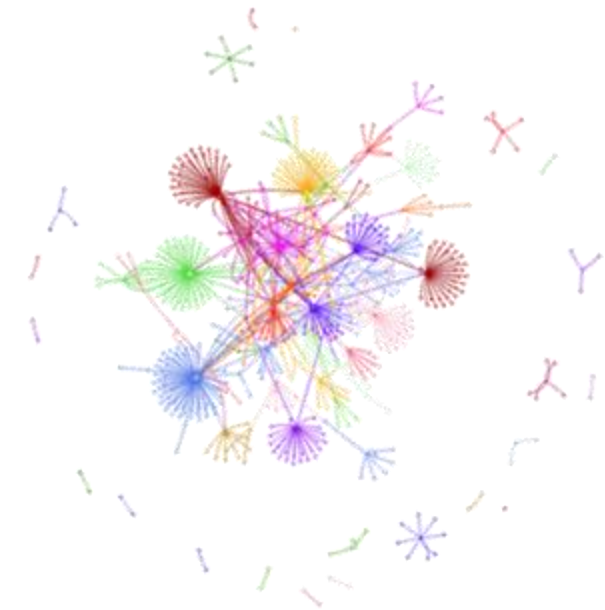
Stanley Brown, AFLCMC/HIO

2d Lt Samantha Ferguson, AFLCMC/HIZA

Dave Story, AFLCMC/HIO

Ernest Kelley, AFLCMC/HIT

Anthony Tamasi, AFLCMC/HIE



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Data Driven Business and Logistics Mission Resilience: Synopsis

- **The AF's collection of information systems reflects the complexity and pace of the AF mission.**
- **Agile software engineering approaches help meet the need to be responsive with solutions, but what tools specifically aid in the comprehension of the AF's vital patterns of information dissemination?**
- **Data about the applications leads to an understanding of mission resilience and cyber vulnerability when complexity science, graph theory, and emergent methods are applied.**
- **This AFITC presentation provides a learning opportunity for applying science, theory, and method to contend with system-of-systems qualities that traditional software design and operation do not.**



Overview

- **Comprehending Information Dissemination in the Air Force**
 - Creating a Digital Air Force
 - Comprehending Information Dissemination in the Air Force: Documentation and Reality
- **Data Driven Digital Air Force: Where to Look for Tools**
 - Complicated or Complex?
 - Graph Theoretics
 - Emergent Methods
- **Creating a Digital Tipping Point**
 - Six Management Questions to Answer
 - Five Ways to Apply a Better Understanding
- **Example cases from PEO BES Interoperability Analysis**
 - Metrics and Comparisons for Centrality and Resilience
 - BES Command and Control
 - Disparate Data and Cosine Similarity
- **Summary**
- **Question and Answer**



U.S. AIR FORCE

Creating a Digital Air Force

“Data will power next-generation combat, so the Air Force must control and manipulate massive volumes of information to out-think and out-maneuver its opponents. The “Digital Air Force” initiative will ensure all Airmen have uninterrupted access to the data they need, where and when they need it.”

Quote Excerpted from Preface:
Message from the Under Secretary of the Air Force
Matthew P. Donovan

Source: <https://www.af.mil/Portals/1/FY19-21%20Air%20Force%20Business%20Operations%20Plan.pdf?ver=2019-03-04-103108-653>

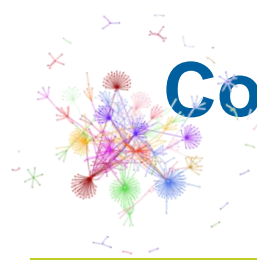


▶ **Sharpening the Air Force's Competitive Edge**
A Business Operations Plan

Fiscal Years 2019-2021
January 2019

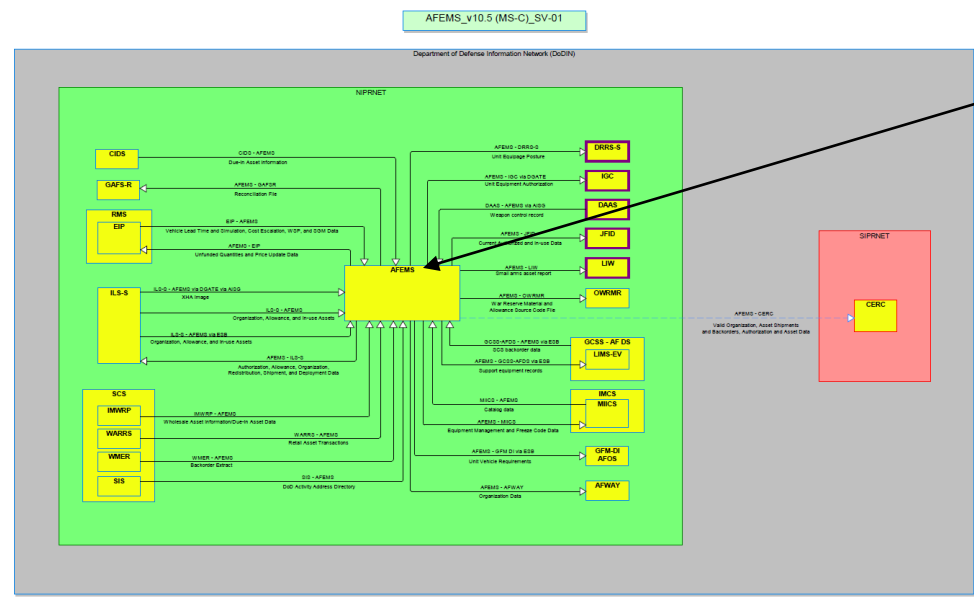
Managing a Digital Air Force: Looking for Tools

- **Information Dissemination: Data on the Move**
- **Digital Twin: System-of-Systems Behavior**

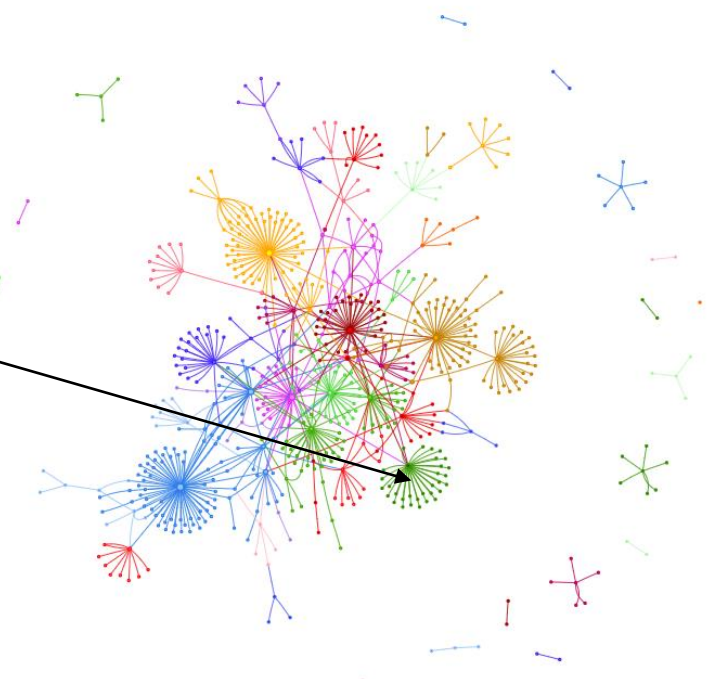


Comprehending Information Dissemination in the Air Force: Documentation and Reality

Context Diagram (aka spider diagram, SV-1)
Boundary of a single system restricts comprehension
End-to-End Mission Under-represented



AFEMS



Information Dissemination: Data on the Move
Digital Twin: System-of-Systems Behavior
Reality *and* Future State

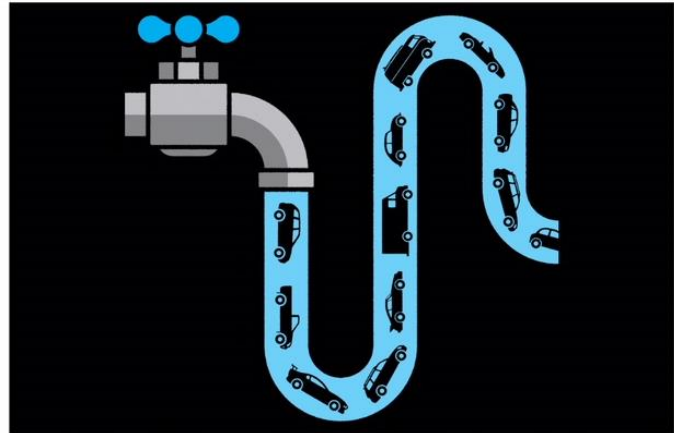
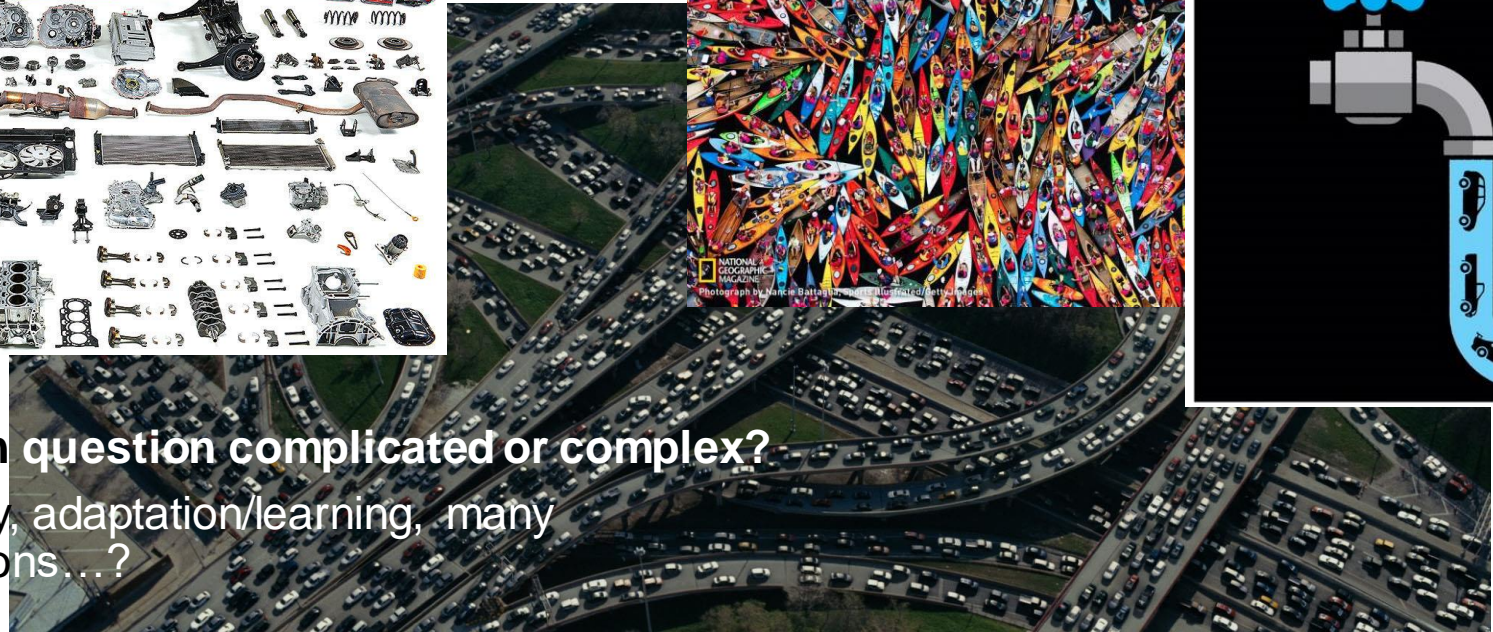
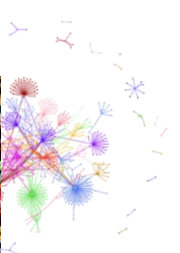
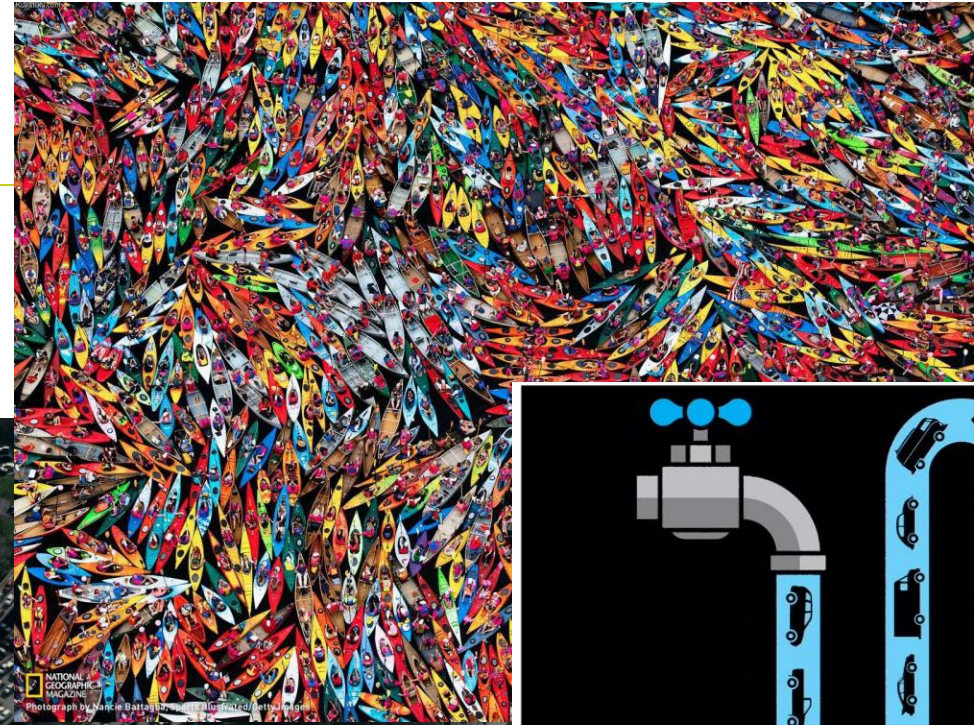
Where are the vital patterns of information dissemination? A view we need to appreciate with tools and methods.



Data Driven Digital Air Force: Where to Look for Tools

- **Complicated or Complex?**
- **Graph Theoretics**
- **Emergent Methods**

Complicated or Complex? Systems of Systems



- **Is the system in question complicated or complex?**
 - Heterogeneity, adaptation/learning, many interconnections...?

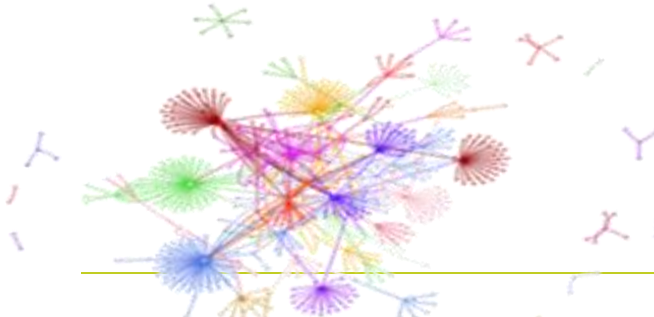
Unhappy Lexus by: <http://lexusenthusiast.com/images/weblog/14-03-31-lexus-ct-200h-disassembled.jpg>

Kayak traffic by: http://www.i-am-bored.com/bored_link.cfm?link_id=97089

Vehicle traffic by: http://h30499.www3.hp.com/t5/HP-Security-Products-Blog/Traffic-jam-Big-data-and-security-analytics/ba-p/6295539#.U9kISFb_zj8

Go with the flow traffic by: https://www.wsj.com/articles/going-with-the-flow-of-traffic-1541612159?emailToken=2176a0f855ca5c7c7e41275571248c489x54OkBKKTyFoIGuHOCKiPeikrUOtZGRfBtBXAi3W8ZjYyI4JaBCjDzfHp9/fPnFo+Sr2m9vjj0Rv2su81gw%3D%3D&reflink=article_imessage_share

Graph Theoretics: A Basis for Measurement

- 
- ***“In mathematics, graph theory is the study of graphs, which are mathematical structures used to model pairwise relations between objects. A graph in this context is made up of vertices (also called nodes or points) which are connected by edges (also called links or lines).”***

https://en.wikipedia.org/wiki/Graph_theory

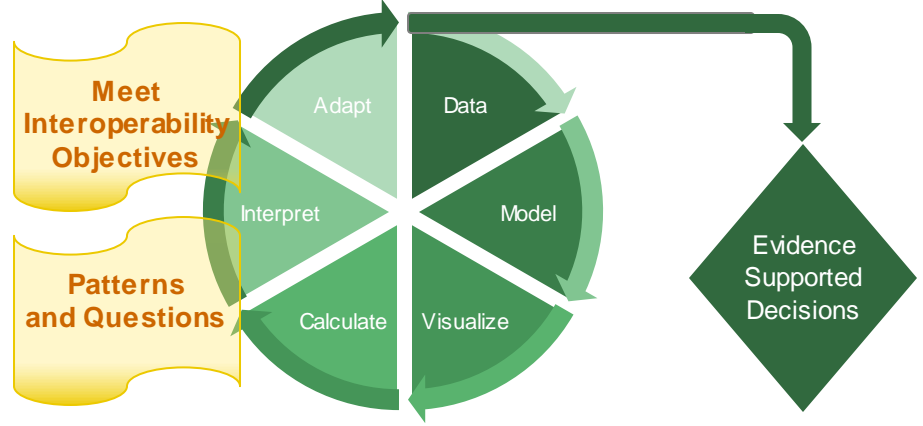
- ***“In graph theory, betweenness centrality is a measure of centrality in a graph based on shortest paths. For every pair of vertices in a connected graph, there exists at least one shortest path between the vertices The betweenness centrality for each vertex is the number of these shortest paths that pass through the vertex.”***

https://en.wikipedia.org/wiki/Betweenness_centrality

Graph Theory supplies measures of information dissemination that allow gauging a given system’s importance in its ecosystem and the resilience of the ecosystem.

Emergent Methods: Template for Iteration

- **Sprint Template Concept is cross between Agile Software Development practice, scientific experiment journal, Model-based System Engineering**
 - Key to Emergent Methods: You start somewhere (Charmaz, 2008; Epstein 2006)
- **Documents journey of questioning through refinements of models**
 - Reproducible and open science (Arribas-Bel et al, 2017)
 - Designed to adapt to OODA Loops
- **Templating ensures that sprint results are adequately captured, described, evaluated, and reproducible, a significant first step in creating a repeatable process.**



Sprint # and Title

- I. Background of Inquiry
- II. Abstract of Sprint Intentions
- III. Data: Scope and Questions
- IV. Models 1-n, Observations
- V. Validation
- VI. Sprint Observations
- VII. Discussion of Evaluative Conclusions
- VIII. Evaluation of analysis method and results
 - ✓ Going somewhere, Probably not useful, Is better than last time
- IX. Improvement opportunities, critique of visuals and communication



Creating a Digital Tipping Point: Connecting Method with Management and Decision Making

■ Examples of Connecting Method and Situations

- Through Questioning: Six Often-Asked IT Management Questions
- Through Analysis Category: Five Ways to Apply a Better Understanding

-Lofty Goal 1-

Create a cadre of decision makers armed with digital, decision-making tools.

-Lofty Goal 2-

**Link to existing implementations and existing data sources.
Architect for sensing.**



Six Often-Asked IT Management Questions: Opportunities for Application

- **What IT assets should have the most, and which, cyber protections?**
- **What spread of applications across hosting and service providers protects key operations?**
- **How does a PM intercept or predict incidents before they impact mission?**
- **What is the health of the Digital Air Force right now? Are we ready?**
- **How does a PM roll out which software features or components when?**
- **How to combine or separate system features for efficient and effective IT solutions?**

Analysis suited to the complexity of a system of systems fed by actual systems data



Five Ways to Apply a Better Understanding

- **Analyze and Compare. Models for analytical and comparative purposes**
 - E.g., cloud migration and ERP strategies for SAF/MG, PEO BES, other PEOs
- **Enterprise Data. Models for enterprise data exploitation**
 - E.g., indicate and prioritize enterprise data for CDO, PEO contributing data pilots
- **Cyber Resilience. Trade-off analysis in cyber scenarios**
 - E.g., system vulnerability leads to mission vulnerability for A-4, A-1, etc.
- **IT Command and Control. System-of-Systems Operation and Management**
 - “digital twin”-- a dynamic and virtual model that behaves like the real thing because it is fed a lot of sensor data from the real thing for PEOs, mission owners, and operators
- **Enterprise IT Investment**
 - E.g., match funding levels with characteristics of system performance for good stewardship

Investment decisions driven by analysis fed by actual systems data



Example cases from PEO BES Interoperability Analysis

- **Metrics and Comparisons for Centrality and Resilience**
- **BES Command and Control**
- **Disparate Data and Cosine Similarity**

Spec Sheet

PEO BES Interoperability Analysis with Graph Theory: Metrics and Comparisons for Centrality and Resilience

MITRE Team

Dr Vivian L. Martin (PI)

Jim Barker (Project Lead)

Laura Antul (Graph Theoretic Plug In)

Jim Dalton (Cloud Migration Comparison)

Michael Ahern (Intern, University of Alabama)

Current Features

Graph of BES and its partner systems

Cluster by color and centrality by node size

Zoom with system acronyms and ID summaries

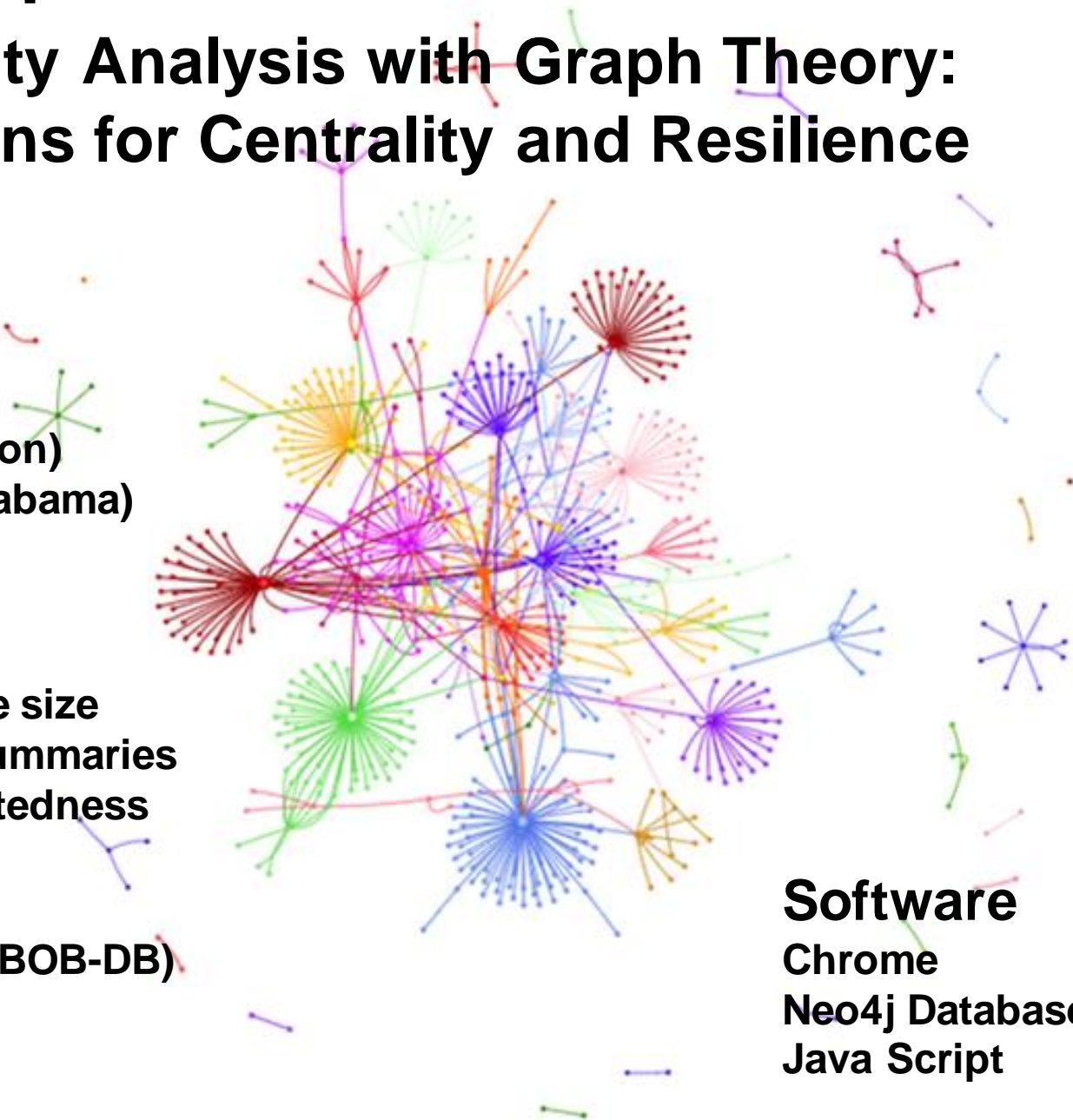
Click and drag motion reflects connectedness

Data Source

BES Operational Baseline - Database (BOB-DB)

649 Systems/Subsystems

760 Interfaces



Software

Chrome

Neo4j Database

Java Script

Spec Sheet

PEO BES Interoperability Analysis with Graph Theory: BES Command and Control

MITRE Team

Adia Foster, Intern

Jim Dalton, T885

Jim Barker, P491

Dr Vivian L. Martin, P491

Current Features

Graph of BES and its partner systems

Zoom with system acronyms and ID summaries

Time series data of system incidents, color coded

Animation of incidents in time series

Pause of animation for risk assessment

GUI for status data import

Data Source

BES Operational Baseline - Database (BOB-DB)

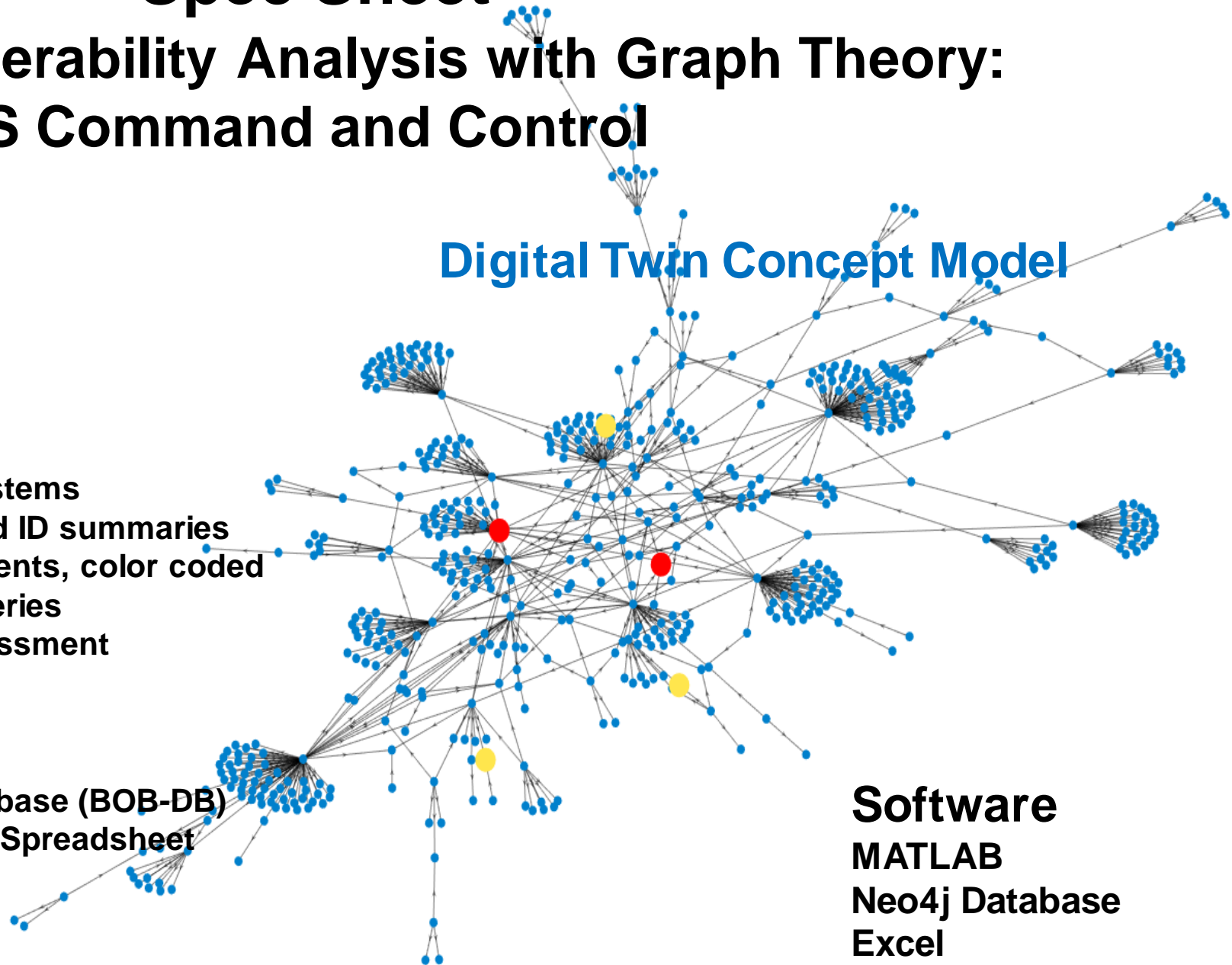
BES Daily Incident Management Spreadsheet

649 Systems/Subsystems

760 Interfaces

156 Days of Status Data

Digital Twin Concept Model



Software

MATLAB

Neo4j Database

Excel

Spec Sheet

PEO BES Interoperability Analysis with Graph Theory: Disparate Data and Cosine Similarity

MITRE Team

Alex Brannon, Intern

Jim Dalton, T885

Jim Barker, P491

Dr Vivian L. Martin, P491

Current Features

Cosine similarity of acronyms from two sources

Listing of cosine similarity measures

Data Source

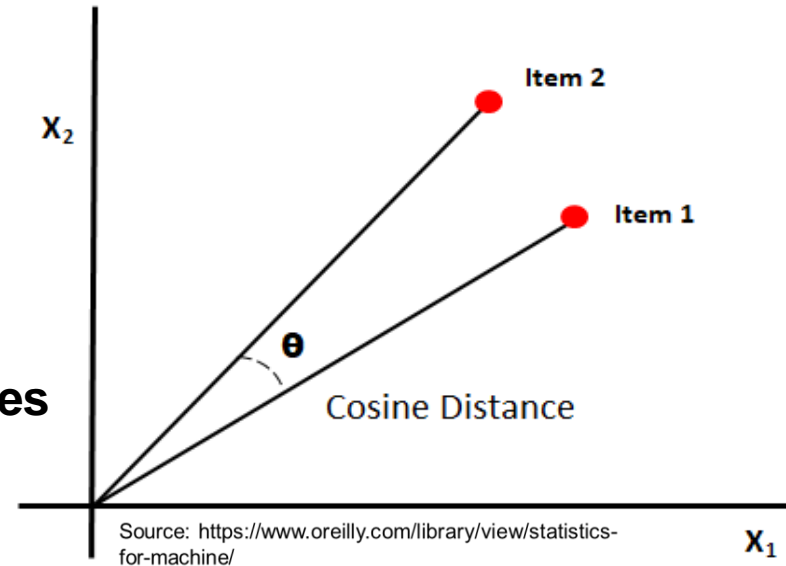
BES Operational Baseline - Database (BOB-DB)

2019 BES Reference Guide

649 Systems/Subsystems

760 Interfaces

Cosine Distance/Similarity



$$\text{similarity} = \cos(\theta) = \frac{\mathbf{A} \cdot \mathbf{B}}{\|\mathbf{A}\| \|\mathbf{B}\|} = \frac{\sum_{i=1}^n A_i B_i}{\sqrt{\sum_{i=1}^n A_i^2} \sqrt{\sum_{i=1}^n B_i^2}}$$

	left_side	right_side	similarity
9	CSMS DE	CSMS DE 2	0.813257
10	CSMS DE	CSMS DE 1	0.813257
77	ATSG/M024B	ATSG/M024	0.930469
100	GFM-DI AFOS	GFM-DI AFOS-SIPR	0.811955
167	AFDS	AF-DSS	0.865678
168	AFDS	AFDSS	0.865678
171	AFDSS	AFDS	0.865678
174	AF-DSS	AFDS	0.865678
201	ATSG/M024	ATSG/M024B	0.930469
216	AROMS	AROMS-R	0.841551
219	AROMS-R	AROMS	0.841551
248	CDAS (FDCCI-DC-43687)	CLASS (FDCCI-DC-43687)	0.808629
263	CLASS (FDCCI-DC-43687)	CDAS (FDCCI-DC-43687)	0.808629
282	CSMS DE 1	CSMS DE	0.813257
284	CSMS DE 1	CSMS DE 2	0.801597
285	CSMS DE 2	CSMS DE	0.813257
285	CSMS DE 2	CSMS DE 1	0.801597
408	DMSI Q302 DMCODB	Q302 DMSI DMCODB	0.833199
495	GFM-DI AFOS-SIPR	GFM-DI AFOS	0.811955
589	Lockheed GA C-130	Lockheed GA C-5	0.823548
591	Lockheed GA C-5	Lockheed GA C-130	0.823548
598	NBSM	NBSM-I	0.915999
600	NBSM-I	NBSM	0.915999
655	Q302 DMSI DMCODB	DMSI Q302 DMCODB	0.833199

Software

Python

- Textract

- Sparse_dot_topn

Neo4j Database

Summary

■ Managing a Digital Air Force

- Information Dissemination: Data on the Move
- Digital Twin: System-of-Systems Behavior
- Characterizing and Measuring the Ecosystem: Reporting >>> Sensing

■ Where to Look for Tools

- Complexity Sciences
- Graph Theory
- Generative Methods

■ Contend with System-of-Systems Qualities that Traditional Software Design and Operation Do Not

-Lofty Goal 1-
Create a cadre of decision makers
armed with digital, decision-making
tools.

-Lofty Goal 2-
Link to existing implementations
and existing data sources.
Architect for sensing.

Impact --- Change what is and measure it

Q & A

“Imagine how hard physics would be if electrons could think”

Murray Gell-Mann

“You can’t manage what you don’t measure.”

Peter Drucker

Debatable advice? ... Just Google this quote

“It ain’t what you don’t know that gets you into trouble. It’s what you know for sure that just ain’t so”

Mark Twain (maybe)

<https://quoteinvestigator.com/2018/11/18/know-trouble/>

“Anything can be measured. If something can be observed in any way at all, it lends itself to some type of measurement method.”

Douglas W. Hubbard

Managing what you don’t understand is really hard

Further Reading

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