



Application of Network Visualization to Identify Gaps in Complex Information System Architectures

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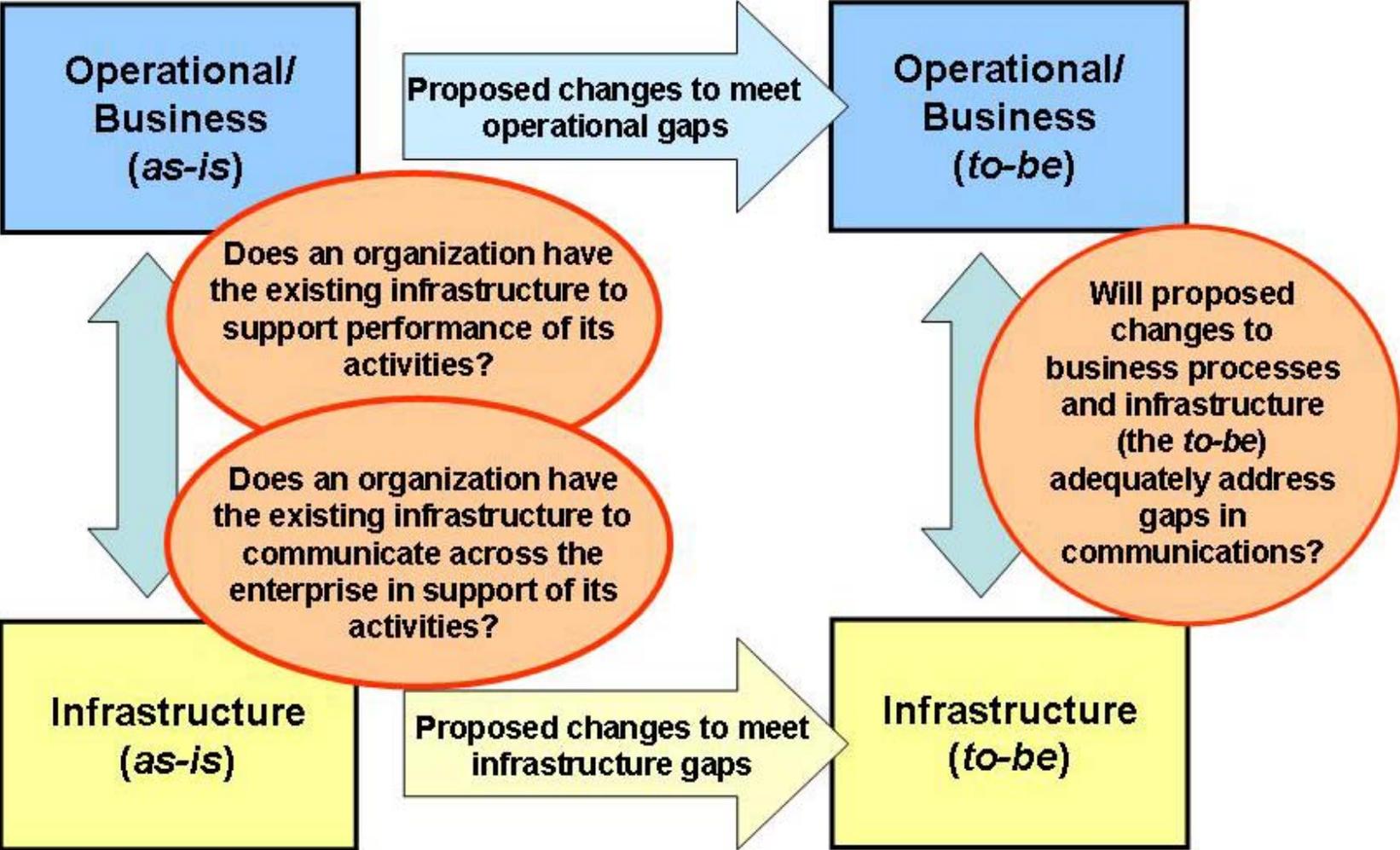
13 May 2008

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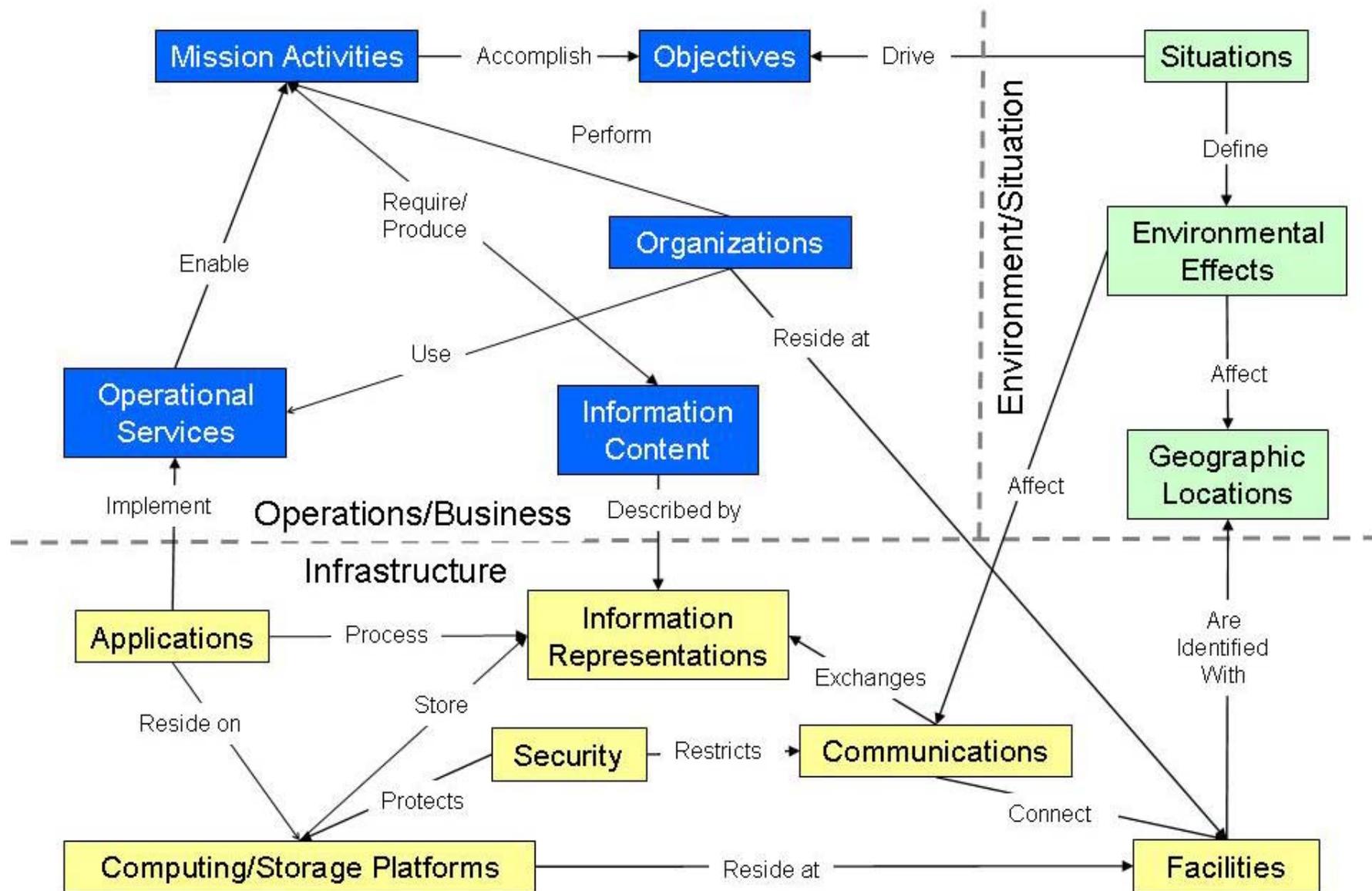
Overview

- **Objectives of Architecture Analysis**
- **Model of a Complex Information Systems Architecture**
- **Relational Database Implementation**
- **Analysis of Tabular Sample Data**
- **Use of Visualization to Conduct Analyses**
- **Additional Analyses through Visualizations**
- **Conclusions**

Objectives of Architecture Analysis

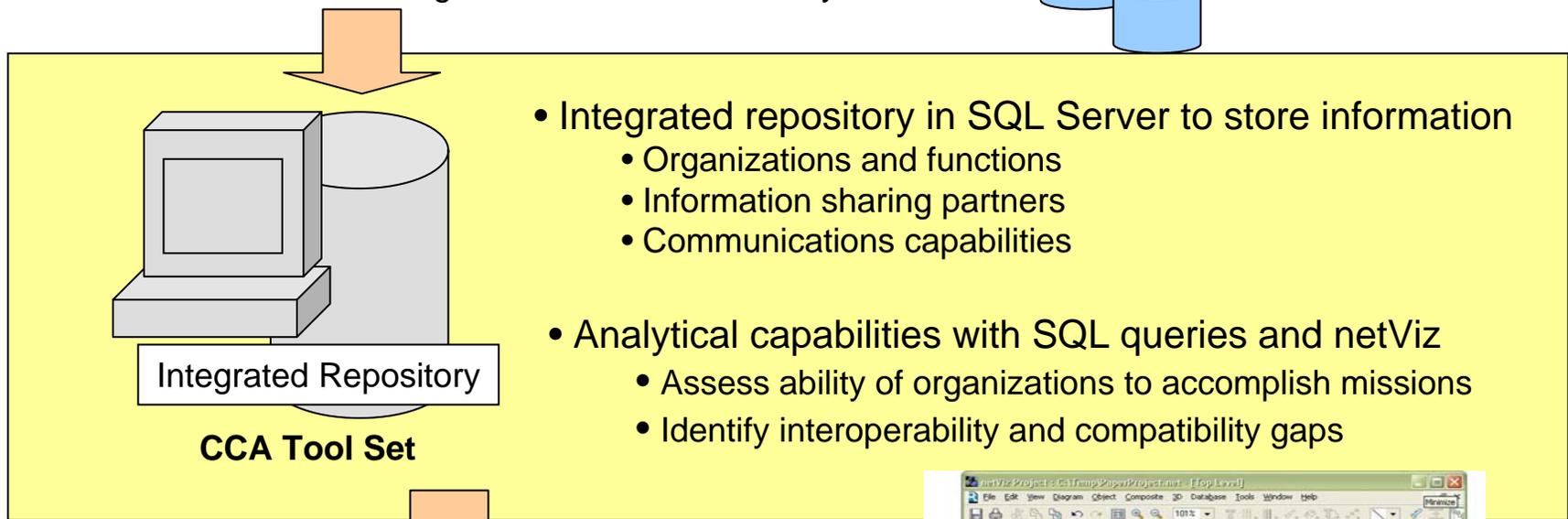
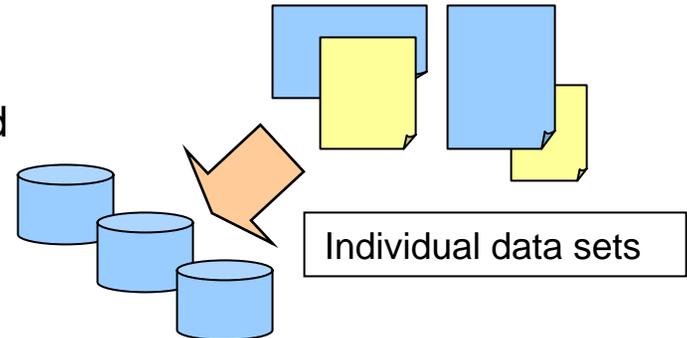


Model of a Complex Information Systems Architecture



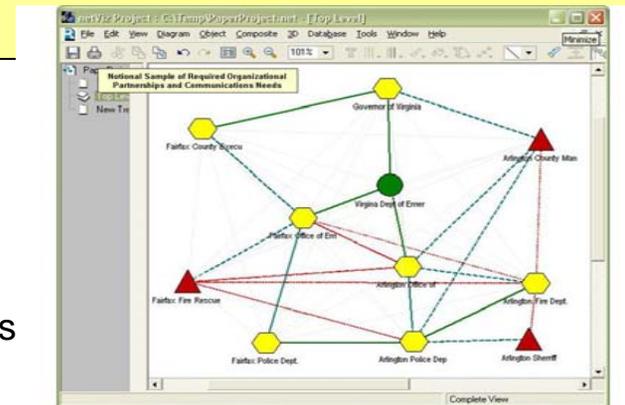
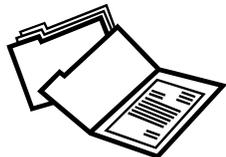
Relational Database Implementation

- User-friendly “front-end” in MS Access to organize and catalog organizational and functional data
 - Employs “pick lists” based on consistent terminology
 - Facilitates data loading and minimizes data entry errors



• Reports and visualizations

- Organizational partner disconnects
- Information exchange disconnects
- Communications infrastructure deficiencies



Screen Display from Sample Data Set

Government Functions

State Government

USER

State Government Validated

1 Function Name
Issue Fairfax County citations for fire code violations

2 Function Description
Fire inspectors will observe violations of fire codes and issue citations during routine inspections or subsequent to actual fires. Inspectors/fire marshalls will return to the cite and confirm compliance. They may testify in court regarding the infraction.

Function Type

3 Security Classification	4 Point of Contact	5 Source Title	Edited By	Date Edited
Unclassified	Unknown		USER	5/13/2008

6 Add Responsible Sub-element

▶ Fire and Rescue Department (Fairfax)	Delete
* [Empty]	Delete

Record: 1 of 1 No Filter Search

Legal Interdependency Criticality Assessment

- Requires International Partner
 - Requires Federal Partner Support
 - Requires State Partner Support
 - Requires Local Partner Support
 - Requires Territorial Partner Support
 - Requires Tribal Partner Support
 - Requires Private Sector Support
- Interdependency Identified
 - Support Another Organization

Add Partner Organization

Partner Organizations

Partner		Communications Needed		
		Audio	Video	Data
▶ Virginia Judiciary	Delete	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Private Sector	Delete	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Police Department (Fairfax)	Delete	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Office of Sheriff (Fairfax)	Delete	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
* [Empty]	Delete	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Record: 1 of 4 No Filter Search

Tabular Presentation of Sample Data

Notional Sample of Required Organizational Partnerships and Communications Needs

Organizations and Their Partners	Governor of Virginia	Virginia Department of Emergency Management	County Executive (Fairfax)	Office of Emergency Management (Fairfax)	Fire and Rescue Department (Fairfax)	Police Department (Fairfax)	County Manager (Arlington)	Office of Emergency Management (Arlington)	Fire Department (Arlington)	Police Department (Arlington)	Sheriff (Arlington)
Governor of Virginia		a,v,d	a,v,d				a,v				
Virginia Department of Emergency Management	a,v,d			a,v,d				a,v,d			
County Executive (Fairfax)	a,v,d			a,v							
Office of Emergency Management (Fairfax)		a,v,d	a,d		a,d	a,d		a			
Fire and Rescue Department (Fairfax)				a				a		a	
Police Department (Fairfax)				a						a	
County Manager (Arlington)	a							a,d	a,d	a,d	
Office of Emergency Management (Arlington)		a,v,d		a,d			a,v,d		a,v,d	a,v,d	
Fire Department (Arlington)					a			a		a	
Police Department (Arlington)						a	a	a,d	a		a
Sheriff (Arlington)									a	a,d	

Key:

- Vertical axis indicates polled organizations.
- Horizontal axis indicates partner organizations identified by polled organizations.
- Letters in cells indicate means of communications identified as needed by polled organization (a=audio, v=video, d=data).

Interpretation of Tabular Sample Data

Notional Sample of Required Organizational Partnerships and Communications Needs

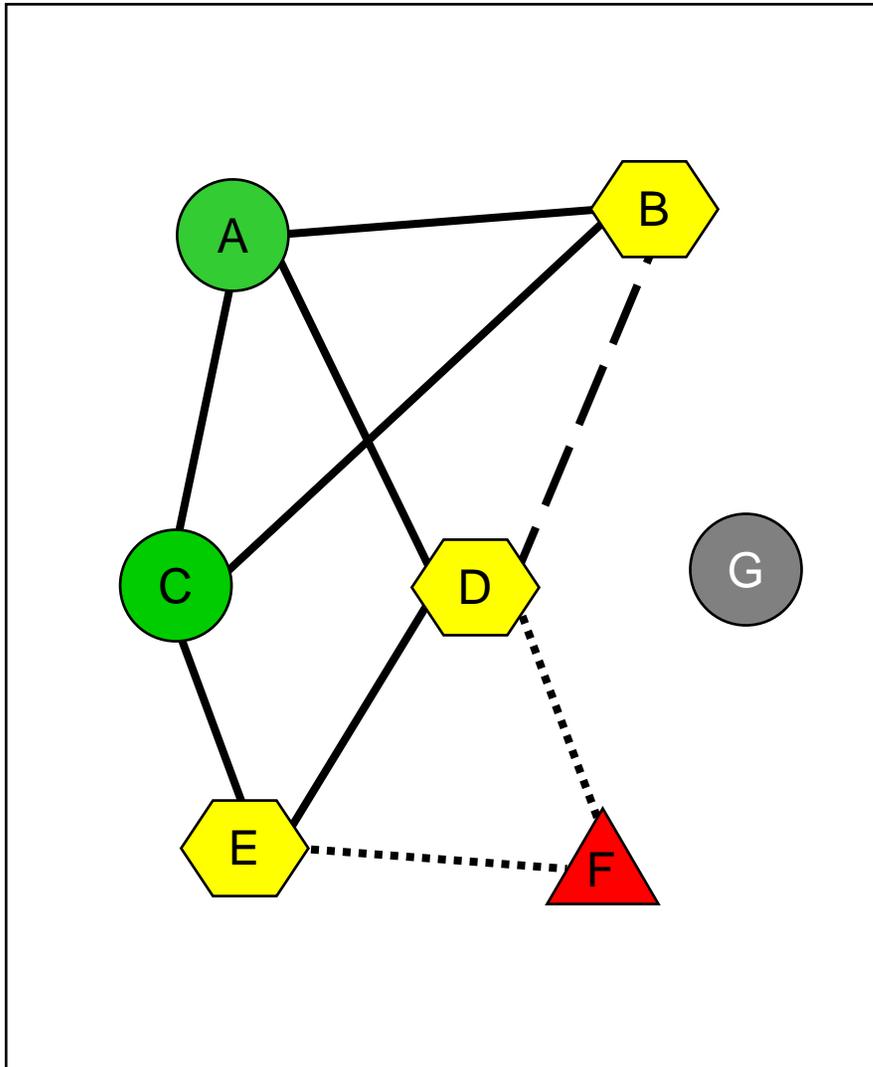
Organizations and Their Partners	Governor of Virginia	Virginia Department of Emergency Management	County Executive (Fairfax)	Office of Emergency Management (Fairfax)	Fire and Rescue Department (Fairfax)	Police Department (Fairfax)	County Manager (Arlington)	Office of Emergency Management (Arlington)	Fire Department (Arlington)	Police Department (Arlington)	Sheriff (Arlington)
Governor of Virginia		a,v,d	a,v,d				a,v				
Virginia Department of Emergency Management	a,v,d			a,d				a,v,d			
County Executive (Fairfax)	a,v,d			a,v							
Office of Emergency Management (Fairfax)		a,v,d	a,d		a,d	a,d		a			
Fire and Rescue Department (Fairfax)				a				a		a	
Police Department (Fairfax)				a						a	
County Manager (Arlington)	a							a,d	a,d	a,d	
Office of Emergency Management (Arlington)		a,v,d		a,d			a,v,d		a,v,d	a,v,d	
Fire Department (Arlington)								a		a	
Police Department (Arlington)						a	a	a,d	a		a
Sheriff (Arlington)									a	a,d	

Key:

- Vertical axis indicates polled organizations.
- Horizontal axis indicates partner organizations identified by polled organizations.
- Letters in cells indicate means of communications identified as needed by polled organization (a=audio, v=video, d=data).

Use of Visualization to Analyze the Same Sample Data Set

Executive Level View of Organizations' Relationships

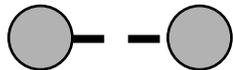


- **Nodes**
 - Organizations in the model
 - Color-coded to represent status of organizations
- **Links**
 - Dependencies among organizations
 - Line styles used to represent characteristics of dependencies

Notational Convention for Organizational Relationships

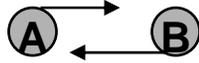
 Organization

 Two organizations have identified a mutually identical partner and media relationship

 Two organizations have identified a mutual partner relationship, but disagree on media

 One of the two organizations has not identified the other as partner

 No relationship identified by either organization

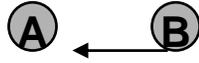
A, V, D (S, non-S)  A identifies B as a partner; B identifies A as a partner; AND, both agree with respect to a mutual needs for audio, video, and data exchanges (secure and non-secure)

A, V, D (S, non-S)

A, D (S, non-S)  A identifies B as a partner; B identifies A as a partner; BUT there is disagreement with respect to their needs for audio, video, and data exchanges

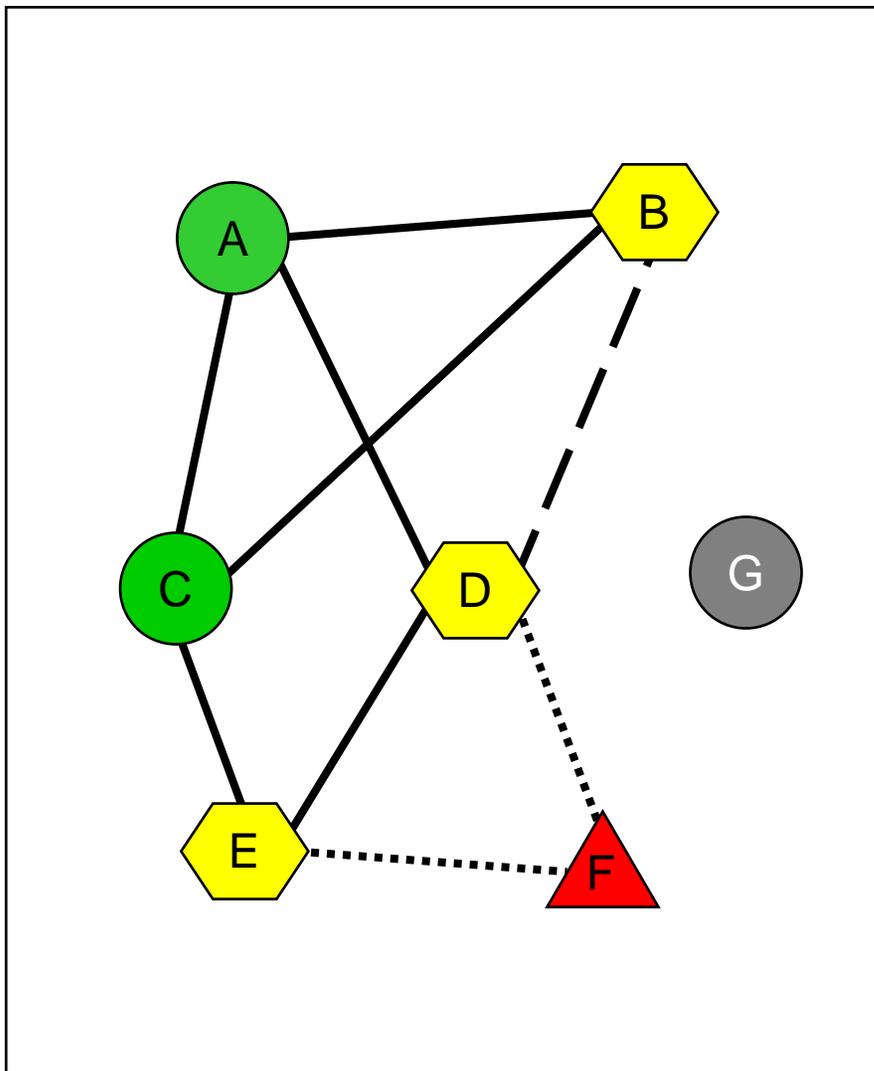
A, V, D (S)

 A identifies B as a partner; B makes no mention of A as a partner, OR

 B identifies A as a partner; A makes no reference to B

 A makes no mention of B; B makes no mention of A

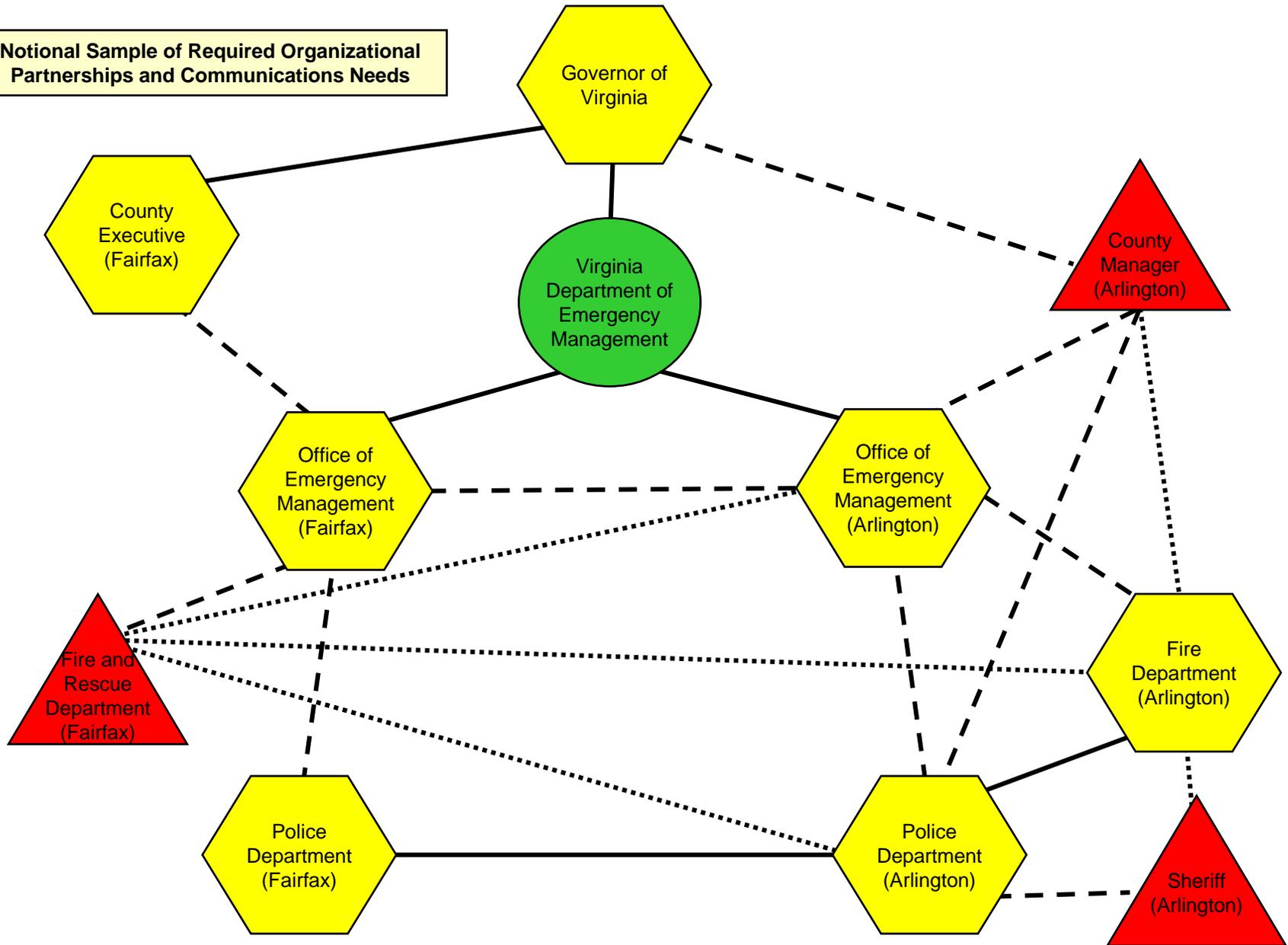
Notational Convention for Status of Organizations' Relationships



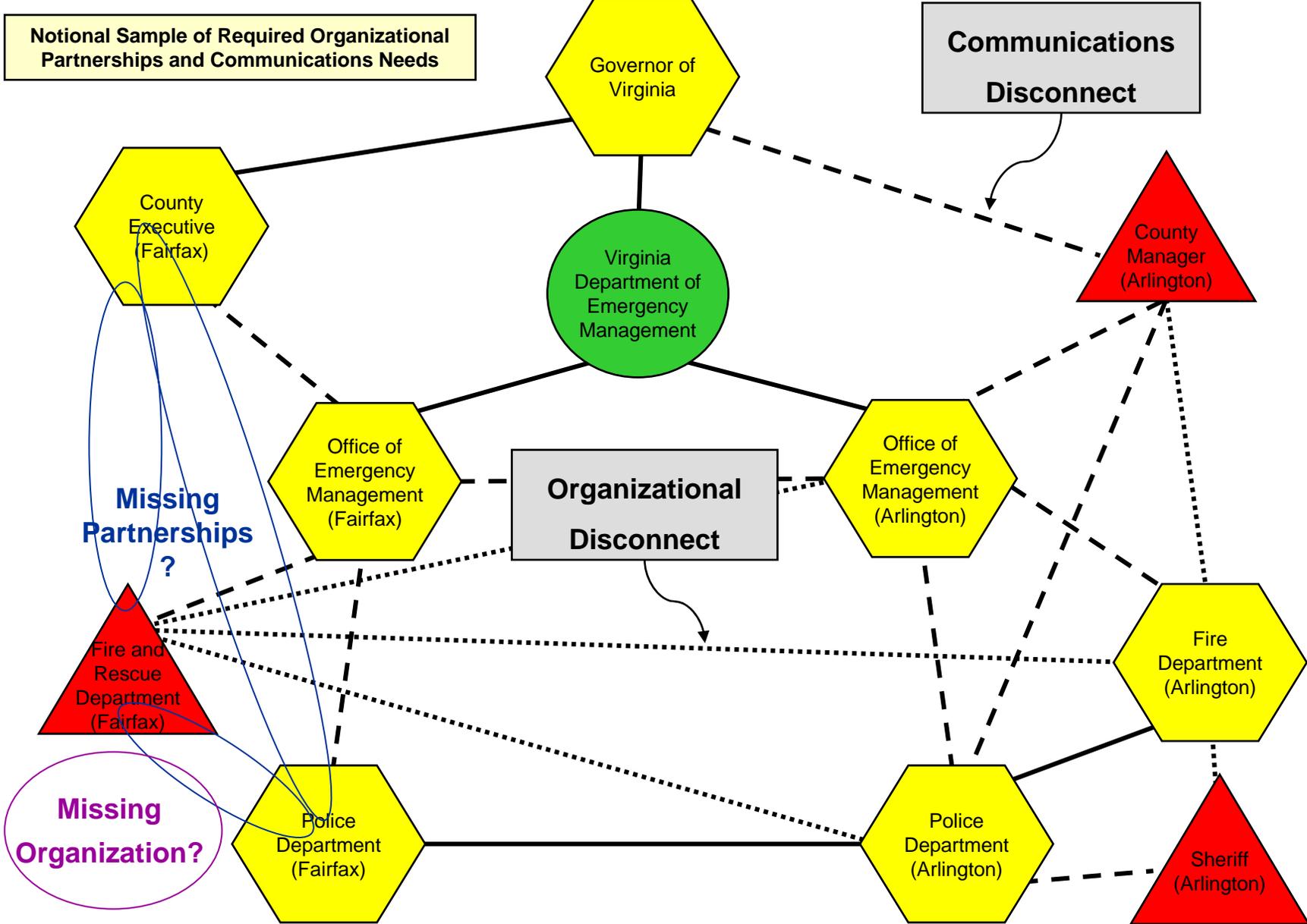
-  **Fully Consistent:** two organizations have **each** identified **a mutually identical** partner and media relationship with each other
-  **Partially Consistent:** two organizations have **each** identified **a** mutual partner relationship with each other, but disagree on media
-  **Inconsistent:** **Only one of** the two organizations has identified the other as partner
-  All of the organization's partner/media relationships are fully consistent
-  Some of the organization's partner/media relationships are fully consistent
-  None of the organization's **partner/media** relationships are **fully** consistent
-  No partner relationships identified

Visualization of Same Sample Data Set

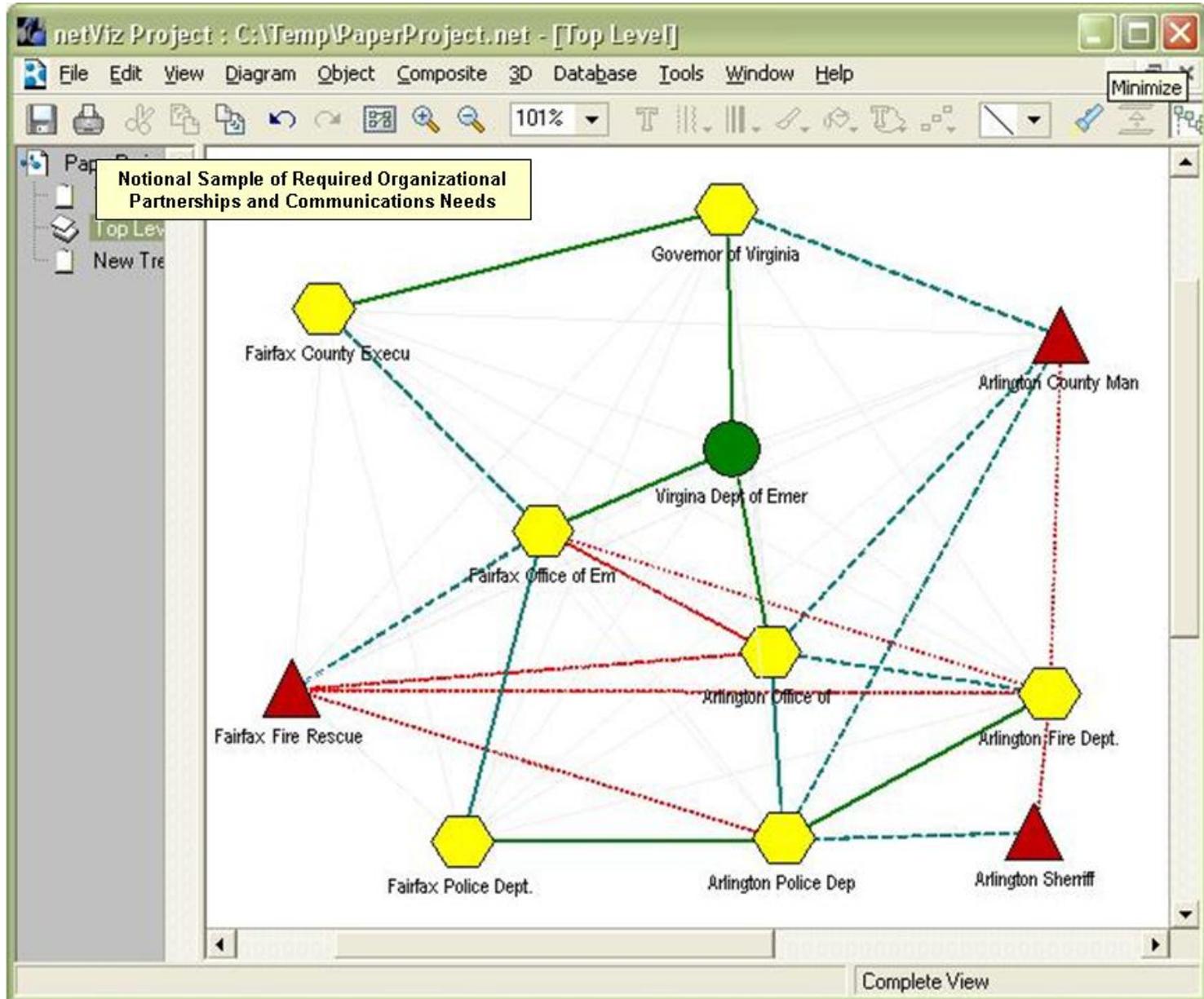
Notional Sample of Required Organizational Partnerships and Communications Needs



Visualization Facilitates Recognition of Gaps



netViz-Generated Visualization



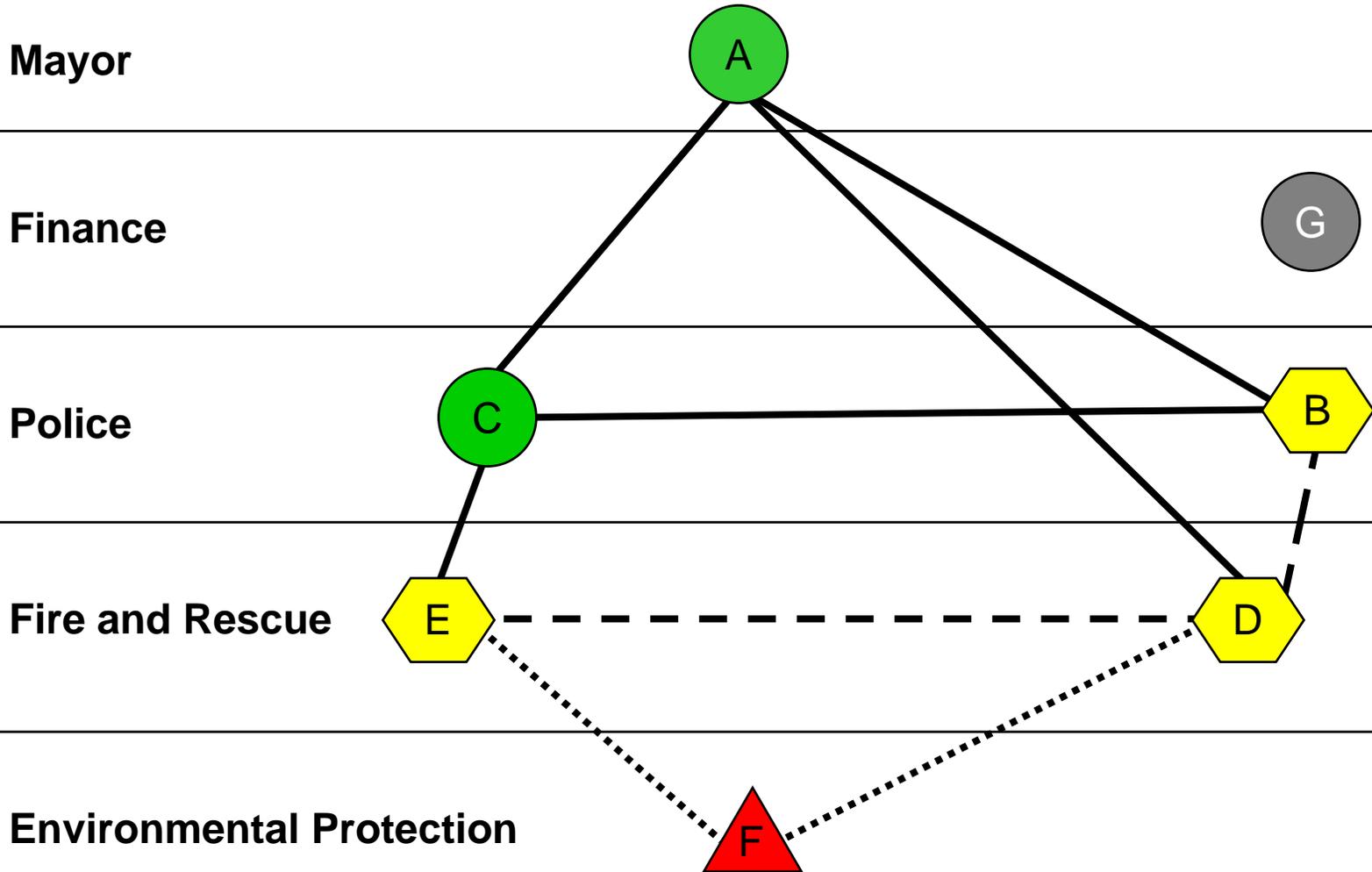
Uses of Visualization to Analyze Command and Control Relationships

- **Describe specific command and control relationships between organizational entities**
 - **Do two organizations have a shared view of their relationship to each other?**
- **Rate the status of organizations' command and control relationships**
 - **To what extent do organizations possess well-defined relationships with other organizations?**

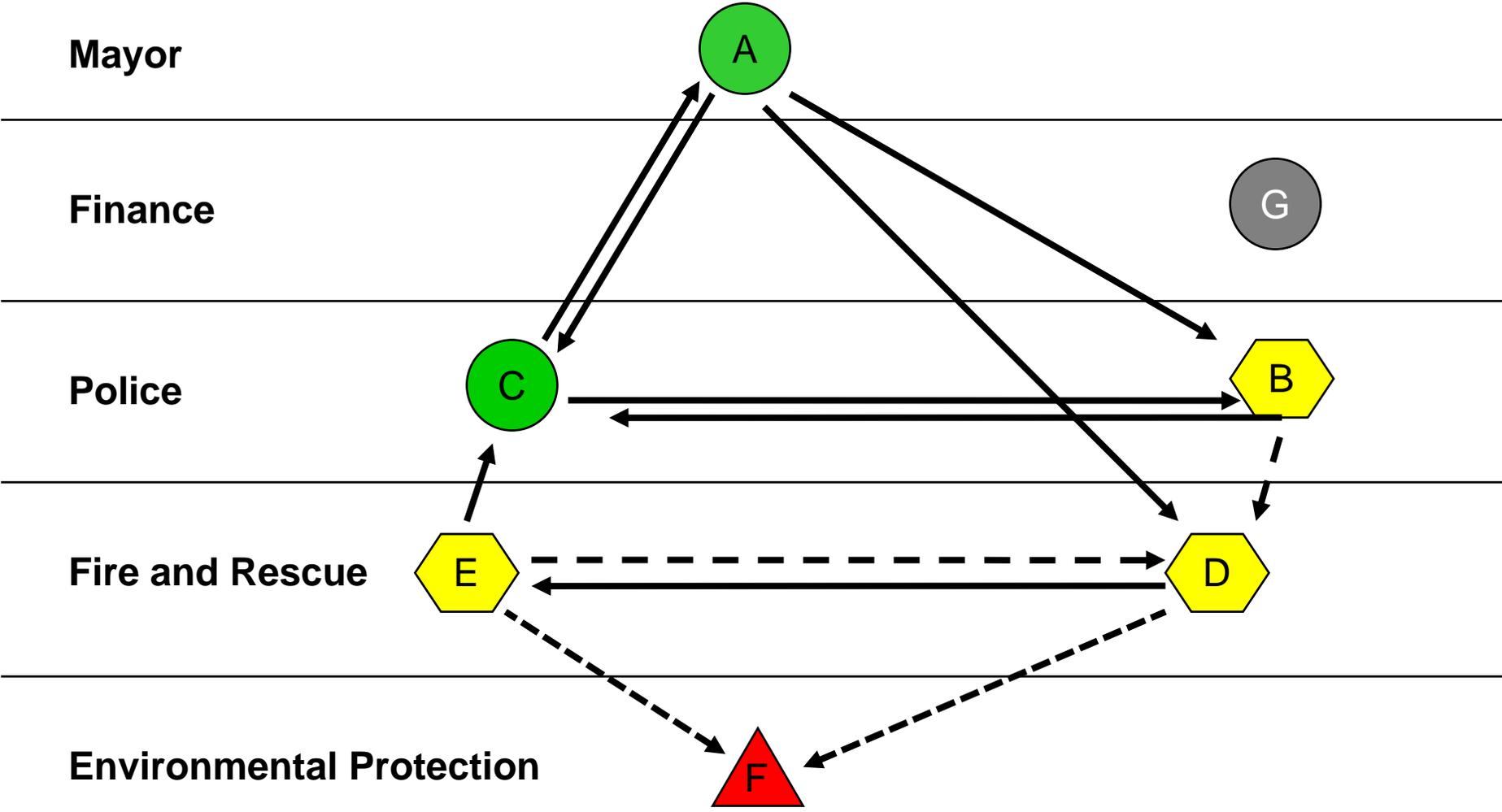
Additional Analyses Supported by Visualization

- **Identify relationships among organizations that serve different functions**
 - **Do the status of organizational relationships match expectations of relationships among functional areas?**
- **Identify directional relationships**
 - **What are the information flows among organizations?**

Visualization of Functional Relationships



Visualization of Information Flows



Conclusions

- **Visualization provides significant advantages over tabular data**
 - **Facilitates comprehension of complex relationships**
 - **Enables recognition of gaps that would be difficult to detect with tabular data**
- **Automated visualization is possible directly from databases (e.g., MS Access/SQL Server with netViz)**
 - **Visualizations can vary based upon alternative, user-defined queries**
 - **Enables analysis of large complex data sets**