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# Techniques for Intelligence Analysis of Networks

**Jeffrey R. Cares**

**73rd MORSS**



# Main Points

- “Complex Networks” have exploitable properties
  - e.g.: Information Age commercial/social successes
- These exploitable properties have military relevance
  - e.g.: Sense and Respond Logistics (OSD-FT)
- There are significant intelligence analysis manifestations of these properties
- A more satisfying theory of Networked Competition (than currently exists for NCW/NCO, etc) is emerging from this research

# Network Metric Thumb Rules

## Experimentation and Analysis

Intel Analysis  
of Networks

Metric	Range	Operational Significance
Number of nodes, $n$	$n > \sim 100$	Network effects unlikely to occur with $n < 50$
Number of links, $l$	$l < \sim 2n$	$l \ll 2n$ , too brittle $l \gg 2n$ , too much overhead
Degree distribution	Skewed	Adaptivity, modularity
Largest hub	$< 100$ links	Hub appears, recedes by reconnection 5% of links
Average path length	$\log(n)$	Short distances even for large networks (e.g., $10^4$ nodes $\rightarrow$ Average path length = $\sim 4$ )
Clustering	Skewed	Hierarchy, organization
Betweenness	Skewed	Cascade control
Path horizon	$\log(n)$	Self-synchronization
Susceptibility/ Robustness	Low (random removal) High (focused removal)	Hubs should be kept obscure until needed, damage abatement/repair schemes
Neutrality Rating	$(0, 1)$	Increased network effects, decreased susceptibility, tipping points
Coefficient of Networked Effects	$(0, 1)$	Network effects $PFE/n$

# Number of Nodes, Links

- A factor in how many links are required for adaptive behavior
  - A very large number of nodes with low link density suggests a brute force strategy
  - A very large number of nodes with high link density suggests confusion
  - A very small number of nodes with high link density suggests tight-knit cabal
  - A very small number of nodes with low link density suggests a brittle organization
- Potential Strategy
  - Drive the link/node ratio in a direction counter to what the target organization may need for assumed mission

# Degree Distribution

- Skewed: Adaptive, Learning Organization
  - Hubs can be kept obscure until needed
  - Hubs can recede, re-appear with re-wiring of 5-10% of links
  - All paths to hubs are short
- Uniform (Lattice): Strict Hierarchy
  - As average degree tends toward 1 organization becomes more “chain-like” and brittle
- Multi-modal: Dispersed Operations
- Potential Strategies
  - Skewed: encourage hub formation, follow short paths
  - Uniform: reduce average degree (increase brittleness)
  - Multi-modal: Divide and conquer



# Clustering

- High: Small World Effect
- Low: Strict Hierarchy
- Skewed: Adaptive
- Potential Strategies
  - High: Follow short paths to target nodes
  - Low: Drive toward brittleness
  - Skewed: Look for “President’s Cluster”



# Betweenness

- Nodes with high betweenness are nodes through which the highest number of shortest paths pass
- Potential Strategies
  - Bombard the target network with noise to flush out high betweenness
  - Keep high betweenness nodes alive until the target network needs them most
  - Look at low degree nodes close to high betweenness for gatekeeper-protected node relationships



# Path Horizon

- Very Low: Tight coordination
- $\text{Log}(n)$ : Adaptive
- High: Chains
- Potential Strategies
  - Very Low: Bombard with noise
  - $\text{Log}(n)$ : Induce different structure on network
  - High: Interdict

# CNE (*h*-cycles)

- Low *h*: Tight coordination
- High *h*: Chain
- Potential Strategy:
  - Low *h*: bombard with noise
  - High *h*: Remove links to turn into low *h* and then bombard with noise



# Conclusions

- Structural Analysis is a useful tool for understanding networks
- Strong complement to traditional methods
- Provides recommendations for how to attack or influence the target network
- Most examples are from non-military contexts
  - Need for military-specific research



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