KNOW THE NETWORK, KNIT THE NETWORK:

APPLYING SNA TO N2C2 MATURITY MODEL EXPERIMENTS

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EDI SOFT

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The Value of SNA

- **Social Network Analysis (SNA)** is a scientific methodology that assists in the explanation of networking and personal interactions.

- **SNA** focuses on **individuals or nodes** and on **degrees or links**

- **SNA** enables to determine how the **network's structure, location and connection properties** affect **organisational performance and effectiveness**.
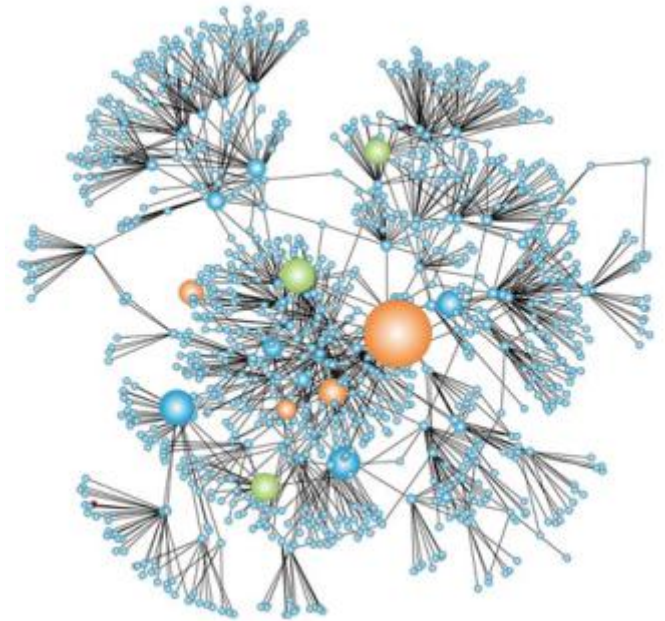
- **ELICIT** is an experimentation platform that instruments the actions of a group of seventeen participants engaged in a situational awareness problem, with the goal to identify the who, what, when and where of a pending attack.
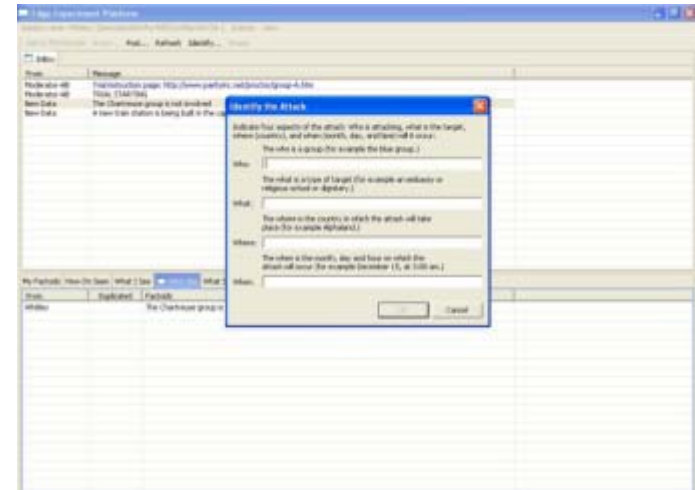

- **ELICIT participants** build situational awareness by gathering and analyzing factoids and **interacting with one another** through **factoids' sharing** directly with each other or **factoids' posting** to websites.

SNA Variable	SNA Variable Description
Node Centrality	Compound variable, measured by: - Node Degree – number of nodes to which a node is directly related to; - Closeness – degree to which a node is close to all other nodes; - Betweeness – frequency by which the node is located between pairs of other nodes.
Node Embeddedness	Node Embeddedness – a compound variable, measured by: - Link Density – the relation between the node's links and the total number of links; - Link Strength – number of times a link has been used; - Link Flow – number of in-degrees and out-degrees of a node.
Network Activity	Number of times each link has been used
Network Mode Path Length	Mode of all nodes' path lengths
Network Diameter	Maximum path within the network
Network Inclusiveness	Relation between the number of isolated nodes and the total number of nodes
Network Clustering Coefficient	Likelihood that two associates of a node are associates themselves
Network Connectedness	Capability of each node to reach all other nodes in the network
Network Structural Cohesion	Minimum number of nodes that, if removed, causes the network to collapse
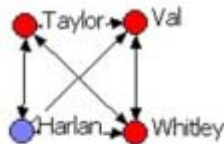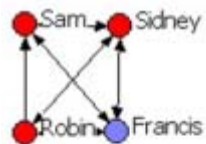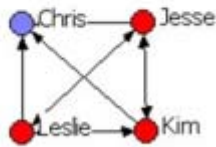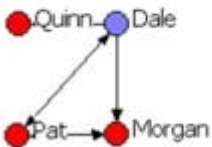
Node Centrality
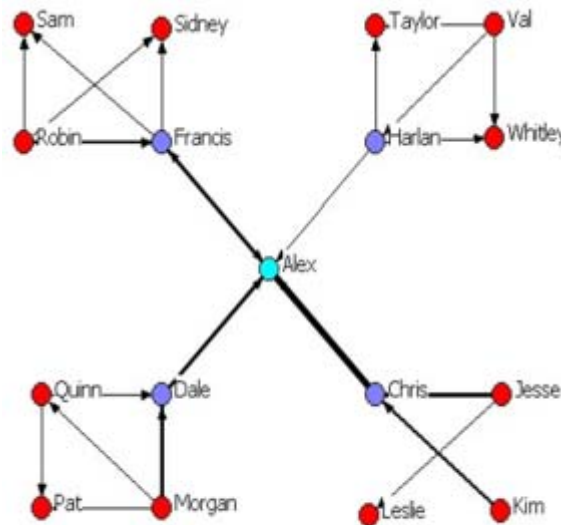
L1 01 Sociogram

L3 03 Sociogram
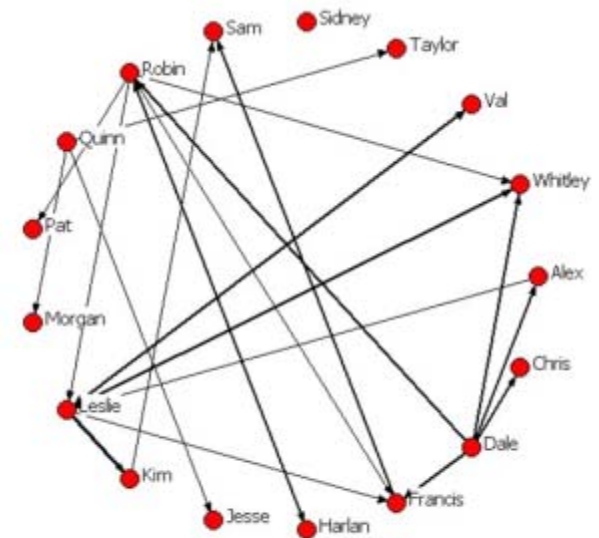
L5 02 Sociogram

Node Centrality

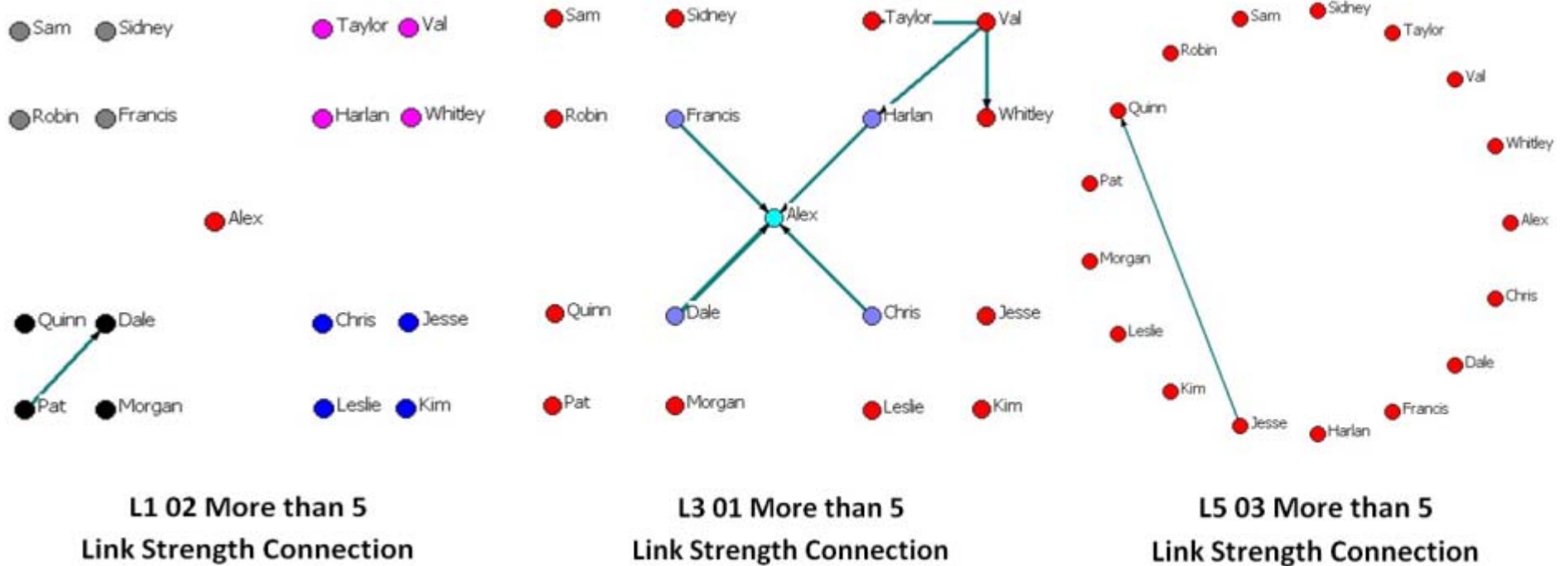| Node Centrality			
	Betweenness	Degree	Closeness
Average L1	0,196	2,529	2,627
Average L2	16,059	2,735	6,946
Average L3	15,857	2,912	7,081
Average L4	3,154	2,132	7,223
Average L5	5,059	2,745	6,363
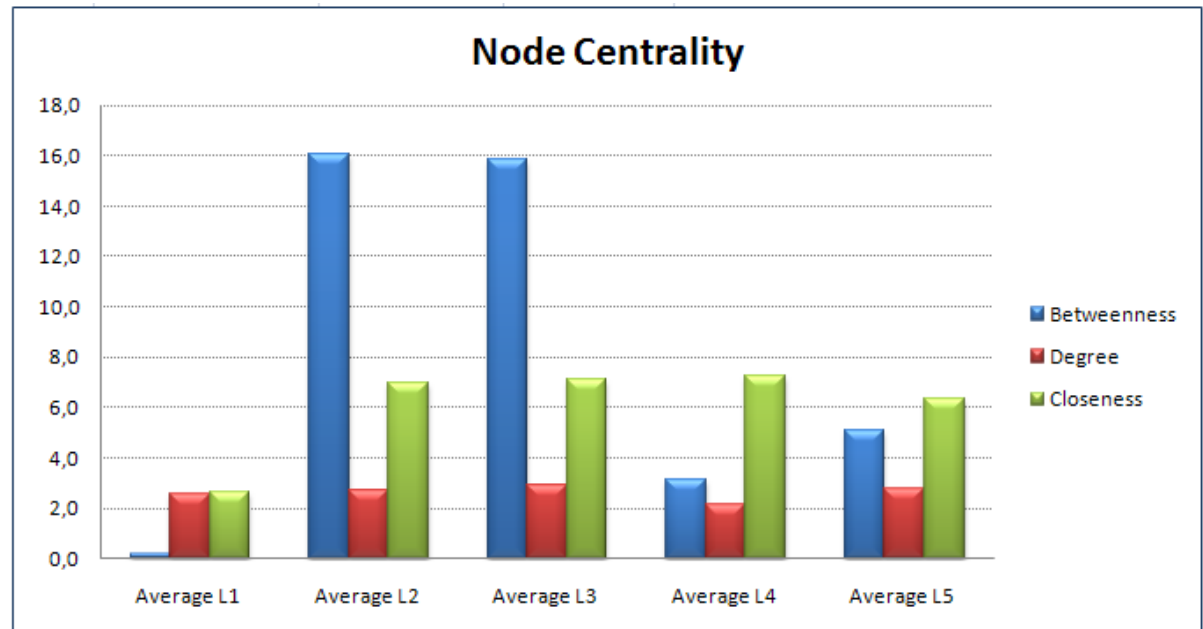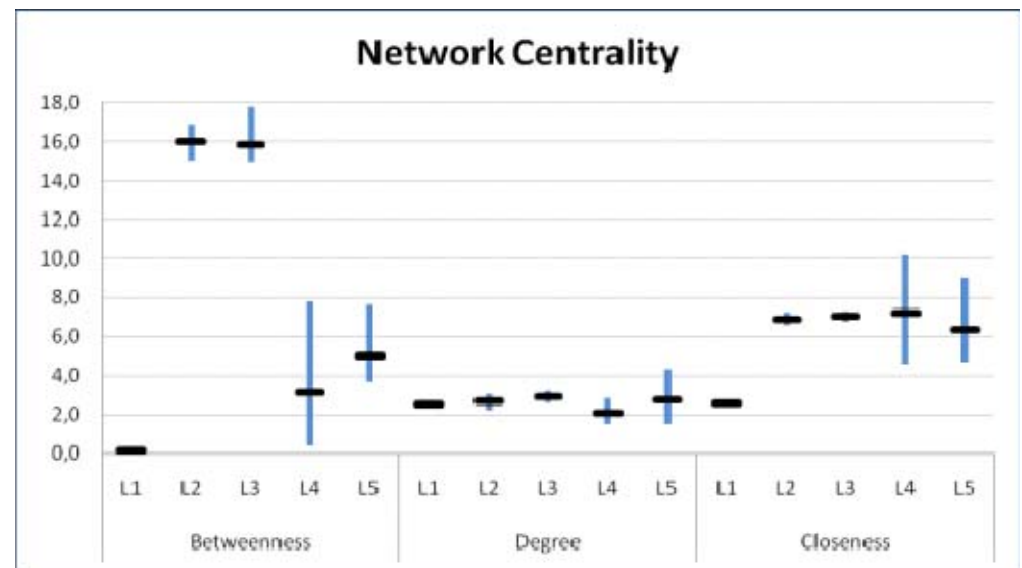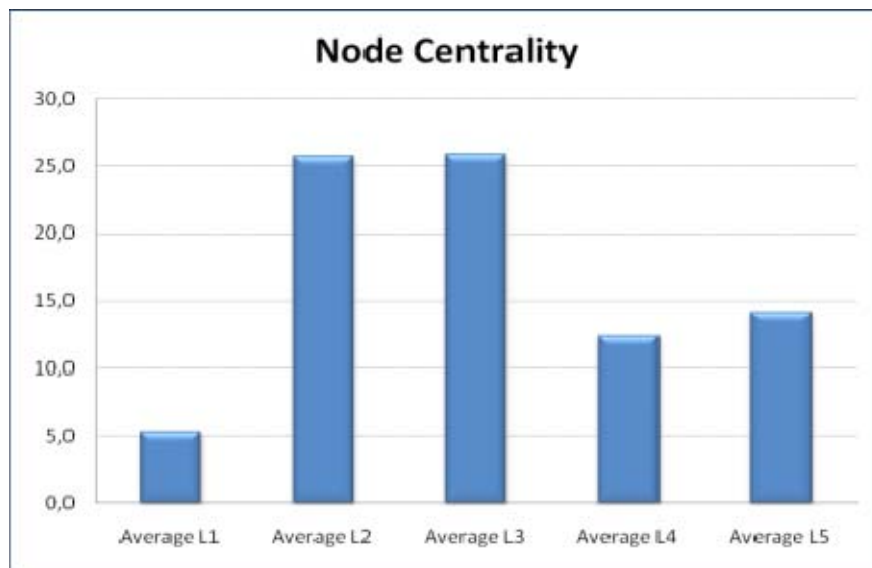
Node Centrality

SNA Variable	Expected SNA Variable Behaviour From Less Mature To More Mature C2 Approaches
Node Centrality	From VERY LOW (isolated node) to HIGH (central node sets) and to MEDIUM (decentralised network)

Node Embeddedness

L1 02 More than 5
Link Strength Connection

L3 01 More than 5
Link Strength Connection

L5 03 More than 5
Link Strength Connection

Node Embeddedness

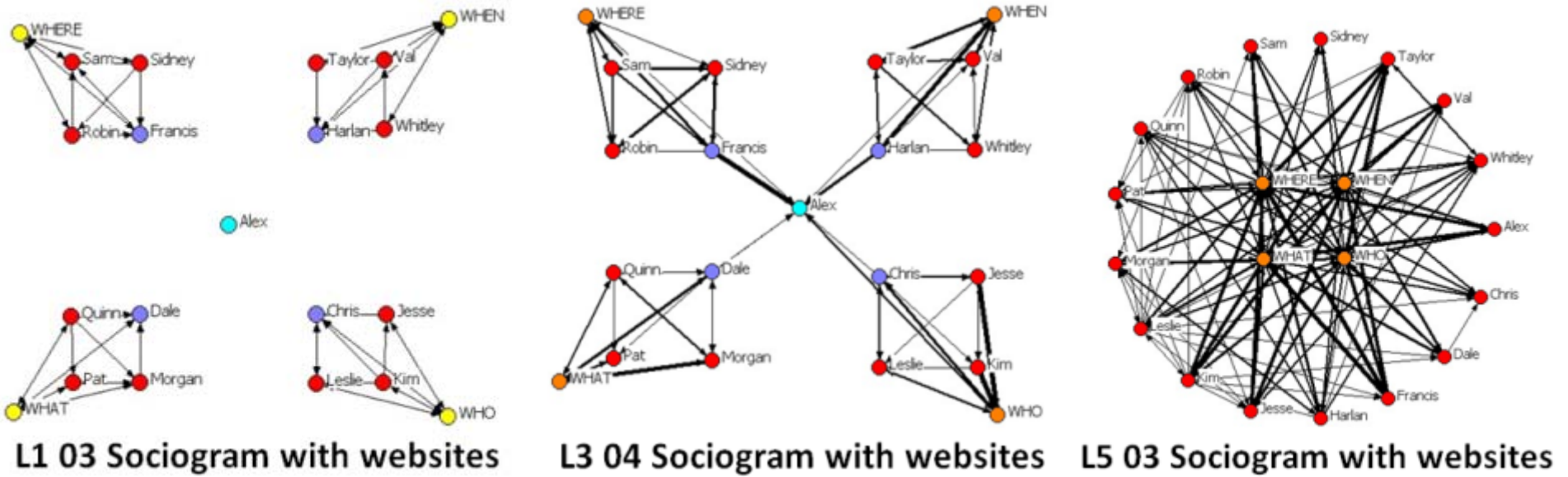| Node Embeddedness			
	Link Density	Link Strength	Link Flow
Average L1	0,196	2,529	2,627
Average L2	0,549	7,397	25,750
Average L3	0,659	5,647	17,176
Average L4	0,143	2,029	7,529
Average L5	0,208	1,392	7,176
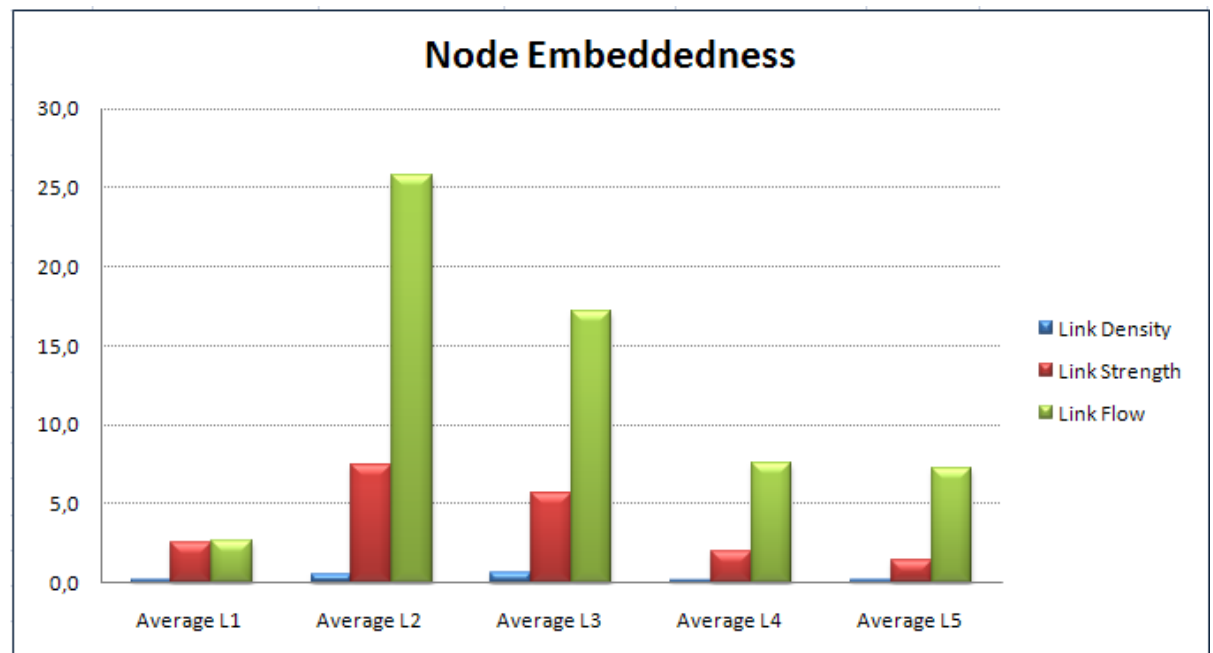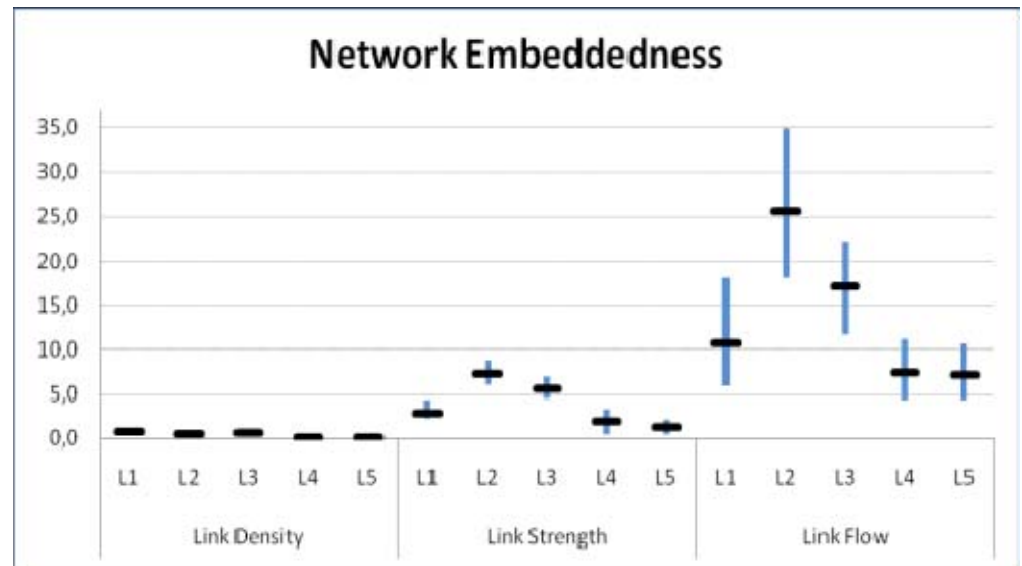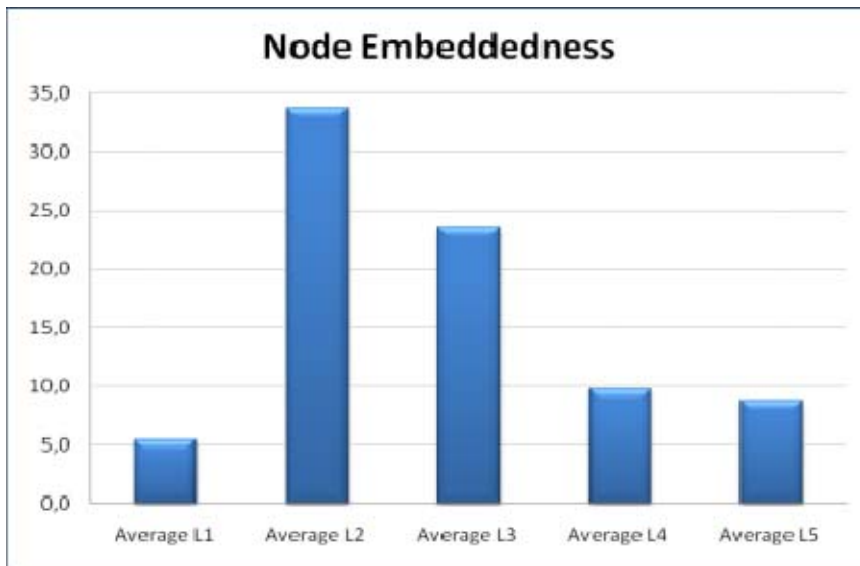
Node Embeddedness

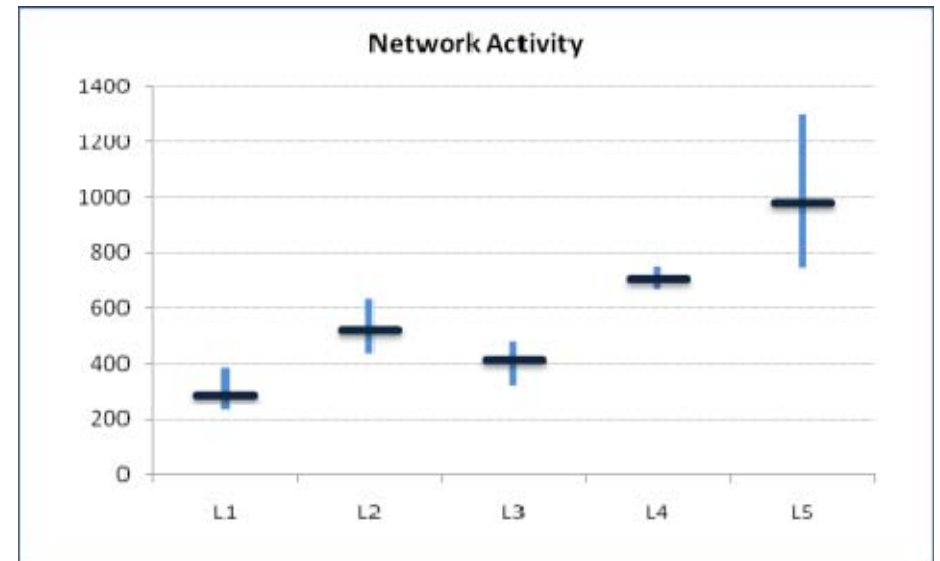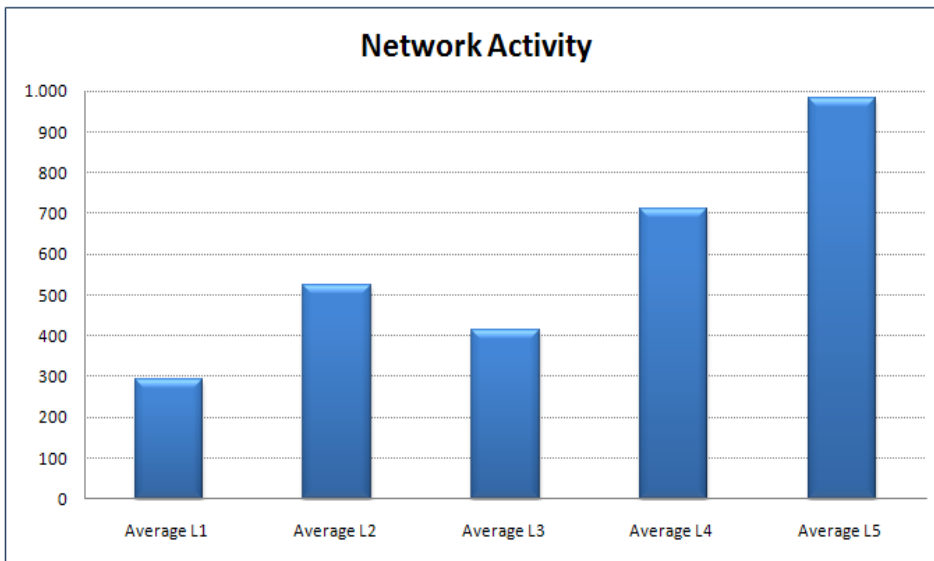| SNA Variable	Expected SNA Variable Behaviour From Less Mature To More Mature C2 Approaches
Node Embeddedness	From LOW (low density) to HIGH (high density) and to MEDIUM (distributed density)

Network Activity

L1 03 Sociogram with websites

L3 04 Sociogram with websites

L5 03 Sociogram with websites
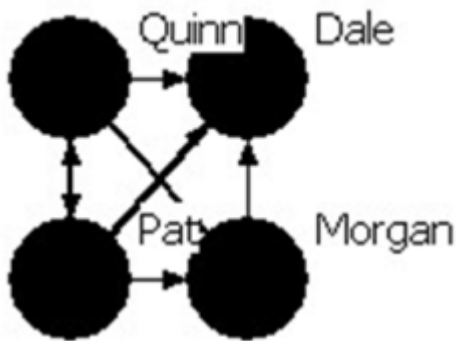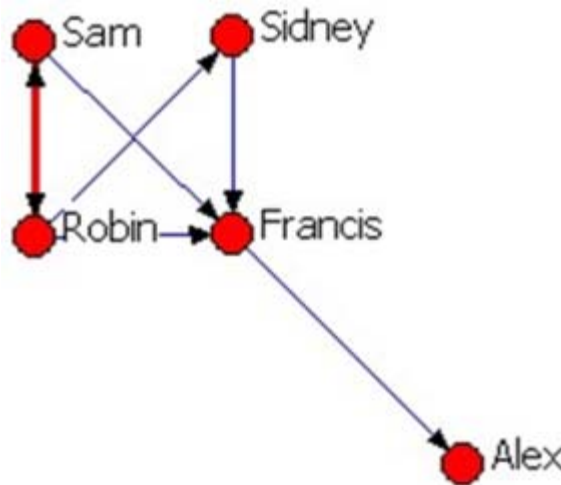
Network Activity

SNA Variable	Expected SNA Variable Behaviour From Less Mature To More Mature C2 Approaches
Network Activity	From LOW (minimal degrees) to MEDIUM (limited degrees) and to HIGH (multiple degrees)

Network Path Length

L1 02 Dale's Egonet

L3 02 Francis' Egonet
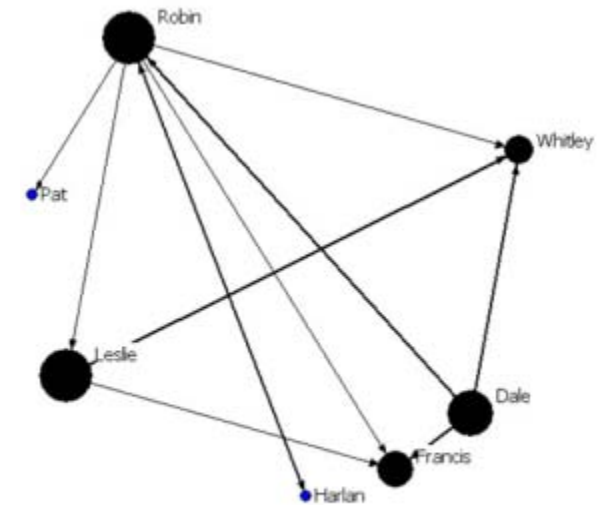
L5 02 Robin's Egonet
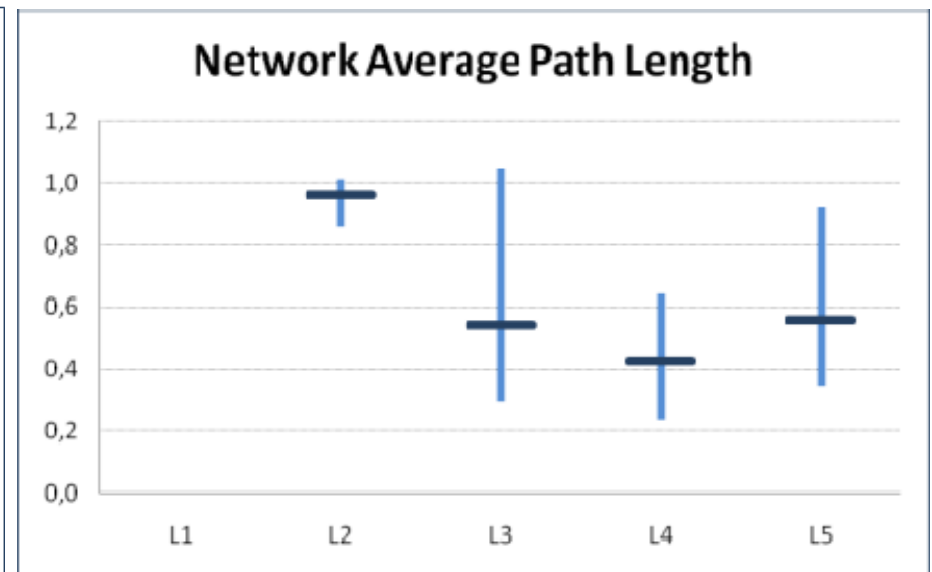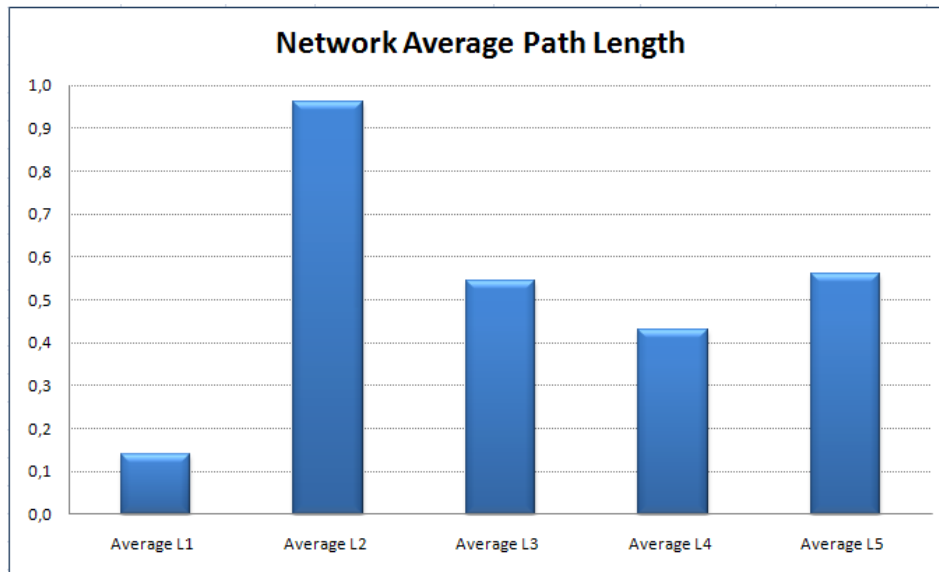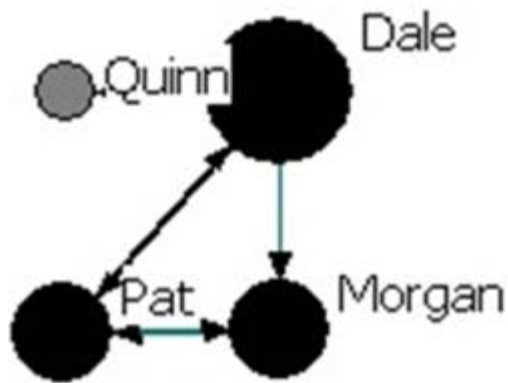
Network Path Length
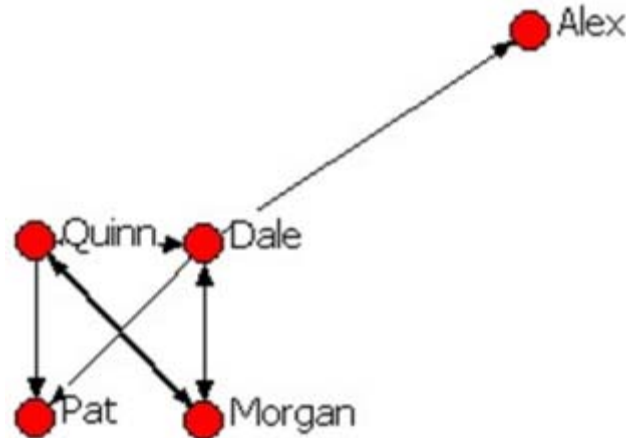

Network Average Path Length

SNA Variable	Expected SNA Variable Behaviour From Less Mature To More Mature C2 Approaches
Network Mode Path Length	From HIGH (first order zone) to LOW (hierarchical rules) and to LOW (geodesics)

Network Diameter

L1 01 Dale's Egonet

L3 04 Dale's Egonet

L5 01 Kim's Egonet
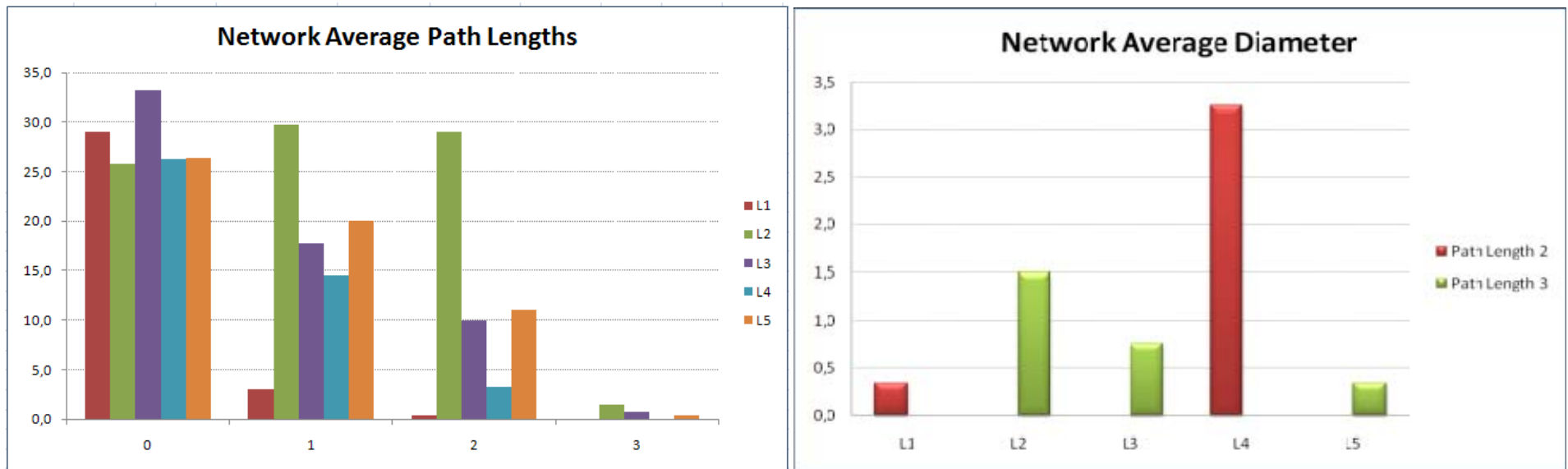
Network Diameter

Network Average Path Lengths

Network Average Diameter

SNA Variable	Expected SNA Variable Behaviour From Less Mature To More Mature C2 Approaches
Network Diameter	From LOW (adjacency) to MEDIUM (hierarchical setting) and to LOW (wider neighbourhood of geodesics)

Network Inclusiveness

L1 02 Isolates

L3 02 Component

L5 02 Isolates

SNA Findings in the N2C2M2 ELICIT Experiments

Network Inclusiveness
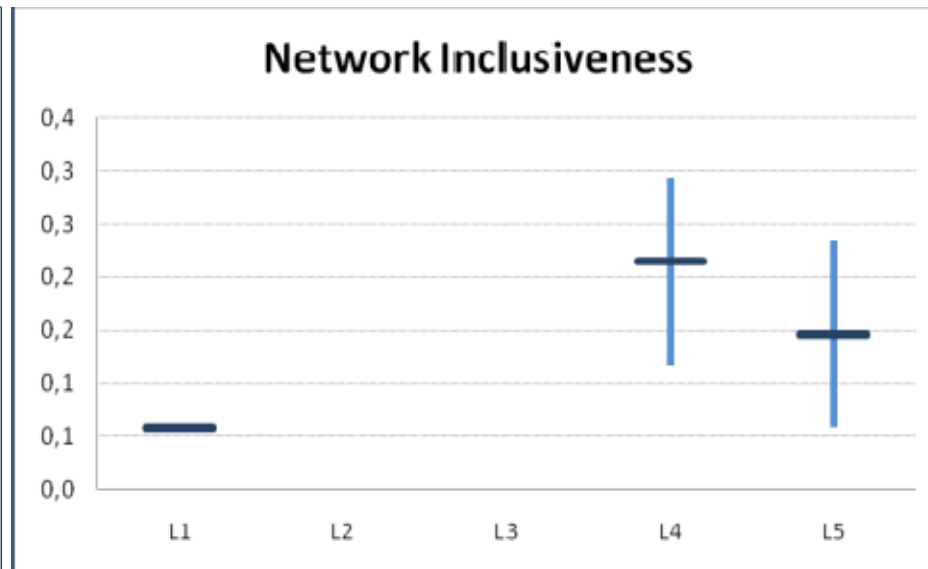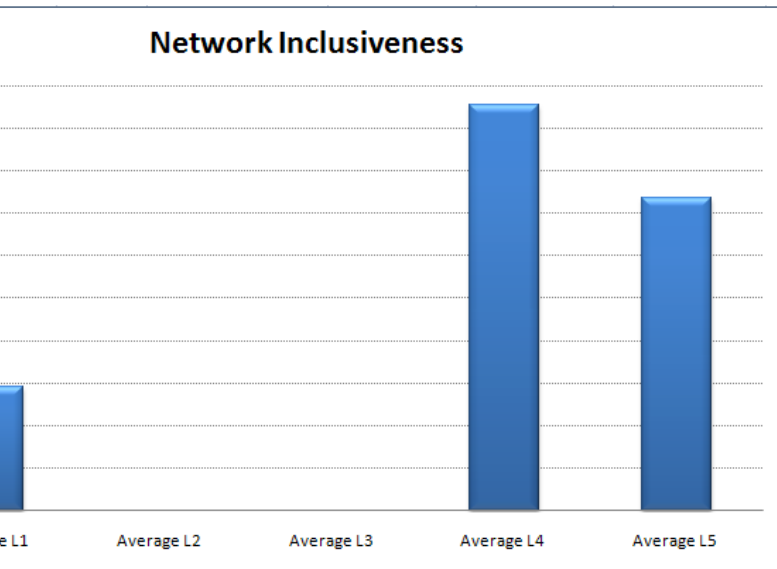
Network Inclusiveness (bar chart: Average L1, Average L2, Average L3, Average L4, Average L5)

Network Inclusiveness (range chart with L1, L2, L3, L4, L5 on x-axis; y-axis 0,0 to 0,4)
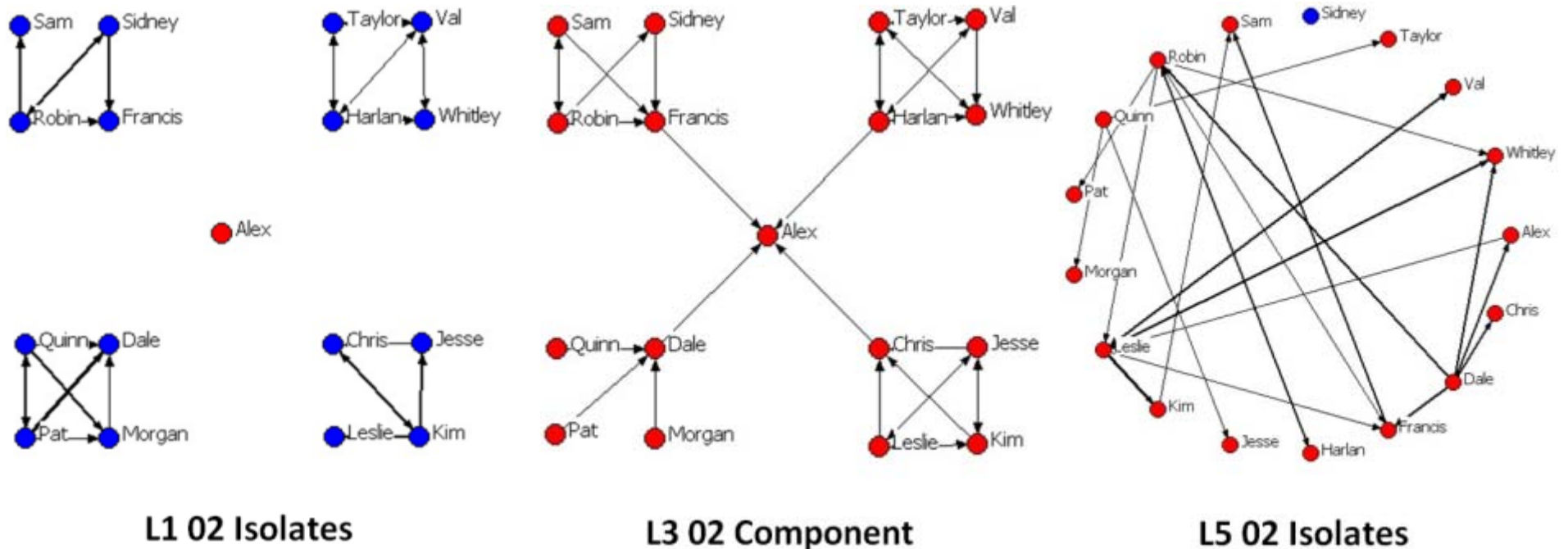
A Variable	Expected SNA Variable Behaviour From Less Mature To More Mature C2 Approaches
clusiveness	From LOW (one isolate) to NOT APPLICABLE (no isolates) and to MEDIUM (isolated node behaviour)

Network Clustering Coefficient

2 Reciprocal Ties   L3 04 Reciprocal Ties   L5 01 Reciprocal Ties

SNA Findings in the N2C2M2 ELICIT Experiments

Network Clustering Coefficient
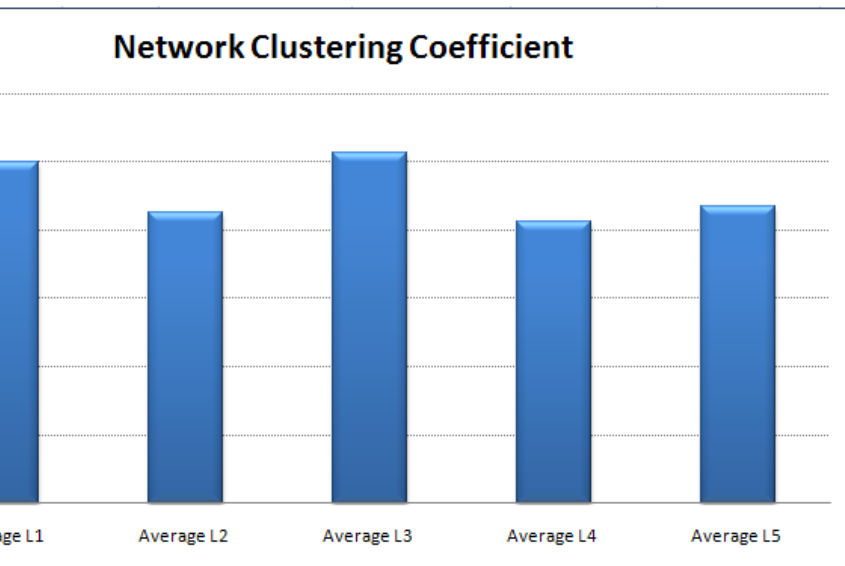
Network Clustering Coefficient (bar chart with Average L1, Average L2, Average L3, Average L4, Average L5)

Network Clustering Coefficient (range chart with L1, L2, L3, L4, L5; y-axis from 0,0 to 25,0)

A Variable	Expected SNA Variable Behaviour From Less Mature To More Mature C2 Approaches
ustering Coefficient	From HIGH (small node sets) to LOW (rigid node association) and to VERY LOW (free node association)

Network Connectedness
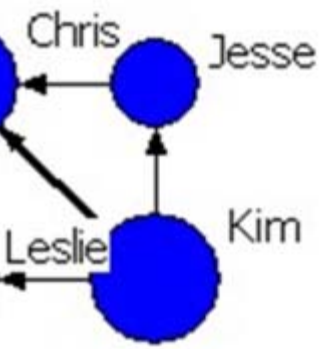
03 Kim's Egonet
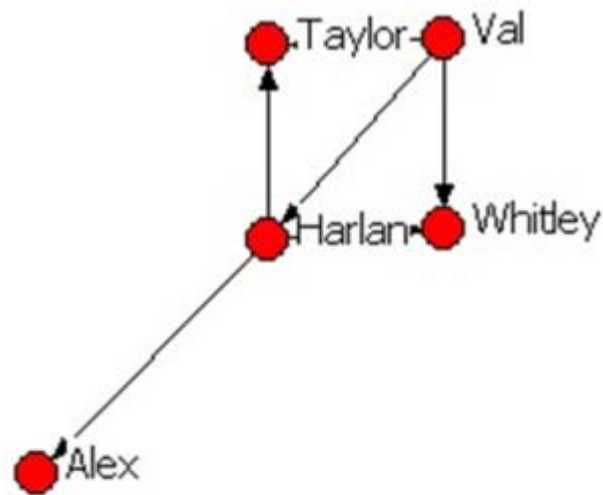
L3 03 Harlan's Egonet
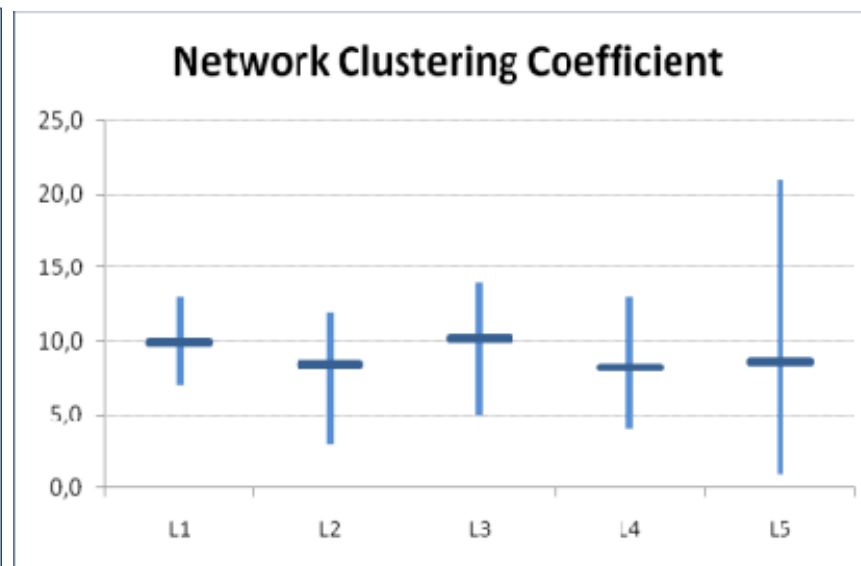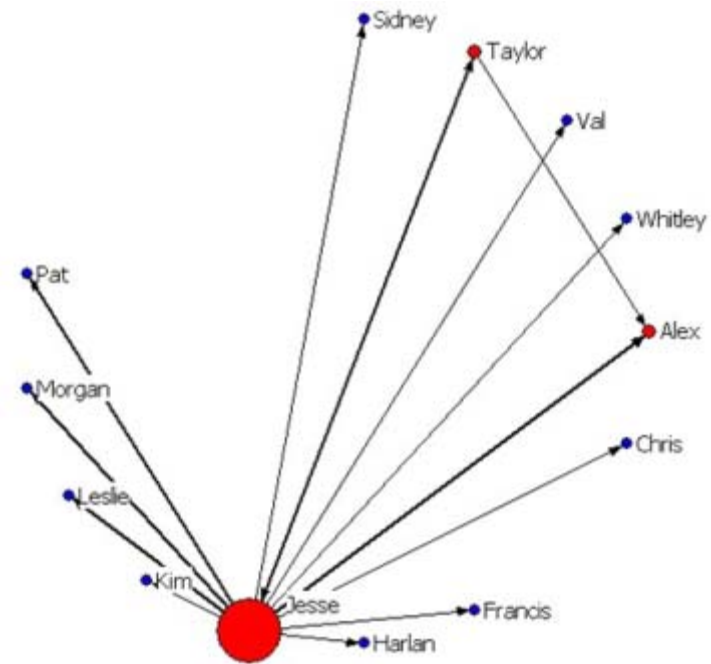
L5 03 Jesse's Egonet
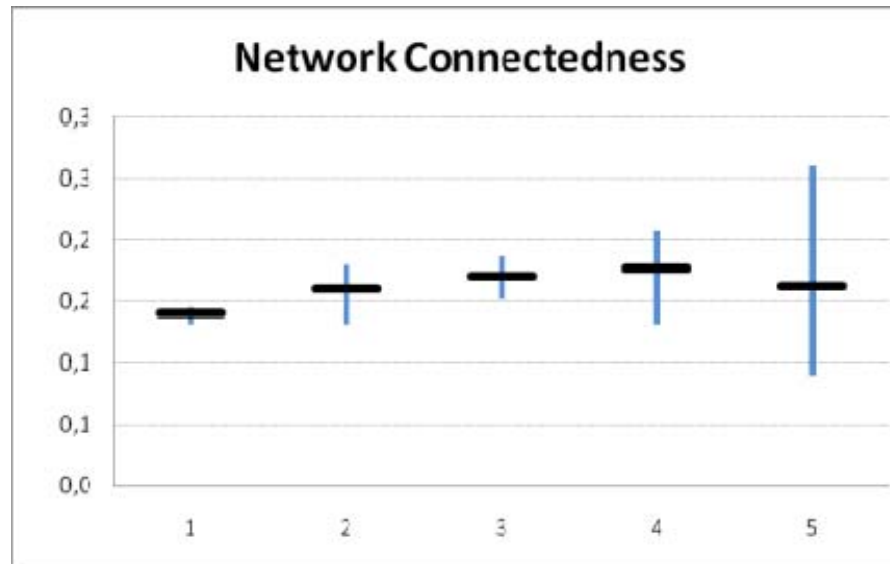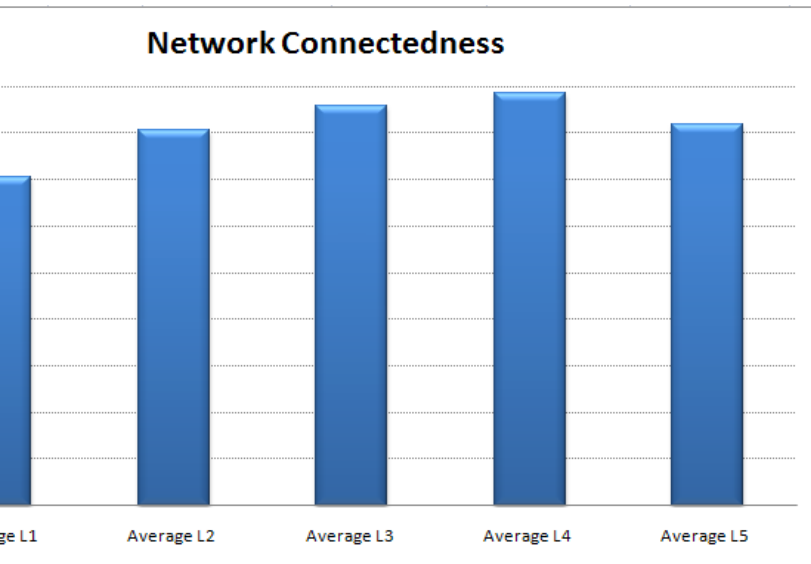
Network Connectedness

A Variable	Expected SNA Variable Behaviour From Less Mature To More Mature C2 Approaches
nnectedness	From LOW (minimum node reach) to MEDIUM (limited node reach) and to HIGH (full node reach)

Network Structural Cohesion

Blocks and Cutpoints

L3 01 Blocks and Cutpoints

L5 02 Blocks and Cutpoints

Network Structural Cohesion
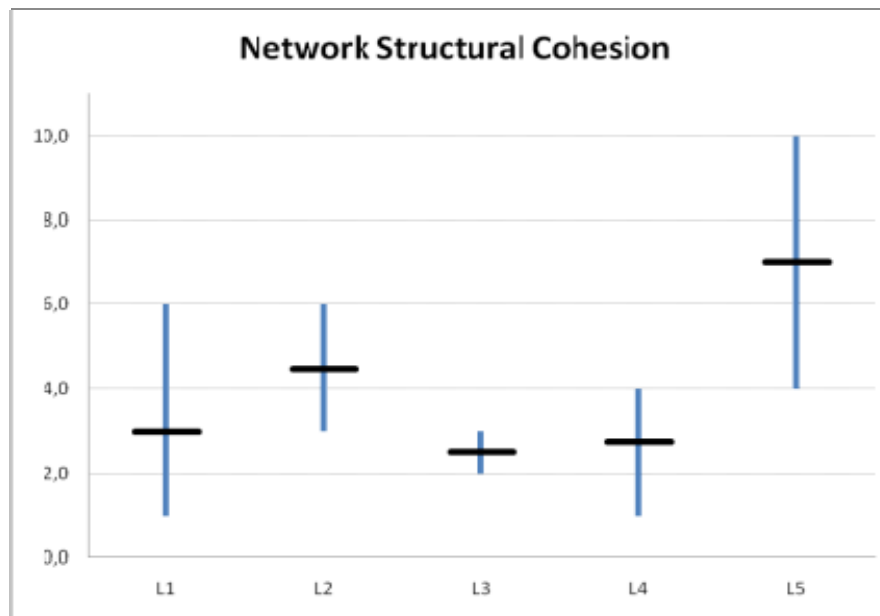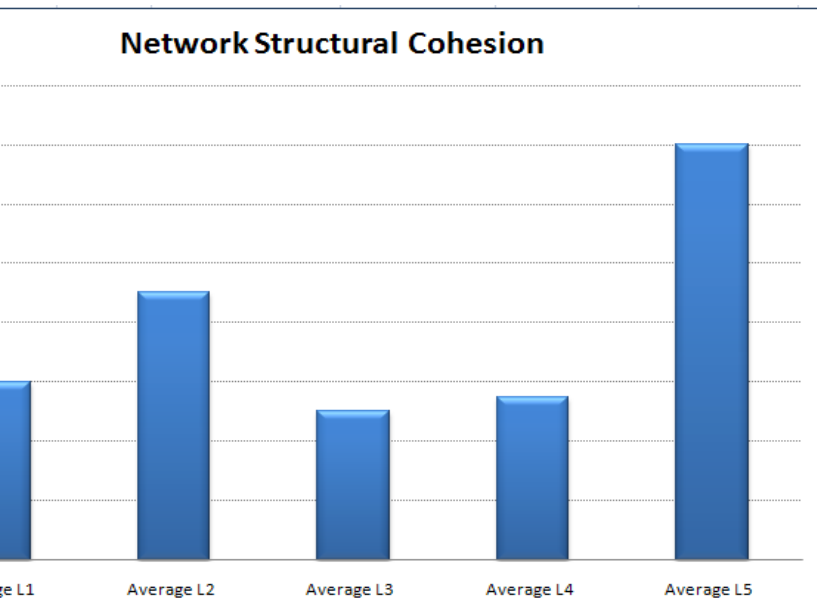
A Variable	Expected SNA Variable Behaviour From Less Mature To More Mature C2 Approaches
...ructural Cohesion	From LOW (small network cohesion) to VERY LOW (minimum network cohesion) and to HIGH (high network cohesion)

SNA Findings in the N2C2M2 ELICIT Experiments

Node Centrality			Node Embeddedness			Network Activity	Network Average Path Length	Network Inclusiveness	Network Clustering Coefficient	Network Connectedness	Network Structural Cohesion
Betweenness	Degree	Closeness	Link Density	Link Strength	Link Flow						
0,196	2,529	2,627	0,196	2,529	2,627	291	0,138	0,058	10,00	14%	3
16,157	2,667	6,903	0,536	6,941	22,725	490	0,950	0,000	8,00	16%	7
16,182	2,824	7,010	0,614	5,863	17,373	400	0,616	0,000	9,00	17%	5
2,852	2,098	8,098	0,154	1,627	6,314	704	0,471	0,157	9,67	19%	3
5,059	2,745	6,363	0,208	1,392	7,176	981	0,561	0,147	8,67	16%	7

L1 Conflicted C2 Approach

Low **node centrality**
Low **node embeddedness**
Constrained/Low **network activity**
Geodesic **path lengths**
Lowest **network diameter**
Low **inclusiveness**
High **clustering coefficient**
Reduced **connectedness**
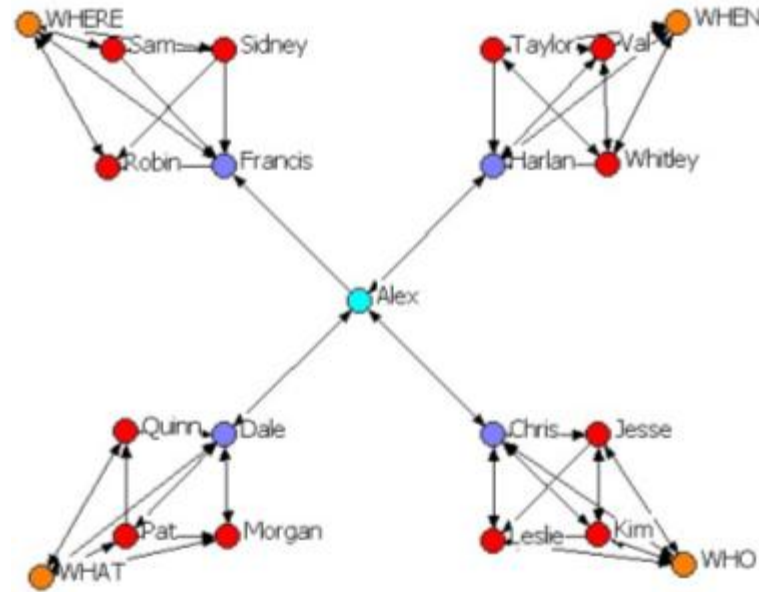Poor **network structural cohesion**
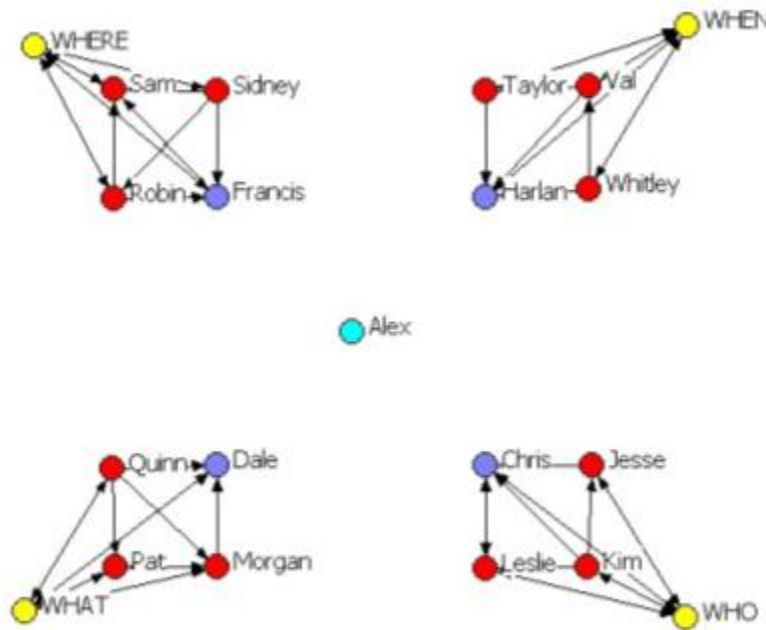
L1 03 Sociogram with websites

In 2 out of 3 runs, **one team solves its own problem space**
Very Low organisational success (mean value = 31%)

L2 Deconflicted C2 Approach

High **node centrality**

Highest **node embeddedness**

Enlarged/Medium **network activity**

Largest **path lengths**

Widest **network diameter**

No **inclusiveness**

Reduced **clustering coefficient**

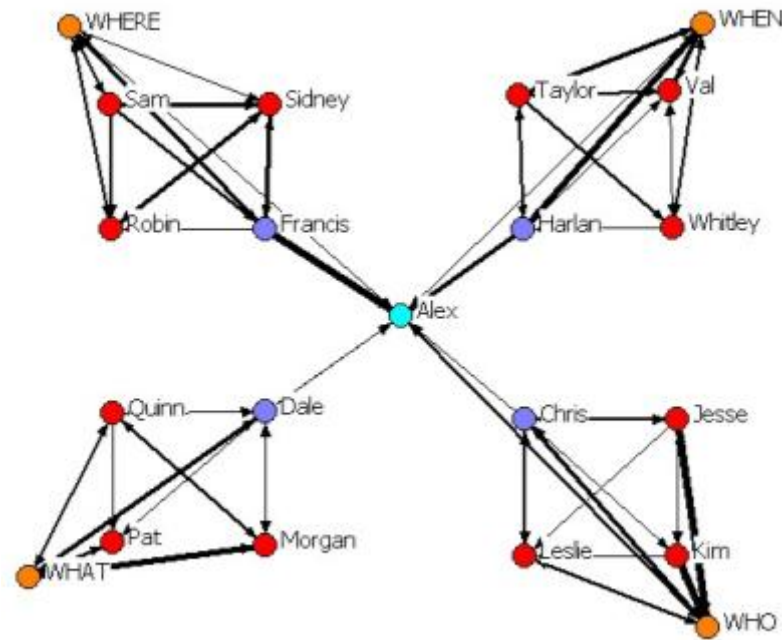High **connectedness**

High **network structural cohesion**

L2 01 Sociogram with websites

In 3 out of 4 runs, **two teams solve their own problem spaces**

Low organisational success (mean value = 44%)

L3 Coordinated C2 Approach

Highest **node centrality**

High **node embeddedness**

Medium **network activity**

Large **path lengths**

Wide **network diameter**

No **inclusiveness**

Highest **clustering coefficient**

High **connectedness**

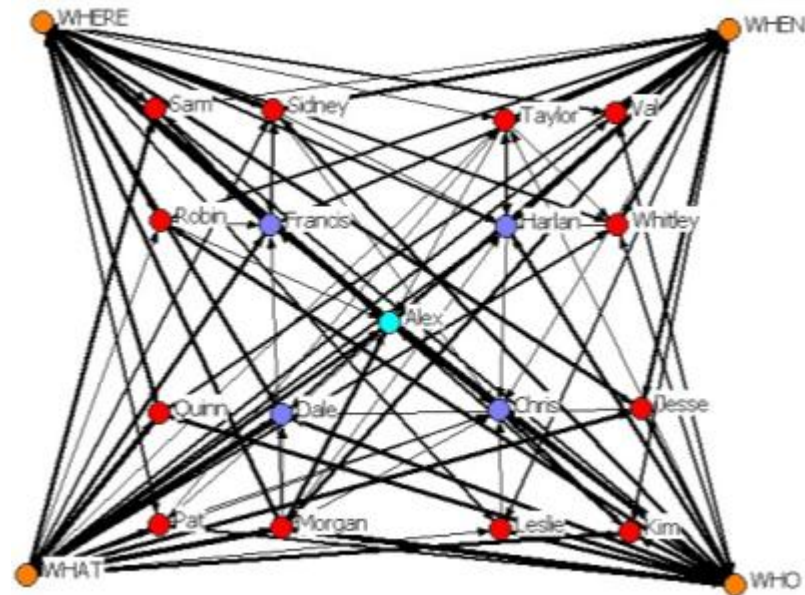Medium **network structural cohesion**

L3 04 Sociogram with websites

In 3 out of 4 runs, the Coordinator solved at most one problem space

Very Low organisational success (mean value = 34%)

L4 Collaborative C2 Approach

Low **node centrality**
Low **node embeddedness**
High **network activity**
Smallest **path lengths**
Small **network diameter**
Highest **inclusiveness**
Lowest **clustering coefficient**
Highest **connectedness**
Low **network structural cohesion**
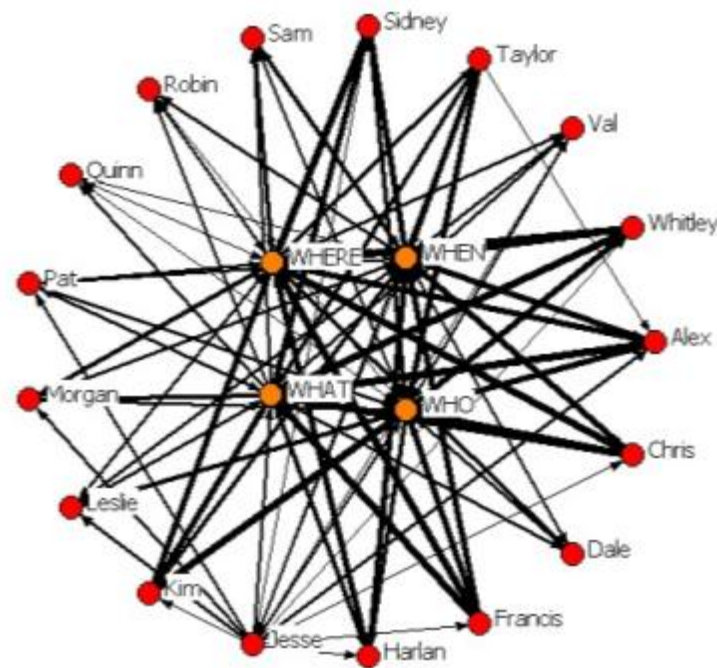

L4 01 Sociogram with websites

In 3 out of 4 runs, **three teams solve their own problem** spaces or the Facilitator solves three problem spaces
High organisational success (mean value = 80%)

L5 Edge C2 Approach

Medium **node centrality**

Medium **node embeddedness**

Highest **network activity**

Small **path lengths**

Large **network diameter**

Medium **inclusiveness**

Low **clustering coefficient**

High **connectedness**

Highest **network structural cohesion**


L5 03 Sociogram with websites

Ds plurality in 3 out of 4 problem spaces are correct

Moderate organisational success (mean value = 61%)

Knowing the Network, Knitting the Network

SNA is successful in displaying ganisational networking.

The power of **knowing the network** ables the opportunity to actively anage it or **knit it**.

SNA is a tool to build creative organisations, based upon teraction dynamics and **collaboration facilities,** so as to liver **enhanced performance** and achieve **success.**
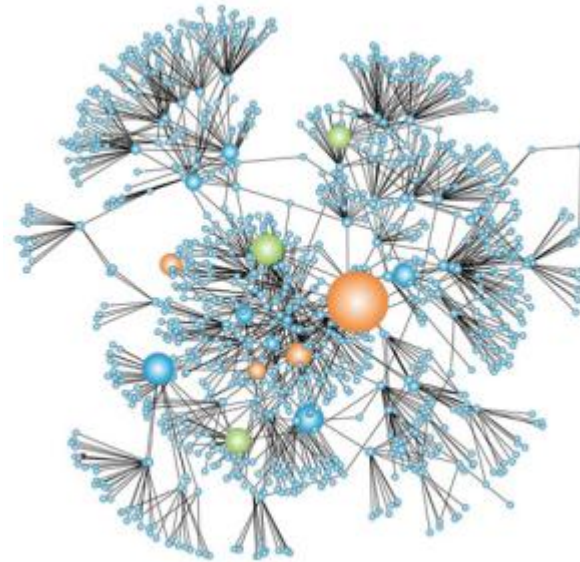
..:: Thank You for Your Attention ::..

Questions?