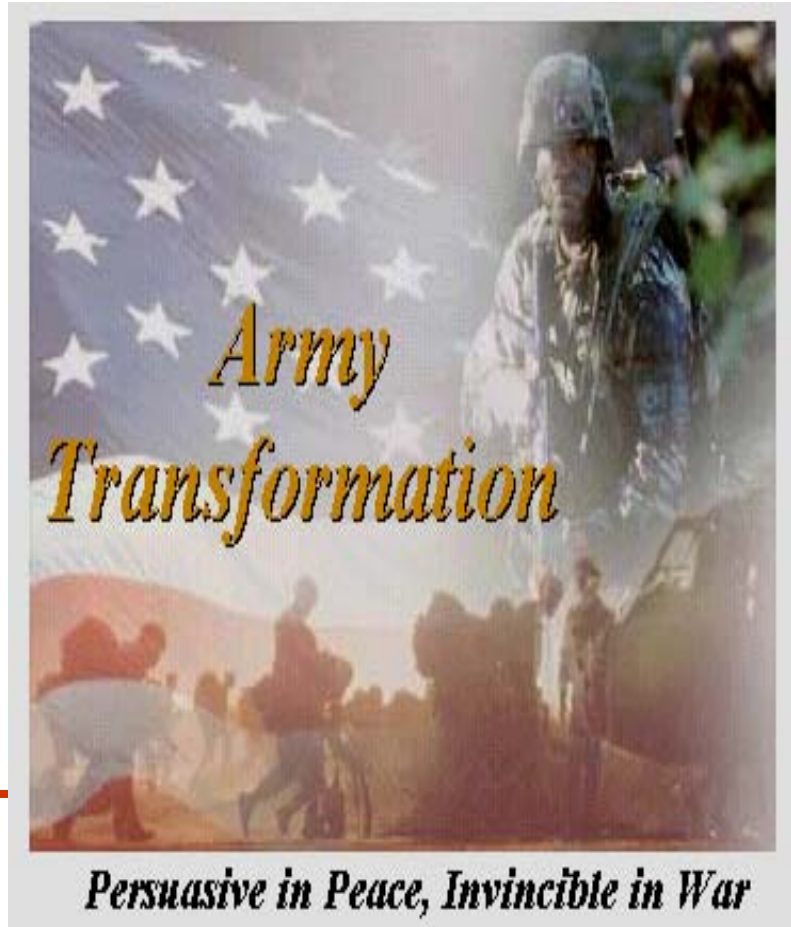
# Army Research Laboratory

Human Research and Engineering Directorate

## Technologies for Augmented Collaboration

**Pierce, Sutton, Foltz, Lavoie, Scott-Nash, and Lauper**

**2006 CCRTS**
**The State of the Art and the State of the Practice**




**Presented by:**
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# Future Force for Full Spectrum of Missions

***Environmental Complexity***

***High***
***Urban***

***Open rolling terrain***

***Low***

***Major Theater War***

***Small Scale Contingencies***

***Security, Transition, and Reconstruction Operations (STRO)***

***Spectrum of Conflict***

- **Future Battlefields**
  - More rapid tempos
  - Diverse missions
  - Culturally diverse teams
  - Distributed teams
- **Future Force**
  - Rapid deployment
  - Rapidly forming/reforming teams
  - Dynamic team building with diverse team members
  - More decentralized decision making
  - Novel problem solving for situations not covered by standard doctrine
  - Execution based planning

***Renders Previous Ways of Warfighting Obsolete***

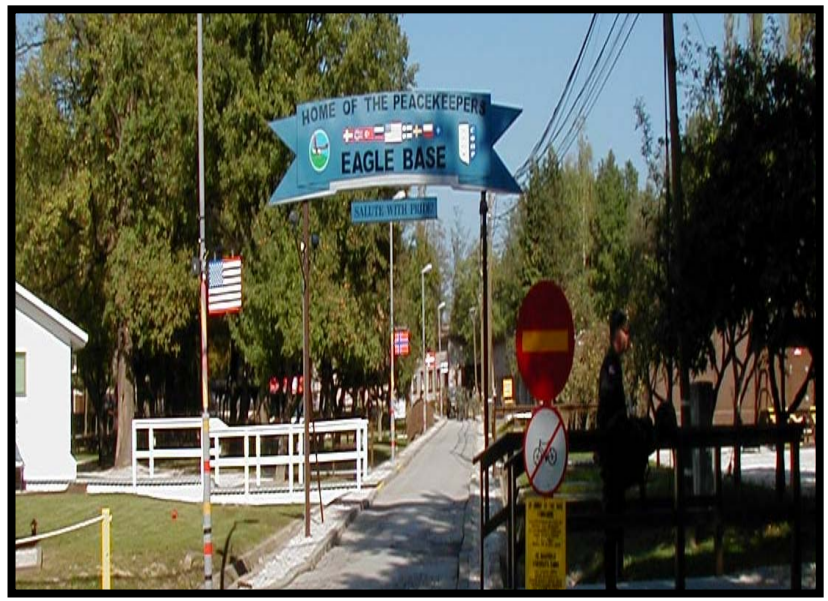
# *Stability, Security, Transition and Reconstruction Missions are "Wicked" Problems*

- **Simple Scenario:**
  - **Unit conducts a deliberate assault on regime forces defending a capital city *(decisive battle)***
  - **Battle staff plans and executes the operation using practiced battle staff drills**
- **Complex Scenario:**
  - **Unit conducts an assault on insurgency forces in an ethnically sensitive area *(asymmetric engagement)***
  - **Battle staff must extend battle calculus and adapt doctrine to address non-traditional adversary**
- **Wicked Scenario:**
  - **Unit coordinates peacekeeping operation with coalition partner who disagrees with priority of objectives *(protect ethnic population vs economic reconstruction)* and methods of engagement *("iron fist" vs "velvet glove")***
  - **Battle staff must collaborate extensively to define objectives, constraints, and range of appropriate actions**

***Negotiation among culturally diverse team members is an essential feature of wicked scenarios!***

# *Understanding Requirements*

- **Data were collected during Task Force Eagle (TFE) pre-deployment training (FY00).**




- **Structured observations and interviews were conducted at TFE Division and Battalion command posts at 1, 4, 6, and 10 months post deployment (FY01).**

- **Research was expanded to include multinational teamwork at SFOR HQ - data were collected quarterly (FY02-03).**

- **Research was supported by an MOA between ARL and FORSCOM.**

# *Observations from Bosnia-Herzegovina*

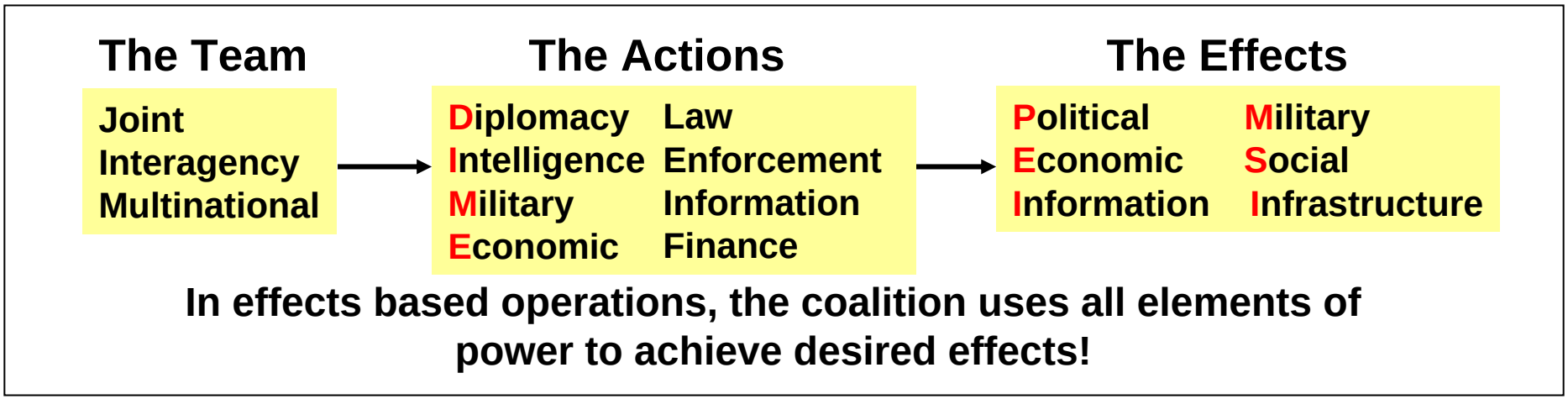
- **Training**
  - **Training in peacekeeping was not routine.**
  - **Training environment was complex and afforded limited feedback or replay.**
  - **Steady state skills were not well trained.**
    - **Information operations**
    - **Influence, persuasion and negotiations**
  - **Civil affairs or Civil Military Coordination (CIMIC) was not well represented.**
  - **Interaction with international agencies and multinational forces was limited.**
- **Organization**
  - **Warfighting mindset**
  - **Personnel instability**
  - **Procedures discouraged multinational cooperation**
- **Technology**
  - **Little collaborative technology for peacekeeping for:**
    - **Pattern analysis**
    - **Situation assessment**
    - **Historical and biographical databases**
  - **Technology supported centralized control.**

# *Bottomline*
# *Impact on Performance*

- **Peacekeeping expertise was slow to develop.**
- **Decision-making tended to be reactive and risk averse.**
- **Teams were not adaptable.**
  - **– Focus on efficiency**
  - **– Limited information exchange**
- **Teamwork was inefficient.**
  - **– Team diversity was not exploited**
  - **– Civil affairs or CIMIC was not integrated into core staff planning or operations**

# *Effects Based Operations*

- **The Army must undertake a major effort to transform the way it operates. The transition is to an effects-based approach to operations.**

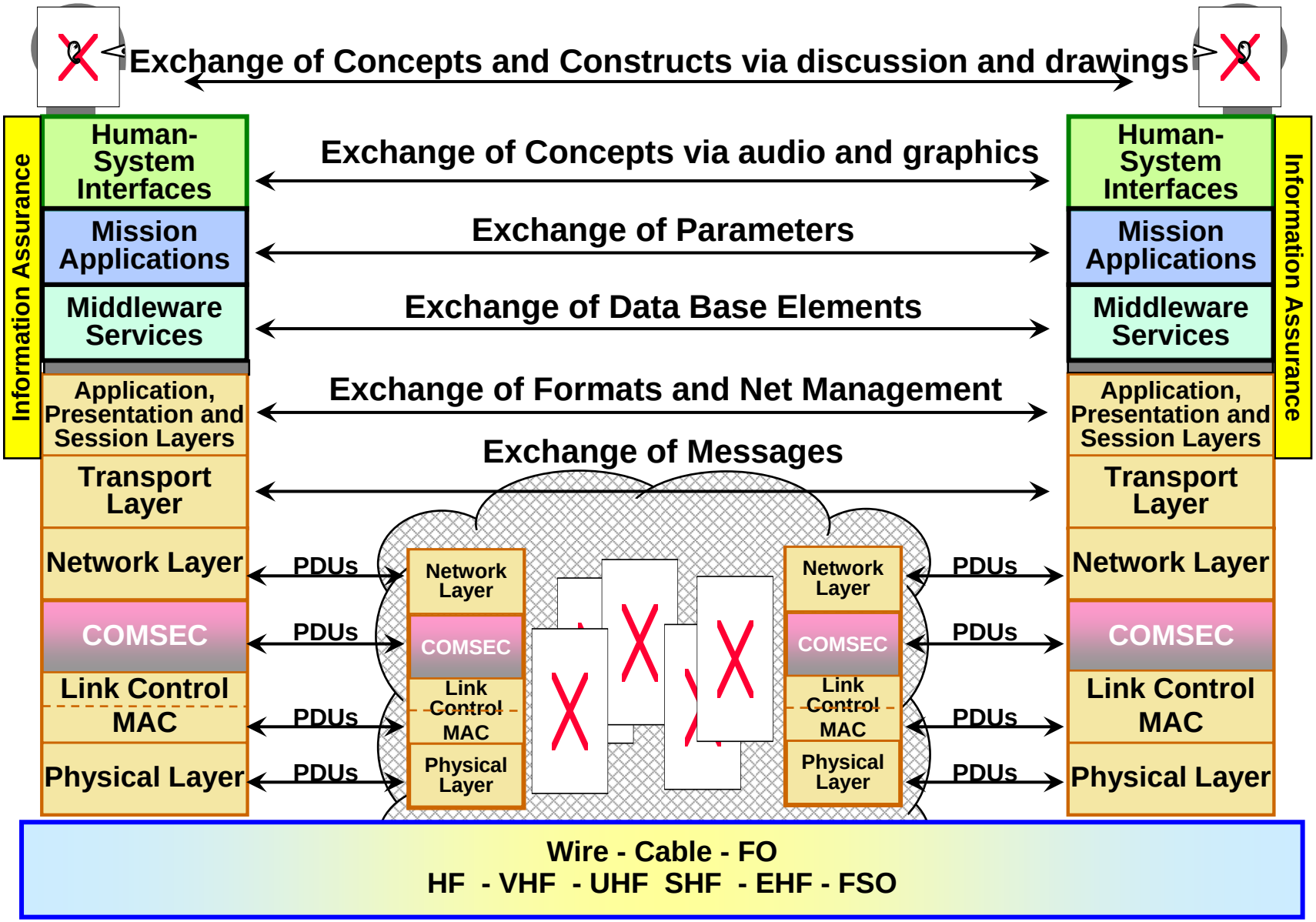



- **All recent operations have been coalition operations.**

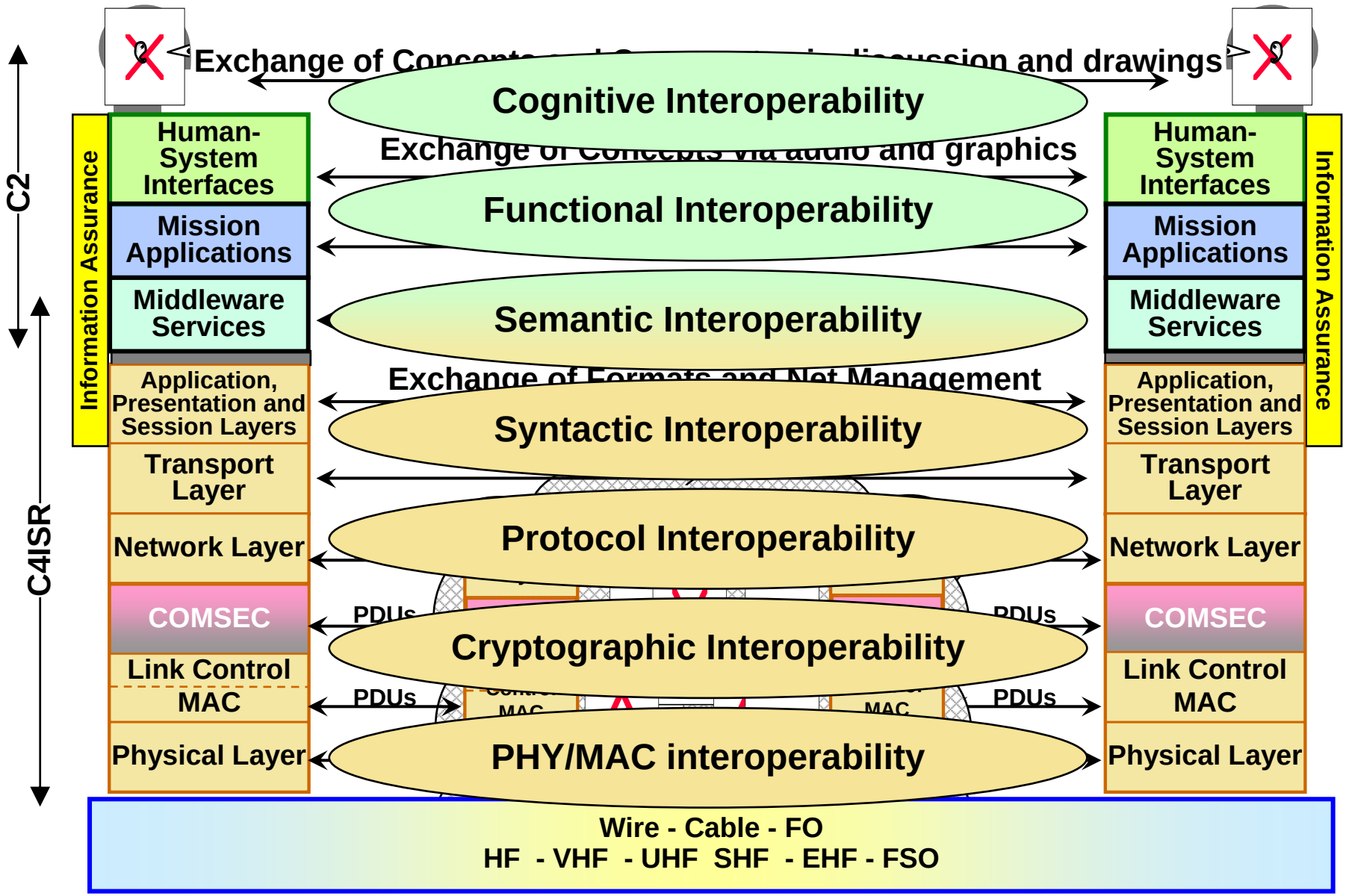
- **Effects based operations require collaboration among diverse, often distributed coalition partners.**

- **This program will develop software technology that significantly increases the ability of the U.S. Army to effectively form coalitions, lead multicultural teams and execute effects-based operations.**

# Information Exchange

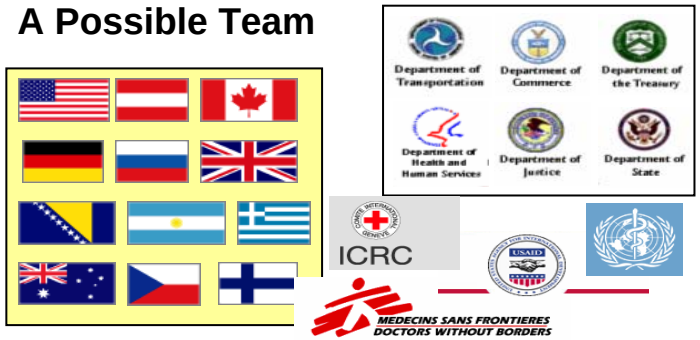


# Interoperability Areas



# *Effects Based Operations Require Multicultural Collaboration*

**A Possible Team**




**U.S. and Multinational Forces, Other Government Agencies, Non-Government Organizations**

***The ability to interoperate is necessary but not sufficient to insure effective collaboration.***

## Potential Barriers

- Limited understanding of team member roles and responsibilities
- Little information exchange
- Poor team coordination
- Little giving or receiving of assistance
- Little motivation to work with others on the team

## Implications

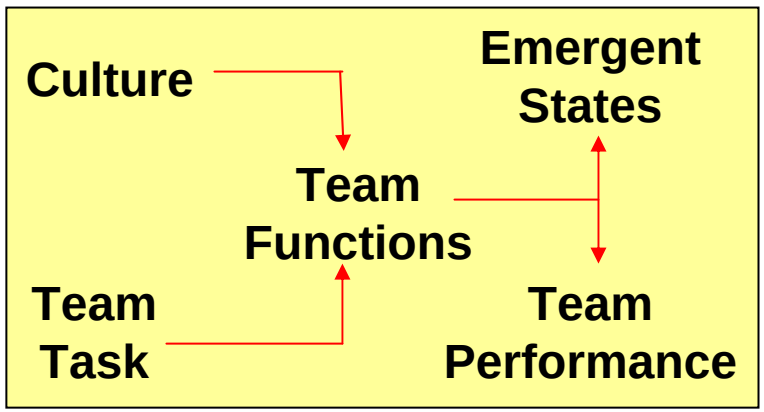
- Inaccurate team mental model
- Inaccurate team situation awareness
- Limited trust
- Increased conflict
- Social loafing or groupthink
- Risky decision making
- Lack of commitment to the team
- Little innovation or risk taking
- Poor team performance

# *Descriptive Model of Multicultural Collaboration*

**Input** → **Processes** → **Measures**

**Team Member Culture**
– Independent-Interdependent
– Egalitarianism-Status
– Risk-Restraint
– Direct-Indirect
– Task-Relationship
– Short term-Long term Orientation

**Team Functions**
– Roles and Responsibilities
– Coordination
– Information Exchange
  – Amount/Type/Quality of information
  – New Ideas
– Giving and receiving aid
– Motivation




**Emergent States**
– Team Mental Model
– Individual and Team Situational Awareness
– Psychological Safety –
– Trust

**Outcome Measures**
– Scenario Success
  – Accuracy/Quality
  – Timeliness
– Workload
– Progress Towards Goals
– Commitment to the team and team decisions
– Consensus - Convergence/Divergence of Ideas
– Range of Issues Considered

# *Technologies for Augmenting Multicultural Collaboration*

- **GlobeSmart ® Commander – Tool to assess cultural biases in cognition and teamwork and improve interaction among diverse team members.**

- **Latent Semantic Analysis – Automated techniques for text understanding that compare and determine the degree of semantic relatedness between any two texts.**

- **Dynamic Network Analysis – Computational models of the relationship among people, resources, tasks, and knowledge generated through real time monitoring of interactions.**

# *Improving Multicultural Collaboration in Effects Based Operations*

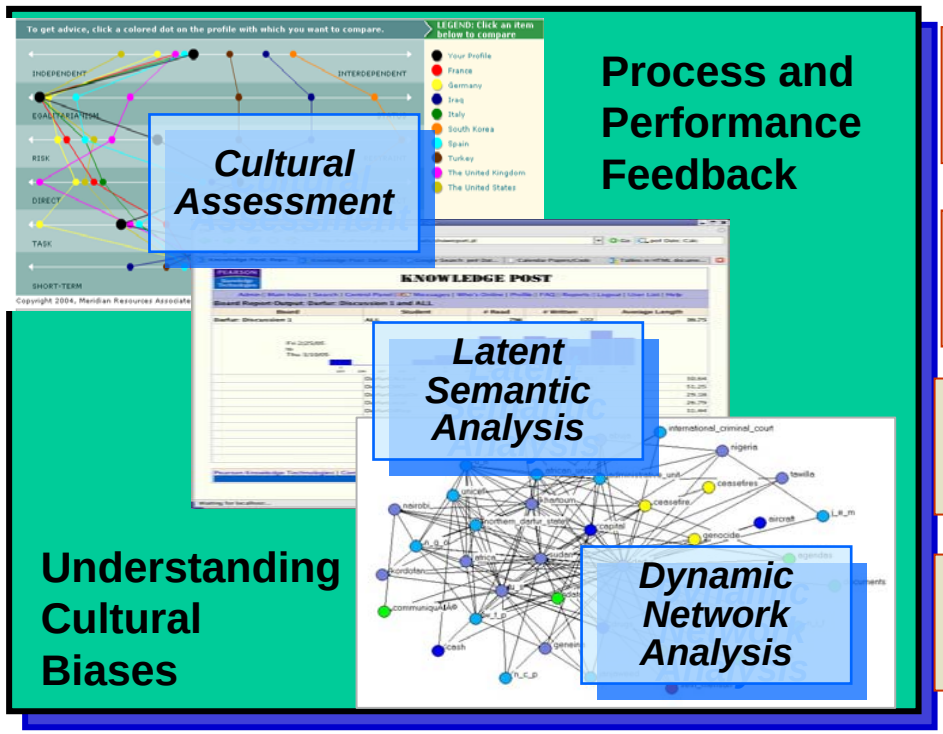
## Technologies for Augmented Collaboration

***The Environment*** ***Collaboration*** ***Support Functions***

### *The Team*
Joint
Multi-agency
Multi-national
Non-government

### *The Actions*
Diplomacy Law
Intelligence Enforcement
Military Information
Economic Finance

### *The Effects*
Political Military
Economic Social
Information Infrastructure
Other




***Team Formation***
**Who should be on this team?**

***Team Coach***
**What does the team need?**

***Understanding***
**What is the team doing?**

***Team Meter***
**Is the team generating viable solutions?**

**Tools to understand self, understand others … and improve collaboration**

# *Cultural Assessment (CA) Tool*

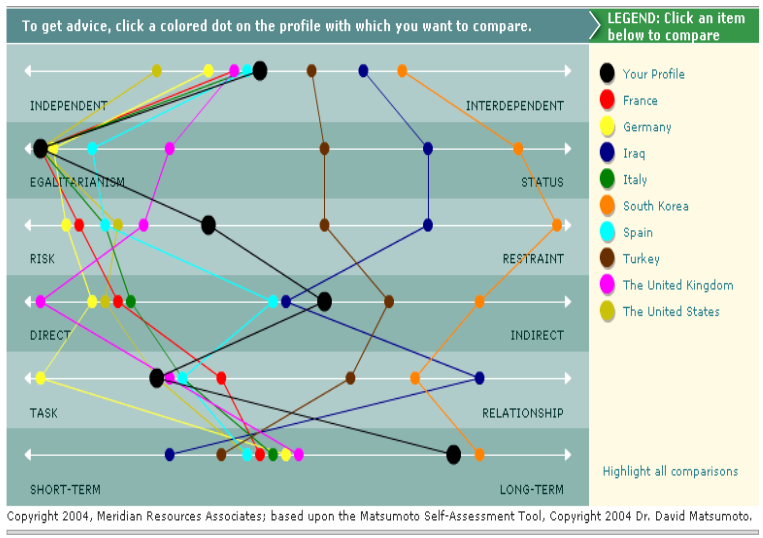
- **Culture is a set of assumptions, values, beliefs or traits shared by a specific community.**

- **Culture influences how people believe, think, and act.**

- **Cultural differences may have a negative affect on team performance.**

- **Approach to Cultural Assessment:**

  – **Apply tools from industry to the military environment.**
  – **Focus on inter-cultural rather than cross-cultural team performance.**


**GlobeSmart ® Commander**

# *1st Three of Six Key Dimensions of Culture*

| Independent | Interdependent |
|---|---|
| • Take more individual initiative | • Focus more on cooperation and group goal |
| • Use individual decision making styles (e.g., brainstorming) | • Use group decision making styles (e.g., consensus, meet before the meeting |
| • Reward / recognize individuals | • Reward / recognize group |

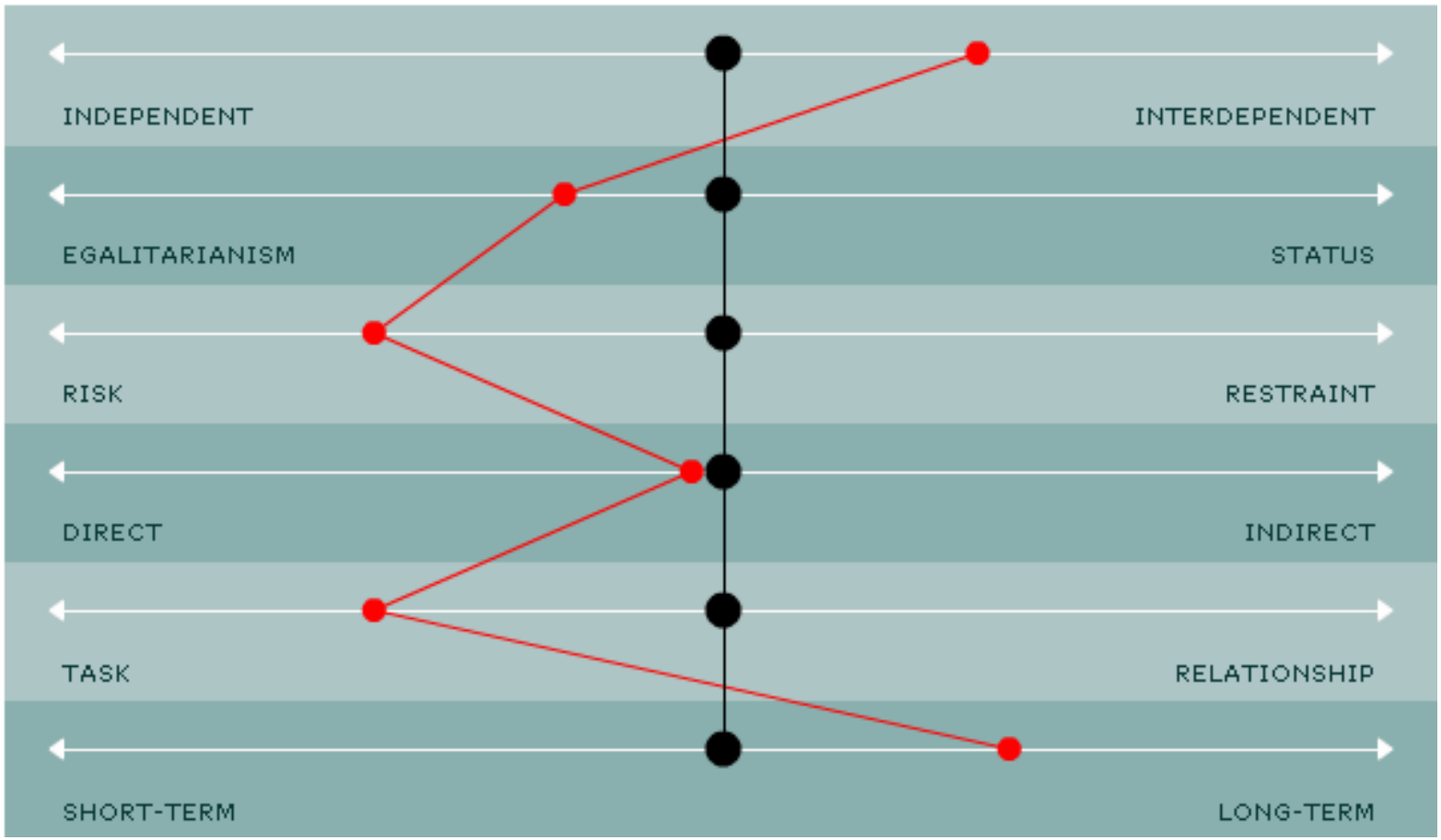
| Egalitarianism | Status |
|---|---|
| • Self-directed | • Enforce / follow guidelines |
| • Flexibility in roles | • Appropriate behavior for different roles |
| • OK to challenge opinion of people in power | • Status and position respected |

| Risk | Restraint |
|---|---|
| • Demonstrate quick results | • Spend time on background research |
| • Flexibility and initiative valued | • Establish proper processes and systems |
| • Speed valued more than thoroughness | • Take time before making a change |

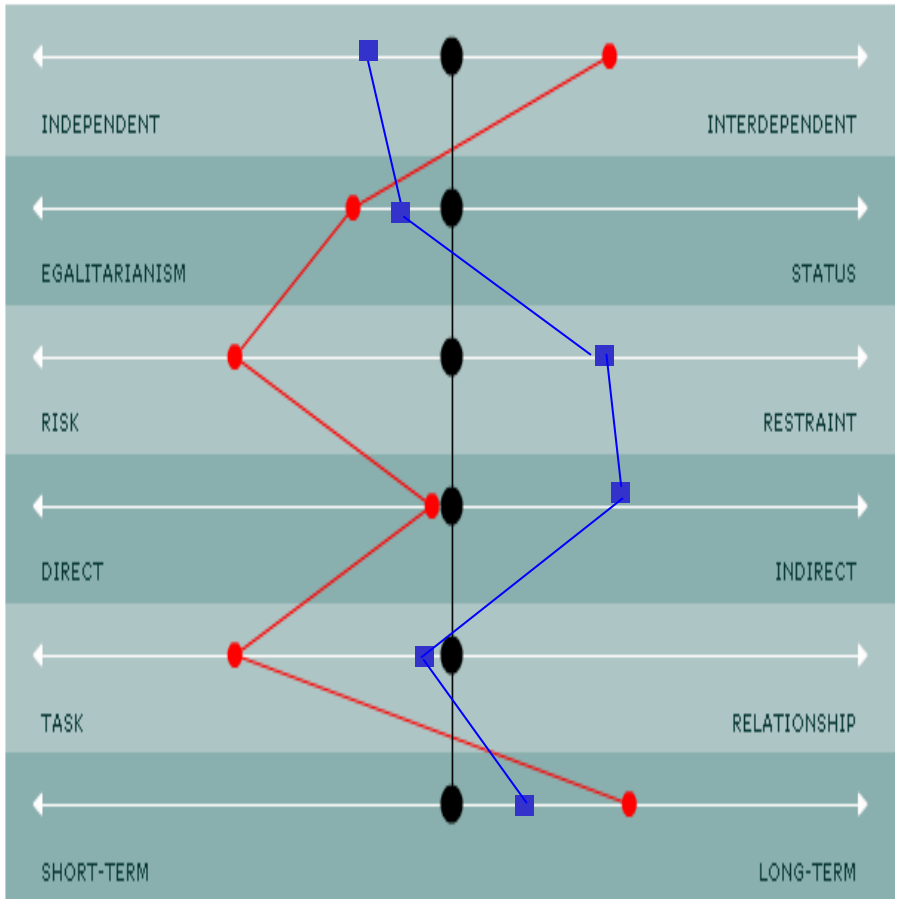
# *2nd Three of Six Key Dimensions of Culture*

| Direct | Indirect |
|---|---|
| • Explicit and to the point<br>• Openly confront difficulties<br>• Constructive feedback | • Carefully consider how things are said<br>• Avoid discussing difficulties in open forums<br>• Personal dignity / face issues are important |
| **Task** | **Relationship** |
| • Move quickly to business, relationships develop alongside<br>• Relationships develop quickly<br>• Focus on what you do, achievements | • Relationship-building is a critical part of getting the job done right<br>• Relationships develop slowly over time<br>• Focus on who you are, network |
| **Short-term** | **Long-term** |
| • Demonstrate immediate results<br>• Efficiency and speed important to decision making process | • Emphasize big picture and long-term results<br>• Thoroughness, consensus-building, and discussion of possible outcomes important |

# *Sample personal profile generated by Globesmart®*



# *Globesmart® Commander Cultural Gap Analysis*




## Behavioral Influences

**Individuals can have significantly different culturally based cognitive biases that influence their behavior.**

**In concert with cognitive biases of others, resulting behaviors will either enhance or damage team performance.**

**Leaders and teams who recognize those biases and understand the impact of culture on teamwork are better prepared to adapt, as needed, to ensure mission success.**

# Latent Semantic Analysis

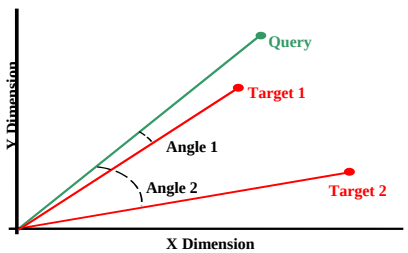
PEARSON Knowledge Technologies

## What is it?

- LSA is a computational approach to modeling language and knowledge.
- Automated technique for text understanding that learns by "reading" large bodies of representative text.
- Can make judgments of similarity on any new text using pre-trained semantic space

## How does it work?

- Compares the holistic meaning vectors of any two texts (news stories, chat contributions, training documents, …)
  - Compares and determines degree of semantic relatedness between any two texts
- Initially represents terms and documents in a matrix as a weighted count of occurrences (global entropy, local log weighting on terms).
  - Result is a very large, very sparse matrix (~100-200K terms X ~100K-1M + documents)
- Uses Singular Value Decomposition to decompose the matrix and reduce dimensionality
  - Result is a high dimensional semantic space
  - Each term and document represented as vectors--sets of 300 numbers
  - Vectors represent overall gist or meaning of words and passages




## LSA Metrics

- Shared Meaning
- Expertise
- Document Retrieval
- Comment Quality
- Team Performance

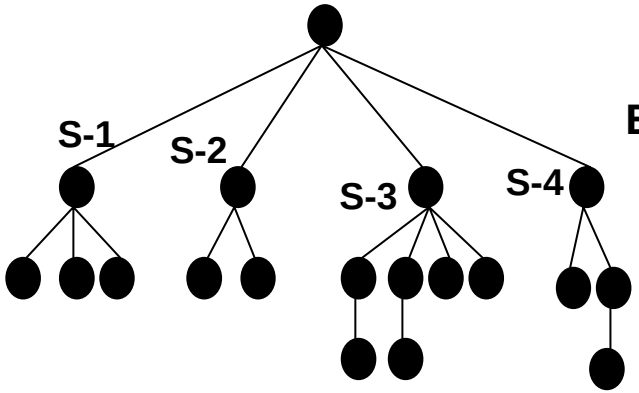

***The Commander could use LSA to inform and moderate team discussions to ensure the expertise of the team members is reflected in the optimal solution!***

# *Machine Learning-based Team Communication Analysis*

- **Judge quality of team performance from communication stream and prior team performance measures**
  - **Typed**
  - **Spoken**
- **Current research results**
  - **Accurately predicts overall team performance from discourse**
  - **Categorizes statements made by team members**
    - ***Uncertainty, planning, acknowledgements, …***
  - **Robust performance when combined with Automatic Speech Recognition Systems**
  - **Language independent (English, Arabic, Swahili, Hindi, …)**
- **Output**
  - **Metrics to track team behavior and performance**
  - **Feedback for Commanders**
  - **Automated AARs**

# Dynamic Network Analysis

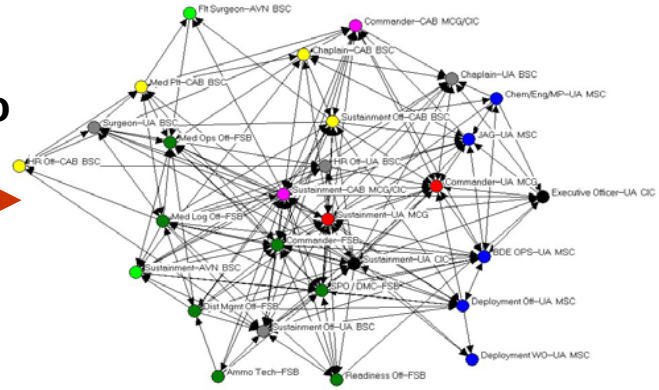
**DNA is a computational approach to modeling and simulating interactions among people, knowledge, resources, and tasks**




*Traditional Brigade Staff Hierarchy: UA Formal Structure*

**EBO moves from traditional to nodal networks.**

**Making sense of EBO informal nodal networks requires a special type of network analysis tool suite!**



*UA Nodal Operations: Informal Network*

## DNA Metrics

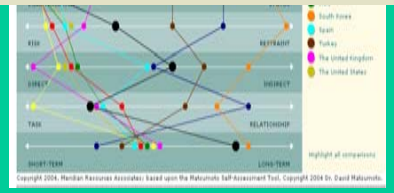
- **Who knows whom – Centrality, Between-ness, Cliques**
- **Who knows what – Expertise, Exclusivity**
- **Who does what, when – Workload, Precedence**
- **How much is done – Workload, Cognitive Demand, Complexity**

| | People / Agents | Knowledge / Resources | Events / Tasks |
|---|---|---|---|
| People / Agents | Social Network | Knowledge Network | Attendance Network |
| Knowledge / Resources | | Information Network / Substitutes | Needs Network |
| Events / Tasks | | | Precedence Ordering |

# Forming, Supporting, and Measuring Team Performance

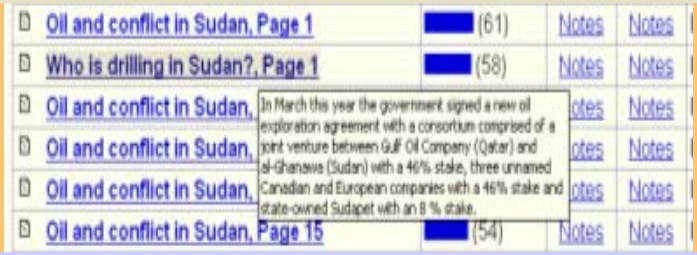
## Formation (Yellow Pages)


- Who and what expertise do we need
- Who is available
- Who works well together

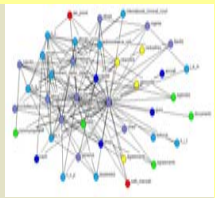



## Coach

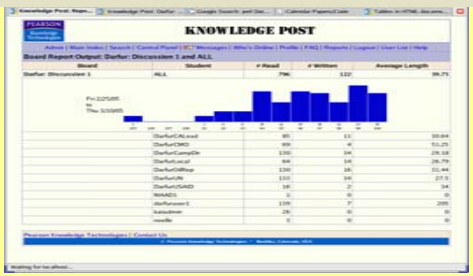
- Support team member interactions
- Identify gaps in knowledge and expertise
- Establish metrics for success

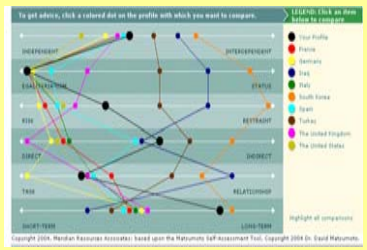



## Understanding



- Display team processes
- Display team networks (social, knowledge, resources)
- Display team performance



## Meter

- On task to completion
- Monitor sources for new information

| | |
|---|---|
| Number of organizations | 47 |
| Number of resources | 40 |
| Number of agents | 126 |
| Number of tasks | 42 |
| Number of locations | 48 |
| Number of knowledge | 62 |

# *Example of TAC in Action*

## *The Darfur Simulation*

**Executed a 10 Day Simulation based on Actual Darfur Mission**

**Darfur is a classic example of an EBO mission**

- **Ongoing conflict in the Darfur region of western Sudan**
- **Government-supported Arab militia vs. non-Arab peoples of the region**
- **Estimated 300,000 deaths**
- **20+ ethnic groups affected, with more than 1.8 million people displaced**
- **50+ NGOs operating**


### *The Mission*

**On order, COL Fernandez deploys to South Darfur state to assume command of all US forces comprising Multinational Force Darfur Watch. When directed, US forces support MNF operations to restore order and stability to the region.**

Internally displaced persons (IDPs) are being forcefully relocated and denied access to humanitarian aid.

Rebels are using boys as young as 12 to carry out attack orders.

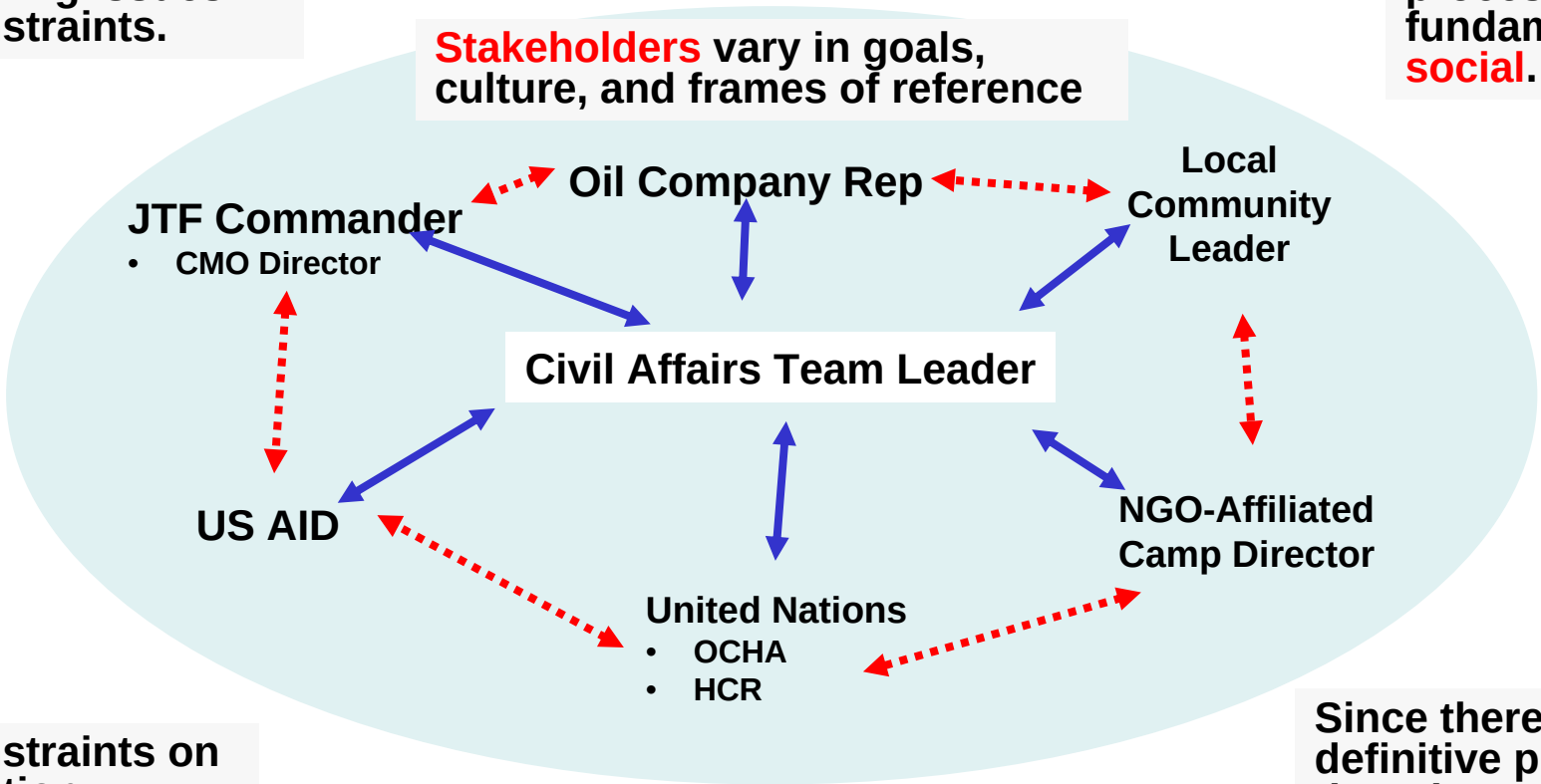
Rebel forces are attacking foreign oil industry workers and infrastructure.

# The Darfur Mission

## A "Wicked" Scenario

**A problem is an evolving set of interlocking issues and constraints.**

**The problem solving process is fundamentally social.**




**The constraints on the solution change over time.**

**Since there is no definitive problem, there is no definitive solution.**

**Complex problems are a social negotiation**

**"On any given day, I deal with the political realm of the Coalition Provisional Authority, the humanitarian realm of the NGOs, and the military realm of firefights, improvised explosive devices, snipers, [and/or] mortar attacks."** Commander in Iraq: Bde Cdr, 1st AD after 16 days in command

# Team Adaptability

## Identifying and Correcting a Problem

### Team Coach

**Identify gaps in knowledge and expertise**

**Determines from the dialog that there is a need for a SME to review the child soldier rehabilitation plan**

**Civil Affairs: We need to assist the MNF, local authorities, and NGOs in the safe recovery of child rebel soldiers seeking freedom**
**USAID: There was a successful project in Burundi.**
**UN: Who knows about the program?**

### Team Formation

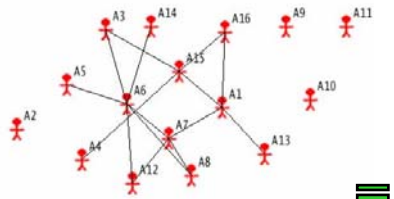
**Determine what expertise is needed**

**Analyze texts from Burundi child soldier rehabilitation projects to identify possible candidates**

**Child Soldier Reintegration Project**
- **First began in November 2003**
- **125 children and adolescents have been reintegrated into the community of Karusi**
- **UNICEF-funded project began in November 2003, expected to last 11 months**

### Understanding

**Show social and knowledge networks**

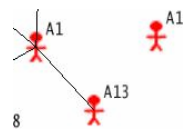



### Team Formation

**Determine who is available and will work well together**

**Cultural Assessment ranks and filters the possible candidates**

**The candidates are filtered based on availability**




D N A  B I O G R A P H Y

Name: Anchita Ghosh

Field: Humanitarian Aid

Current Position: East Africa Regional Director for Save the Children

Areas of Expertise:

Child protection specialist:

Urban street children

Orphaned refugees

Rehabilitating child soldiers

Program manager:

Multi-partner development

Large field programs

Education:

BS Psychology, University of Delhi

MSW University of Manchester, UK

Cultural Background: Ugandan citizen. Family of Hindu Punjabi origin.

Languages: English, Punjabi, Hindi, Swahili.

**Select**

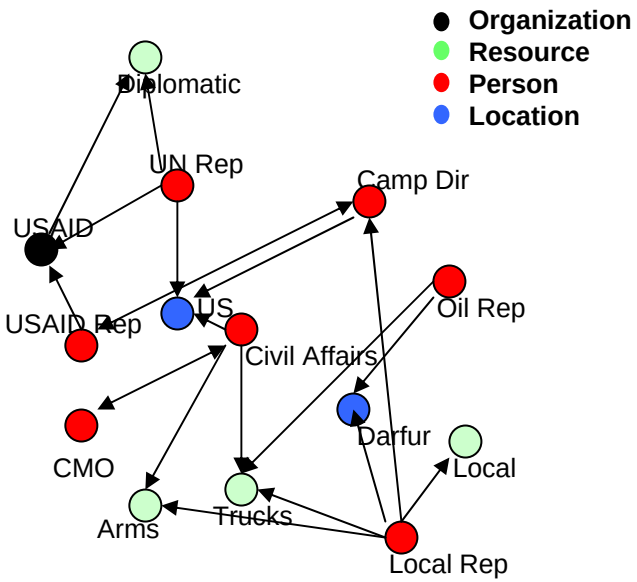
### Team Meter

**Team is back on track**

# Team Self Correction

## *Understanding*

**Display team networks (social, knowledge, resources, etc.)**
**Display team performance**




**Different Roles – Different Agendas**

| Role | Agenda | Cultural Framework | Participation Rate |
|---|---|---|---|
| Civil Affairs | Coordinate with the JTF commander's office to provide local threat intelligence and protection | Military officer: embedded in hierarchal organization but has close ties to host nation's bureaucratic civil community. | 14% |
| Refugee Camp Director | Procure safe transport for food and people<br>Encourage local population to register at camp for services | NGO humanitarian aid worker:<br>Decentralized organizational structure but has ties of varying degrees to most stakeholders, including IDP population, UN, and military. | 29% |
| CMO | Survey status and needs of refugee camp | Military officer: embedded in hierarchical organization but has close ties to diplomatic community. | 3% |
| UN | Coordinate high level goals and meetings | International humanitarian official: embedded in international humanitarian organization but has close ties to NGO workers and diplomatic community. | 27% |

### Implications

- **Isolated military personnel are on the periphery of the problem solving process.**

- **Need to encourage higher rates of participation between military and non-military team members.**

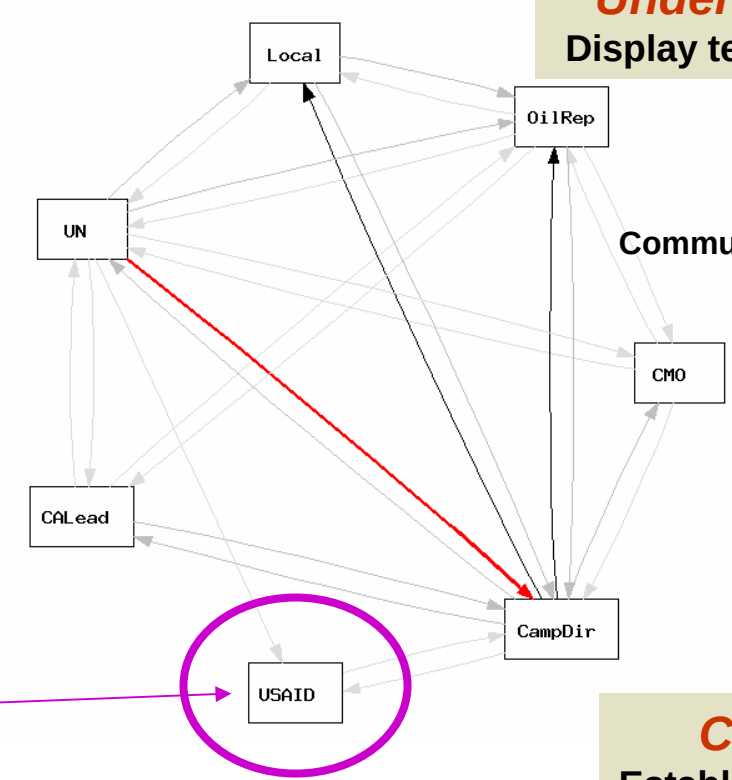
# Team Self Awareness

**Understanding**
**Display team performance**

**Consensus Over Entire Discussion**

| Role | Consensus Score |
|---|---|
| UN | .768 |
| Camp Director | .759 |
| CA Lead | .720 |
| Oil Rep | .718 |
| Local | .701 |
| CMO | .576 |
| USAID | .524 |

**Understanding**
**Display team processes**




**Communication Pattern**

**Coach**
**Establish metrics for success**

**Comparing expected and actual levels of performance**

- **USAID rep's low participation and consensus scores target him for intervention.**

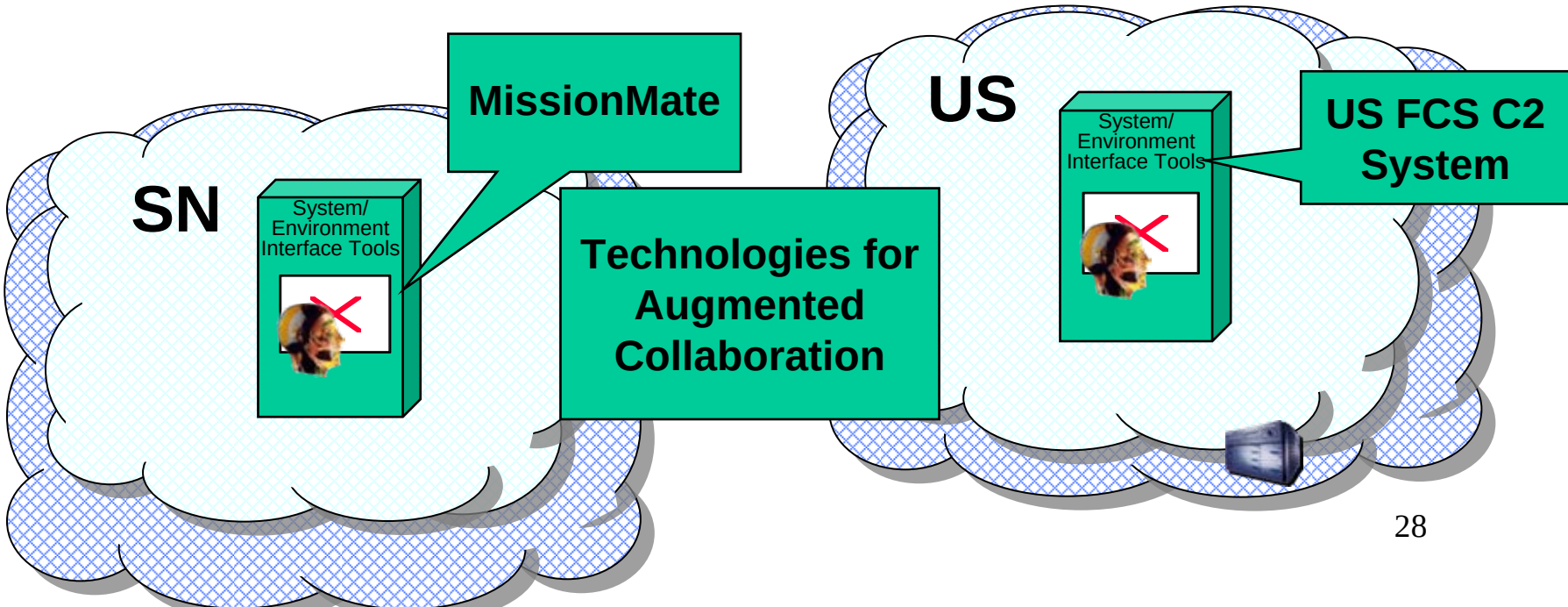
- **However, his position as a high ranking government official means he is expected to have little involvement in the day-to-day issues.**

- **Expected performance matches actual performance**

# *US and SN Experiments*

- **Participants – US and SN Command Staff**
- **Scenario**
  - **Bio-terrorism**
  - **Humanitarian Relief**

- **Independent Variables**
  - **Command System**
  - **Augmented Collaboration Tools**
- **Dependent Variables**
  - **Team Processes**
    - **Shared Mental Model**
    - **Team Situation Awareness**
    - **Trust**
  - **Outcome Measures**



# *Summary of Cultural Adaptability Research*

- **ARL HRED Cultural Adaptability Research Program has been formalized in 2 international working groups:**
  - **Cultural Diversity in Cognition and Teamwork, HQ Supreme Allied Command - Transformation, Futures and Engagement, Concept Development and Experimentation**
  - **Adaptability in Coalition Teamwork (ACT) RTO HFM TG 138**
- **FY06 Research Venues:**
  - **US and Singapore Exercises**
  - **Allied Warrior 05**
  - **Multinational Experiment 4**
- **SABRE (Situation Authorable Behavior Research Environment)**

# QUESTIONS?