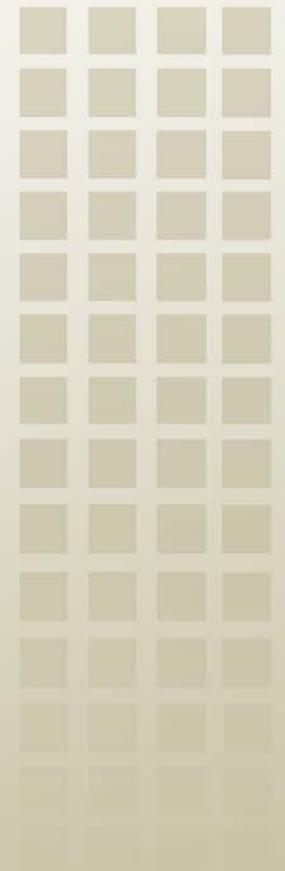


A Process Decomposition Approach for Evaluating Command and Control (C2) Functional Performance



The Johns Hopkins University
APPLIED PHYSICS LABORATORY

Steven L. Forsythe, Ph.D.

Paul North



Purpose

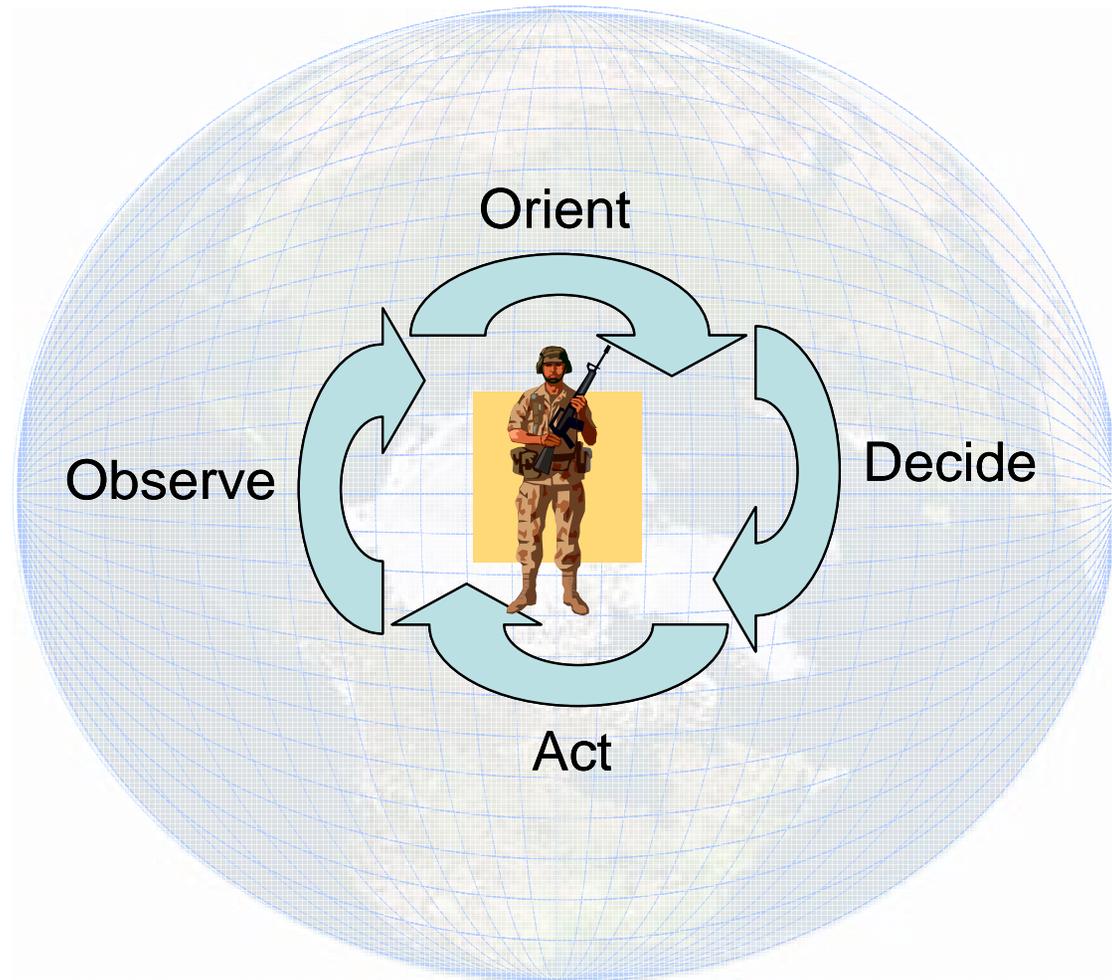
To describe APL's approach for using functional decomposition to understand and evaluate the C2 process.

Outline

- **Description of various C2 Process Models:**
 - OODA
 - MAAPPER
 - Noble (C2 Operational Architecture)
 - Bayne (Enterprise C2)
- **Decomposition of C² into a measurable set of sub-processes**
- **Aggregate C2 Process Model**
- **Example Process Decomposition**
- **Road Ahead via Experimentation & Simulation**

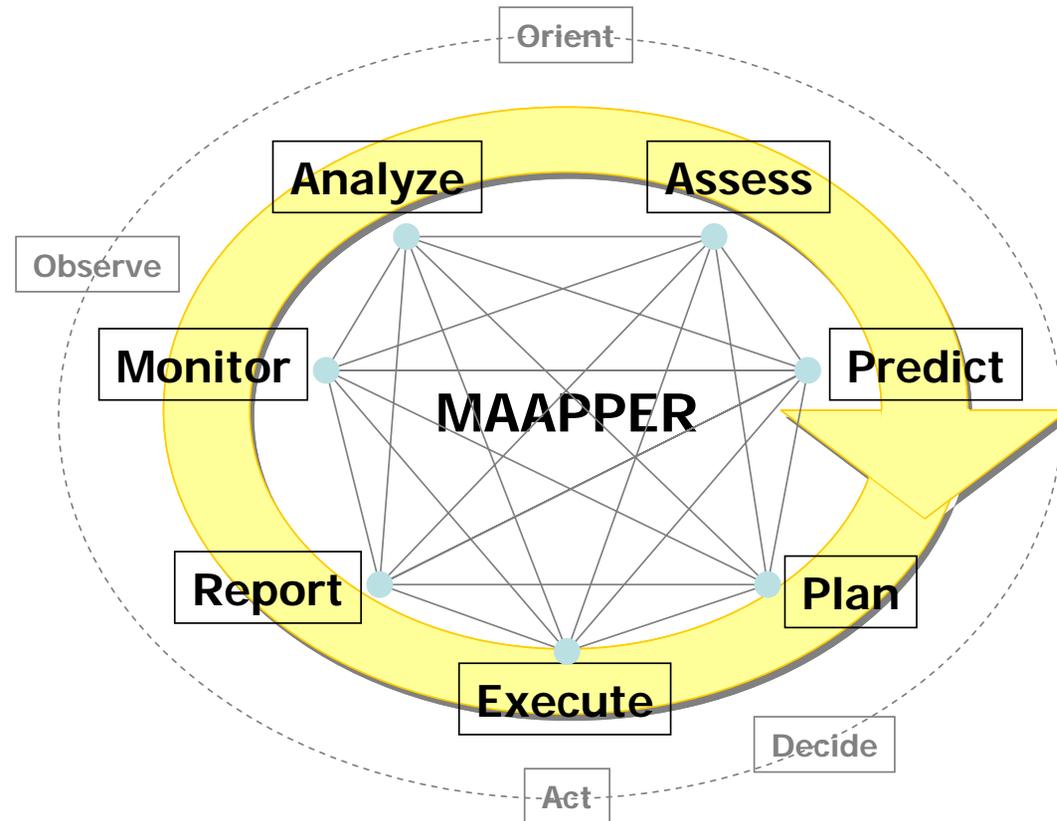
OODA – Col John Boyd

- **Observe**
- **Orient**
- **Decide**
- **Act**



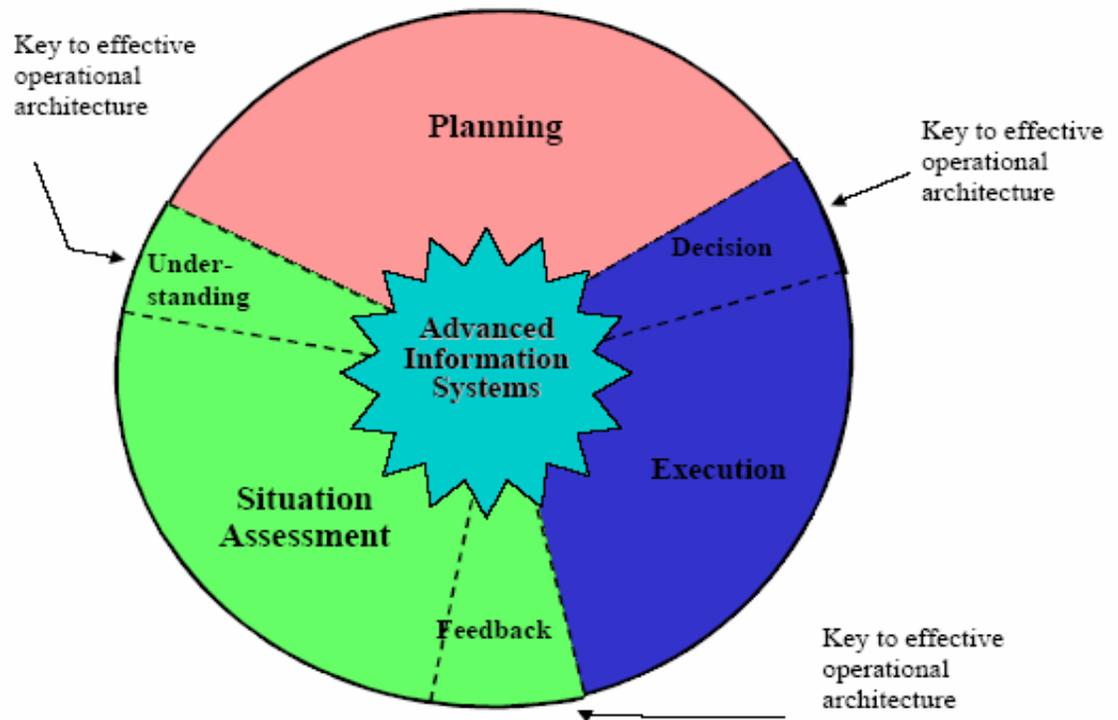
MAAPPER – USSTRATCOM

- Monitor
- Analyze
- Assess
- Predict
- Plan
- Execute
- Report



Operational Architecture - Noble

- **Situational Assessment**
- **Planning**
- **Execution**



Key Elements (KE) of C2

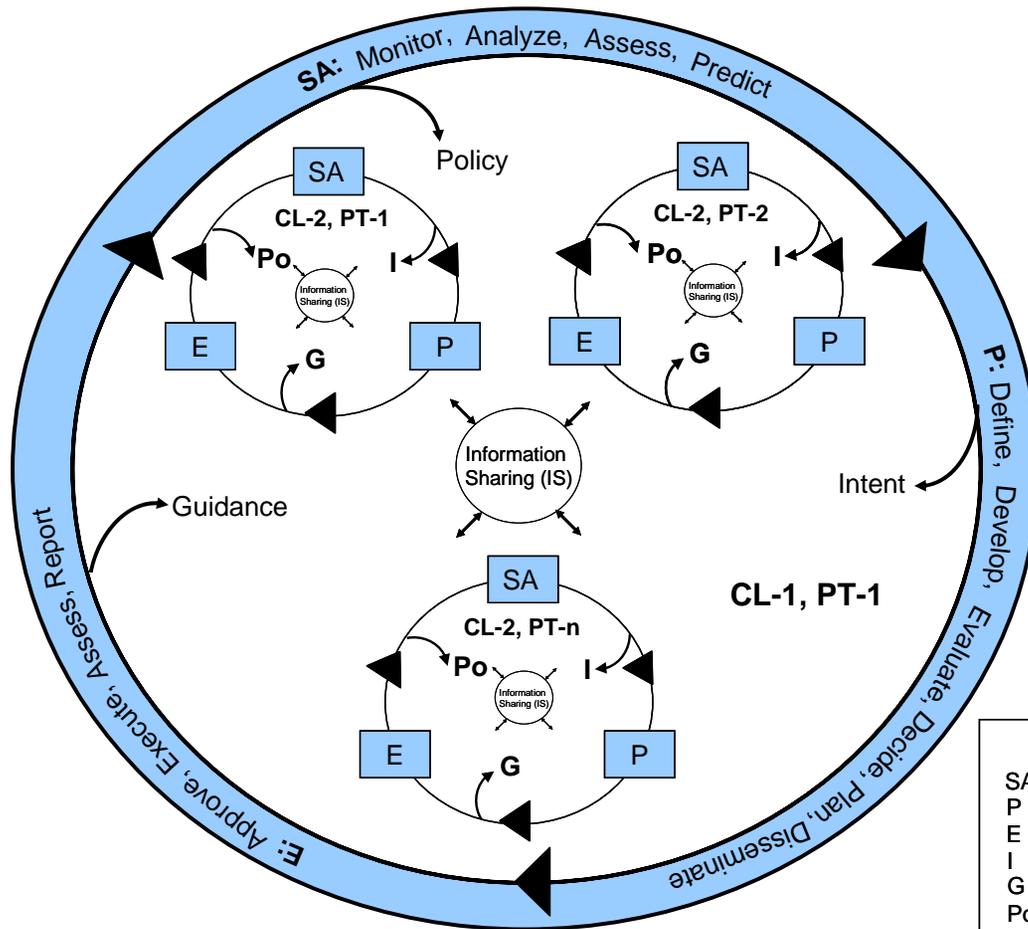
Key Elements of Command and Control					
Situational Assessment		Planning		Execution	
Monitor	Observe and record characteristics of the physical, political, social, and economic environments as they pertain to own and adversary forces	Define (Strategy)	Define mission strategy and requirements based on the characteristics of the emerging situation	Approve Plan	Approve plan for subsequent execution
Analyze	Investigate the details of those observations	Develop COA	Develop one or more Courses of Action (COA) to address the needs of the current situation/mission taking into account as many contingencies as time permits	Execute (Plan)	Carry out the selected COA
Assess	Evaluate the impact of analysis results on current plans	Evaluate	Analyze each COA to ensure it is consistent with the commander's intent and addresses all mission objectives	Assess Situation	Perform battle damage assessment and evaluate the degree to which the COA plan was or is being executed successfully; adapt plan accordingly
Predict	Use estimation results to forecast possible and likely outcomes based on the characteristics of the situation as it is currently understood	Decide	Analyze the probability of success for each COA and select the plan most likely to succeed given the set of assumptions most likely to occur	Report	Report mission execution findings
		Plan in Detail	Based on the selected COA, develop the details of the plan including areas such as logistics, targeting, environmental considerations, contingencies, etc.; allocate resources, assess readiness		
		Disseminate	Distribute plan to appropriate superiors, subordinates and partners		

Compare C2 Process Models

Aggregate	OODA	MAAPPER	Noble	Bayne	JOPES	C2JFCD
Monitor	Observe	Monitor	Situational Awareness	Filter	Monitoring	Monitor & Collect Data
Analyze	Orient	Analyze	Situational Awareness	Filter	Simulation & Analysis	Dev. Situational Understanding
Assess	Orient	Assess	Situational Awareness	Triage	Identify & Assess Threat	Dev. Situational Understanding
Predict	Orient	Predict	Understanding	Triage	Identify & Assess Threat	Dev. Situational Understanding
Define Strategy	Decide	Plan	Planning	Policy, Resource	Determine Strategy	Develop & Select COA
Develop COA	Decide	Plan	Planning	Policy, Resource	Develop COA	Develop & Select COA
Evaluate	Decide	Plan	Planning	Policy, Resource	Develop COA	Develop & Select COA
Decide	Decide	Plan	Planning	Approval	Develop COA	Develop & Select COA
Plan (in detail)	Decide	Plan	Planning	Policy, Resource	Plan in Detail	Develop a Plan
Disseminate	Decide	Plan	Planning	Approval	Plan in Detail	Develop a Plan
Approve (Plan)	Decide	Plan	Decision	Approval	Plan in Detail	Develop a Plan
Execute (Plan)	Act	Execute	Execute	Execute	Implement	Execute the Plan
Assess Situation	Act	Execute	Feedback	Execute	Implement	Monitor & Adapt
Report	Act	Report	Feedback	Execute	Implement	Monitor & Adapt

The Aggregate Model accounts for the other models by grouping and aggregating the C2 subprocesses

Aggregate C2 Process Model



■ C2 Fractal

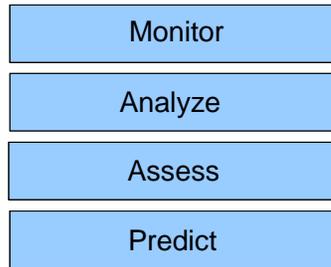
- Replicated at all levels within a unit
- Replicated by all units

Key

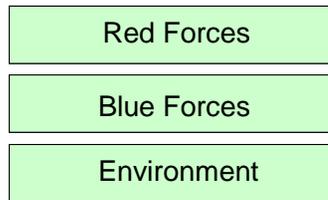
SA = Situational Assessment
 P = Planning
 E = Execution
 I = Intent
 G = Guidance
 Po = Policy
 CL = Command Level
 PT = Participant

Example C2 Process Decomposition

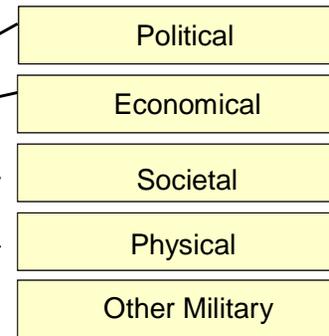
Situational Assessment KE
1st Level Decomposition



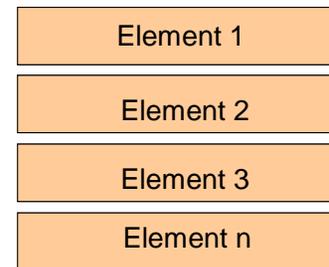
Situational Assessment KE
2nd Level Decomposition



Situational Assessment KE
3rd Level Decomposition



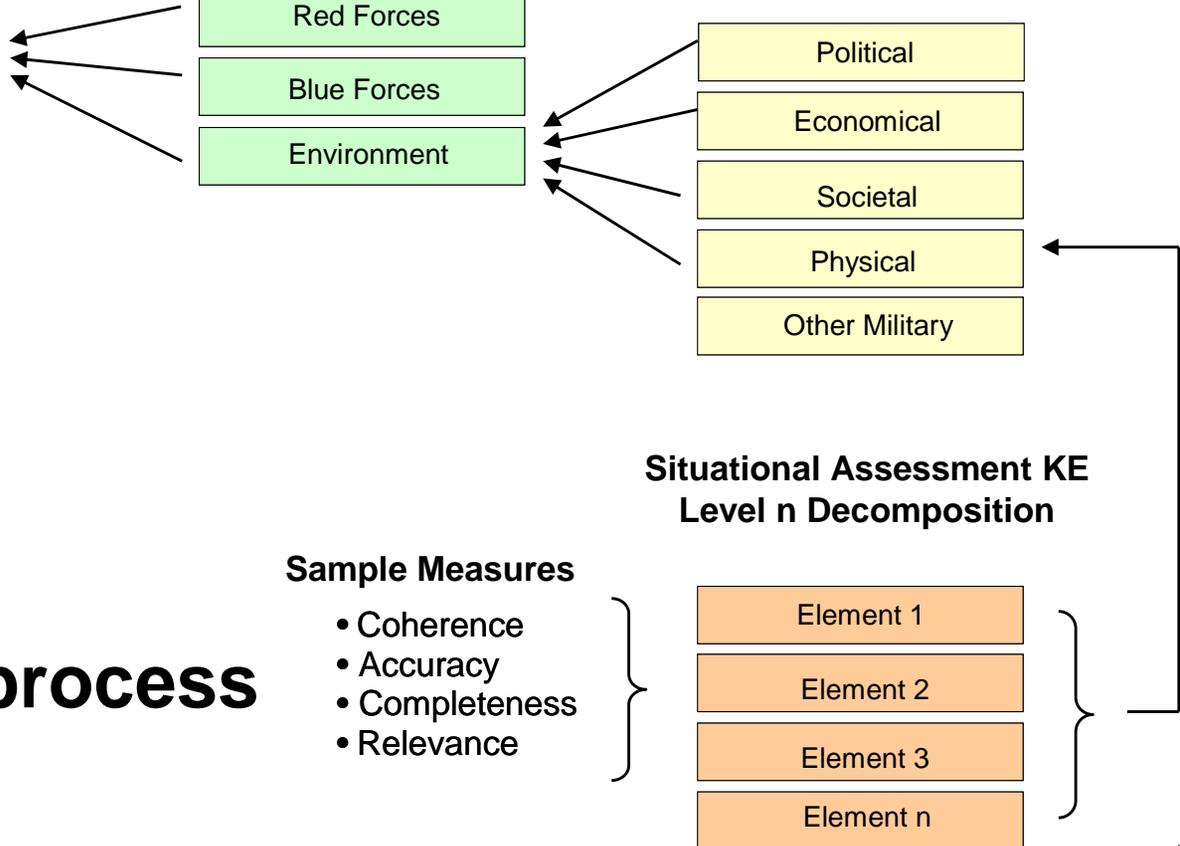
Situational Assessment KE
Level n Decomposition



Sample Measures

- Coherence
- Accuracy
- Completeness
- Relevance

Monitor Sub-process



Road Ahead

- **Complete a detailed decomposition of C2 KEs**
- **Associate measures and metrics with lowest functional level of that decomposition**
- **Design C2 experiments based on a set of operational scenarios; define one or more hypotheses/experiment**
- **Conduct experiments using the measures and metrics from above to evaluate the hypotheses**
- **Replicate the experiments but in a simulated environment based Multi-resolution Modeling techniques for increased temporal efficiency**