

Dynamic Information Flow Simulation (DIFS)

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Introduction

“Horatio Nelson once said that under the best of circumstances he could send a message to the admiralty by courier and get a response back in approximately six weeks... now I can dictate a message to my orderly and he can send it to the admiralty by radio in minutes; and I can get a response back in approximately six weeks.”

-Paraphrased from Lord Mountbatten

Introduction

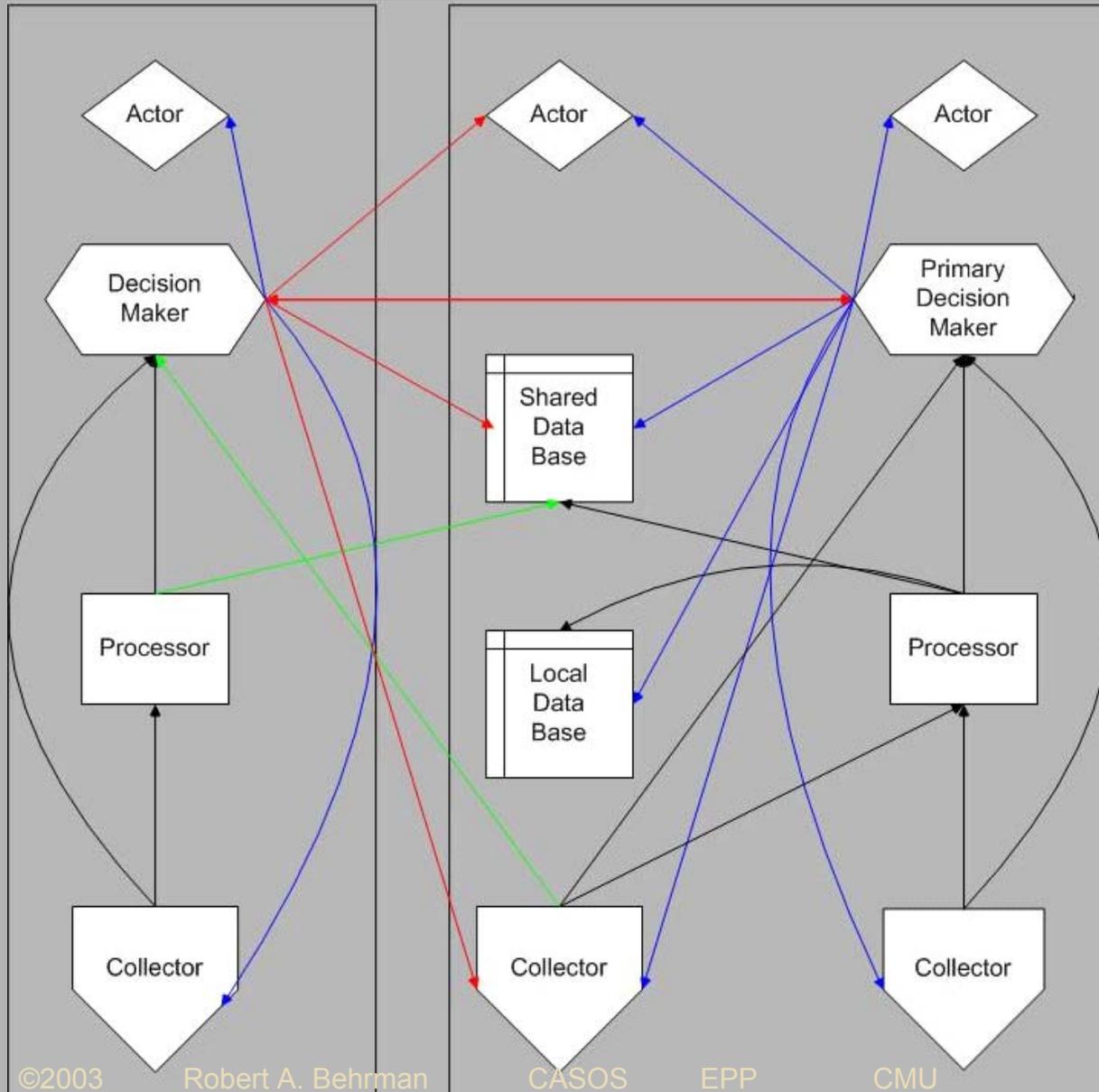
- Attempt at simulation of information / intelligence support organizations
- Structure and function of the simulation
 - Entities within the organization
 - Operation of the entities
 - Assumptions in the model
- Conducting virtual experiments using DIFS
- Current state of the model
 - Sensitivity analysis
 - Case study and validation
- Possible future uses of DIFS

Modeling 'Intelligence'

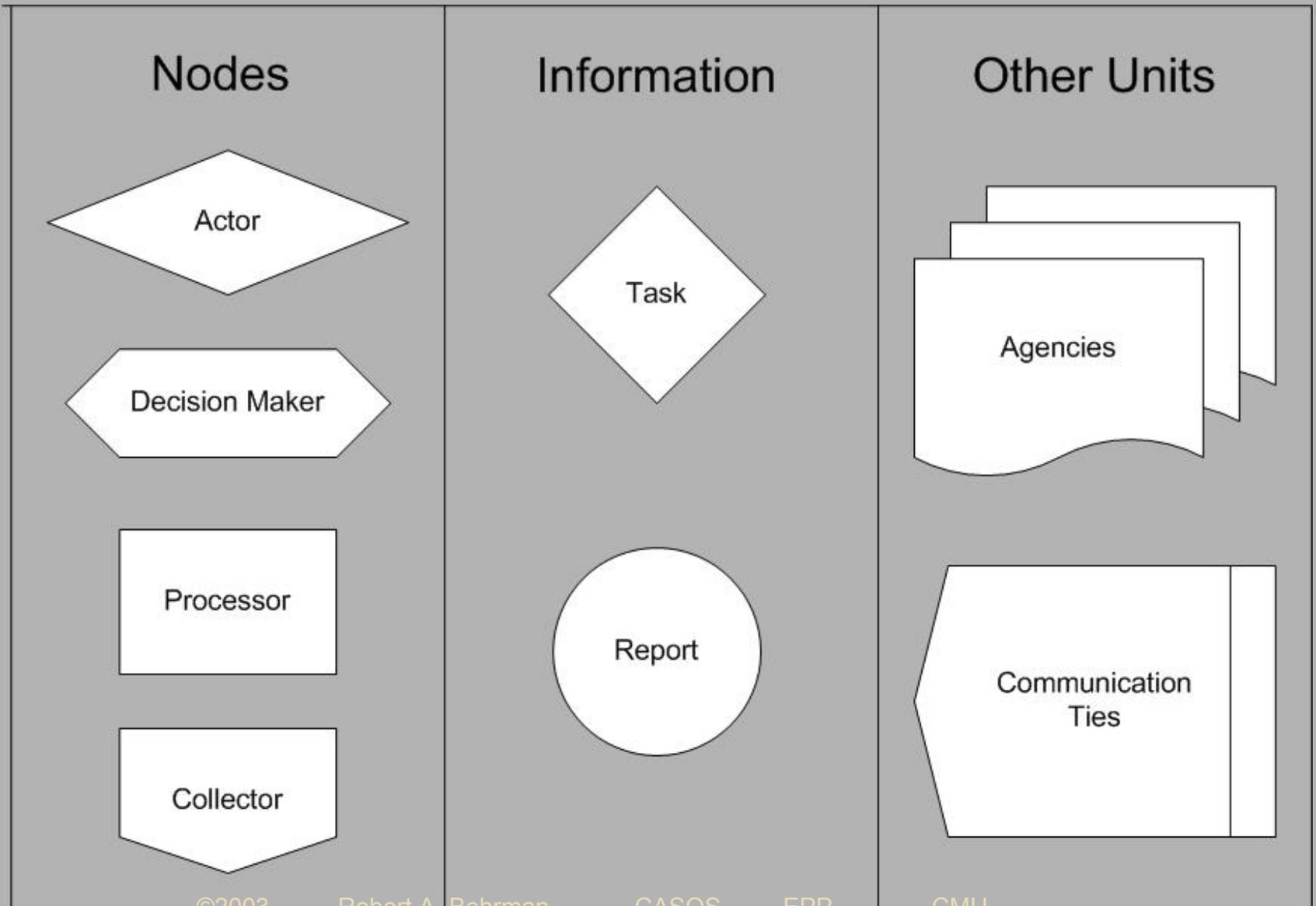
Axioms, assumptions, and points of discussion

- Difficult, if not impossible, to devise a convincing predictive model based on intelligence value.
- Little cohesion between the academic, professional, and military literature on the subject of organization intelligence
- Size, complexity, and uncertainty in/of organizations and functions make formal models difficult

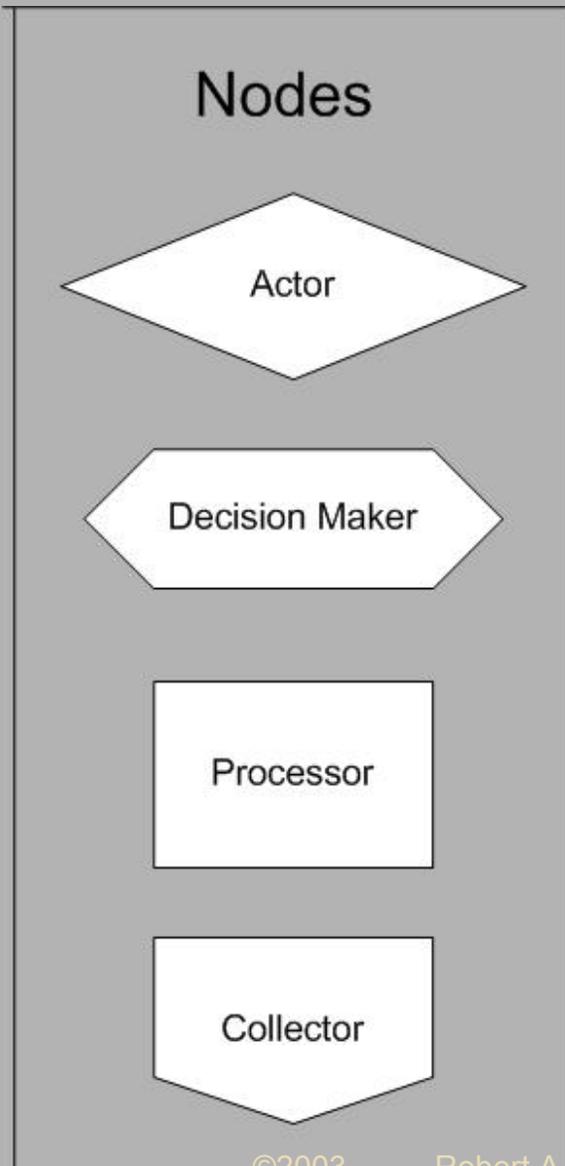
Structure of the model



Structure of the model



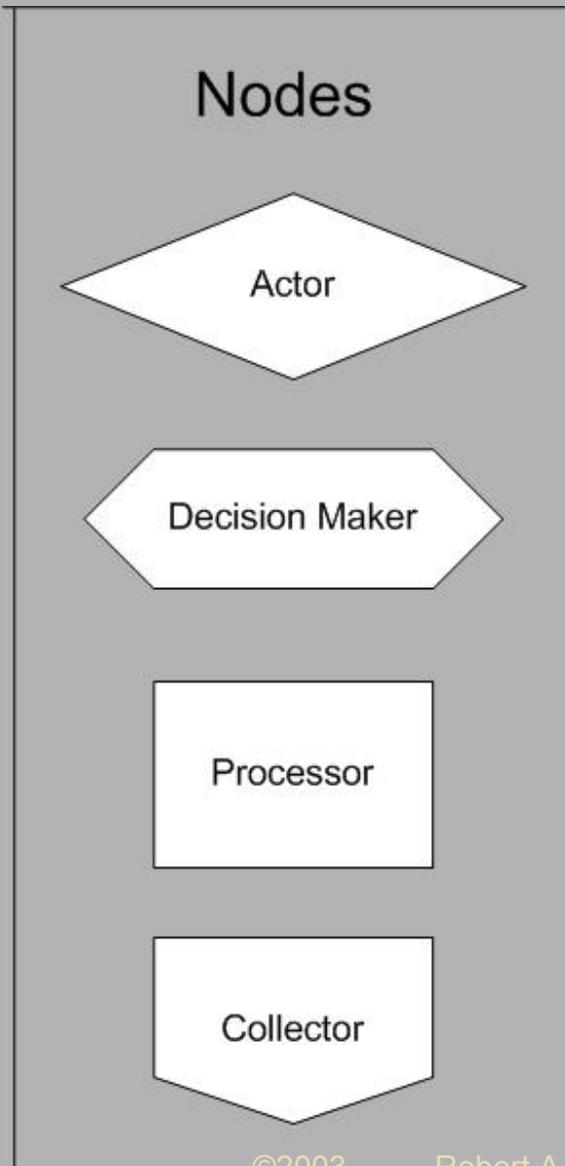
Structure of the model



Nodes model operational elements within intelligence organizations

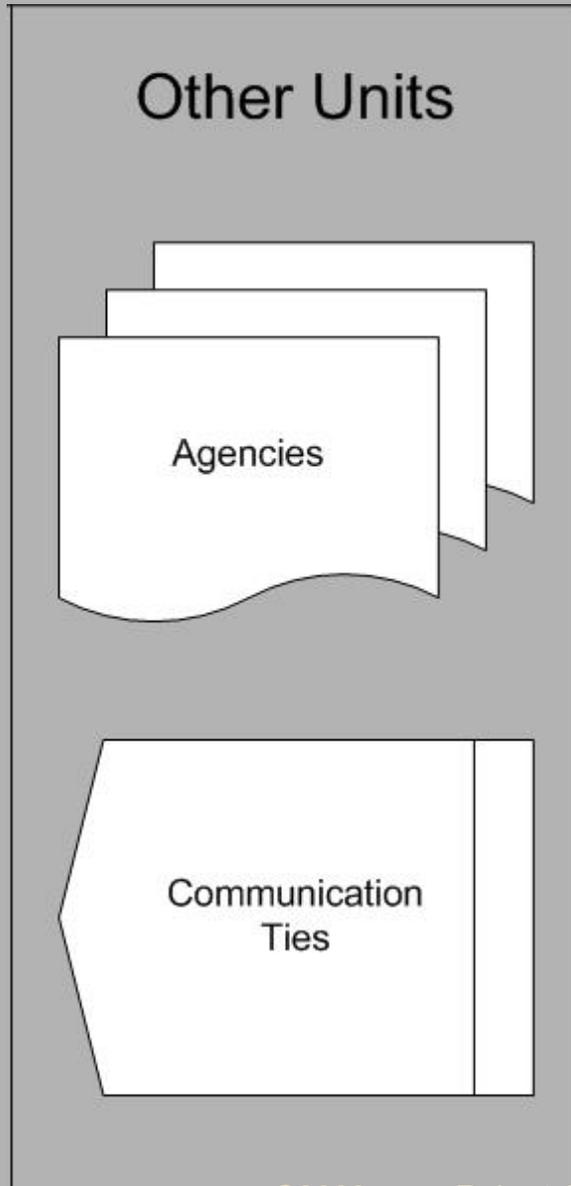
- Decision makers model intelligence prioritizing and tasking units and/or intelligence consumers. Decision Makers order intelligence from subordinate units (collectors and databases) based on arbitrary information requirements; the ability to fulfill these intelligence requirements can be a metric of organization performance.
- Collectors represent the organization/environment environment; the ability of the organization to notice environmental information and fulfill collection requirements.

Structure of the model



- Processors represent intelligence analysts and producers. The simulation represents this as two distinct functions:
 - The ability to collate multiple reports into summarized intelligence products
 - The responsibility for storing information in intelligence organization databases
- Databases represent the intelligence organization memory – simply put, they store reports for access when needed by processors or databases.
- Actors are represented in order to measure command speed (the A in OODA) and organization response / initiative.

Structure of the model

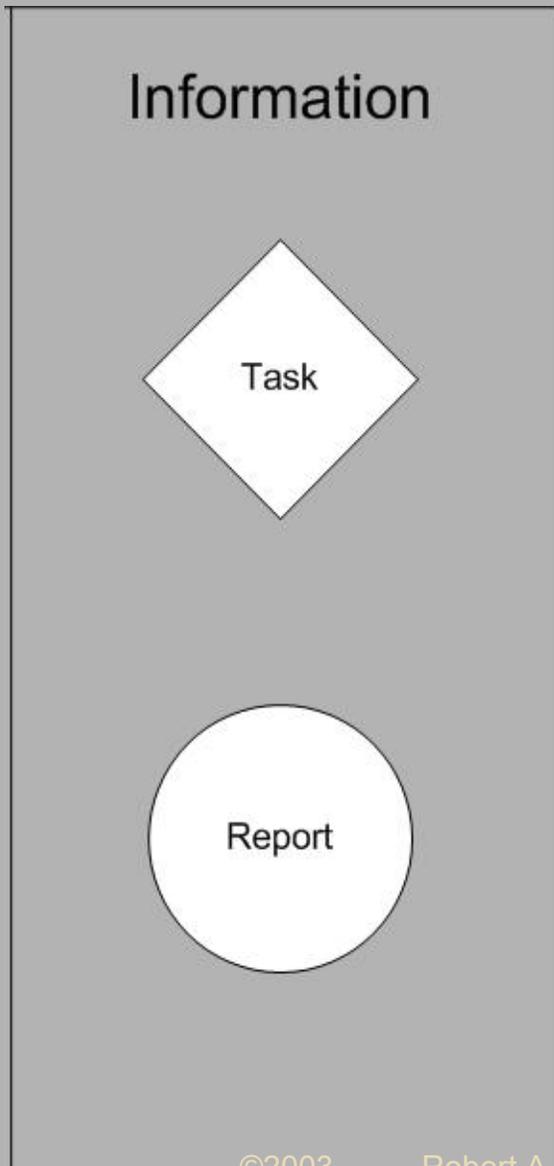


- The true strength of the DIFS model lies in the ability to model organizations composed of multiple agencies, each with different report/task handling phenomena.

- DIFS agencies provide additional information on the methods of handling phenomena (tasks and reports) – sensitivity, priority report handling, and rules for sharing with other agencies.

- DIFS communication ties represent both methods of communication (communication ties can represent any method from radio to courier) and organization hierarchy (the existence of a tasking tie implies some degree of command authority or cooperation)

Structure of the model



- Tasks are specific orders or guidelines to collectors, actors, or databases. They are modeled specifically in order that the routing of intelligence requirements between different agencies can be represented
- Reports represent generalized information correspondence – they contain an arbitrary information value that is used to fill up the decision makers' intelligence requirements.
- At each point in the simulation, the report and task properties are saved, and their location and usage can be tracked through the organization.

Virtual Experiments Using DIFS

Key questions to ask of the simulation:

- Which units in the intelligence organization are underused or overused?
- What effects would changing organization structure have on unit utilization?
- What effects would changing report handling interagency intelligence sharing policy have on intelligence flow to key decision makers?
- What are appropriate ratios of report generation, task generation, etc. that keep the organization working at an efficient level?

Virtual Experiments Using DIFS

Possible Simulation Configurations	High	Medium	Low
Random report inter-arrival rate	Inter-arrival rate less than processing time	Inter-arrival rate greater than processing time	Infrequent or no random report generation
Interagency task priority	Extra-agency task priority increased	No change in task priority between agencies	Extra-agency task priority decreased
Intra-agency priority report handling	High and medium priority reports are sent directly to decision makers	High priority reports are sent directly to decision maker	No reports are sent directly to decision maker (all go through processor)

Virtual Experiments Using DIFS

Performance Metrics:

Intelligence flow:
$$IQflow = \frac{\sum_{\Omega} x^{info}}{\sum_{i=0}^n x_i^{info}}$$

Mean resource queue:
$$MeanQueue = \int_k \frac{\int Q dt}{t_{total}} dk$$

Sensitivity Analysis

- At its current state, the model blows up.
 - Some set of parameters is causing problems. As is, either an insufficient number of reports is generated (which leads to every node in the system being underutilized), or WAY too many reports are generated (leading to huge over-utilization).
 - This is both heartening and not; it indicates that the model might be capable of modeling performance within condition extremes (i.e., extremes that would make a real system blow up); however it is disheartening insofar as the only output I could show you would be craters.
- A sensitivity analysis of the model assumptions is necessary to determining the important ratios between assumed simulation variables.

The future of the project

- Case studies and validation
 - The DIFS model, insofar as it is designed to model various complex information support organizations, will be able to be directly programmed to fit existing organizations; however, results from case studies will be more certain the simpler the organization is.
 - Validation can be performed through previous organization analyses and parameter sensitivity analysis.
- Docking of the model with task-completion based C2 models
 - The DIFS decision makers don't make any decisions. However, they COULD. The content of the model can be used in combination with other simulations to represent intelligence support to the decision makers.
 - Wargaming intelligence organizations against a common environment parameter with a task completion model would allow the combined model to convincingly wargame O-O-D-A loop performance.

Questions and comments?