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Enabling Battlefield Visualization: An Agent-based Information Management Approach

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The greatest challenge for commanders is to focus the intelligence effort, and to gain dissemination of intelligence to the right place in time for key decisions.

—Army FM 100-5

Problem Definition

- Network-centric warfare and Future Combat Systems concepts will result in a proliferation of unprocessed data.
- How to enable the gathering, management, and use of knowledge for future warfare?
- How to intelligently manage CCIRs in a dynamic battlespace?

- Goal: Enable more rapid and accurate situational understanding and battlefield decision-making.
  - Reduce a commander's information- and cognitive-overload
  - Improve the speed and quality of decisions
  - Enable warfighters to better focus on mission-critical information

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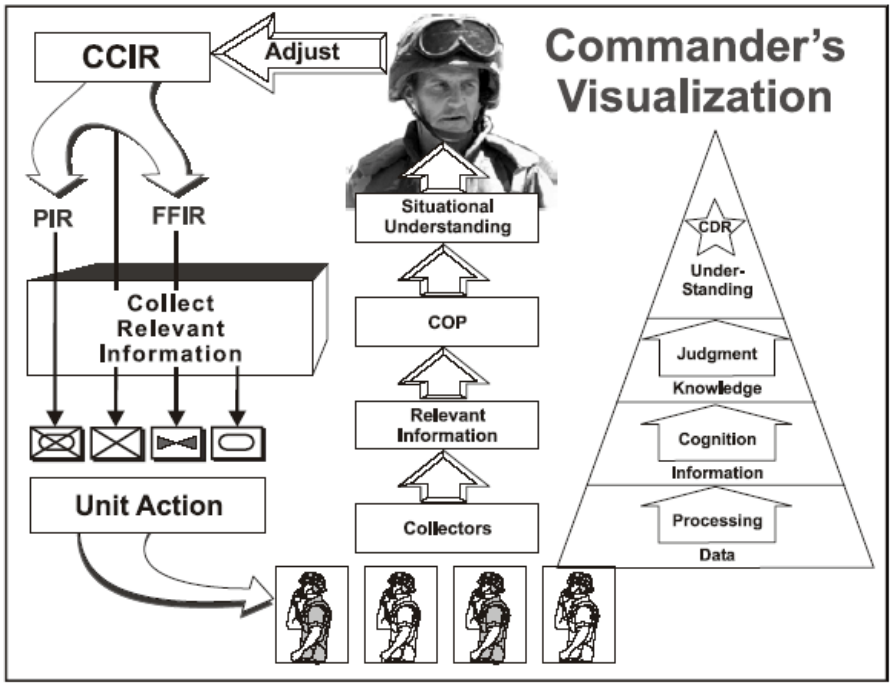
Challenges

- Develop techniques to allow the commander to specify and track information requirements
- Develop technology to support information management from MDMP to understanding
- Determine techniques for displaying and presenting required information to support decision-making



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Research Objectives

- Combine structured and semantically rich knowledge with goal-directed, cognitive reasoning to support Battlefield Visualization:
  - IR derivation from decisions
  - CCIR suggestion and monitoring
  - Collection planning and asset tasking
  - Converting data into knowledge
- Decision support in an adjustable autonomy/mixed-initiative framework

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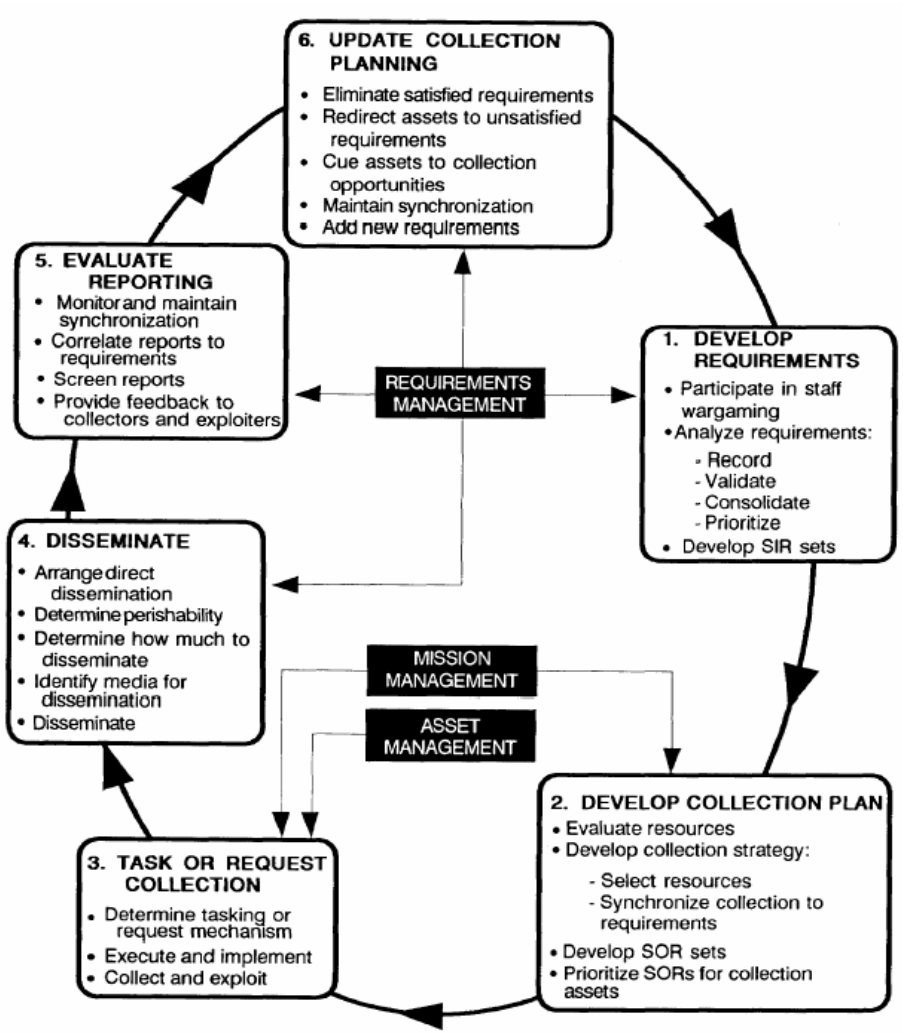
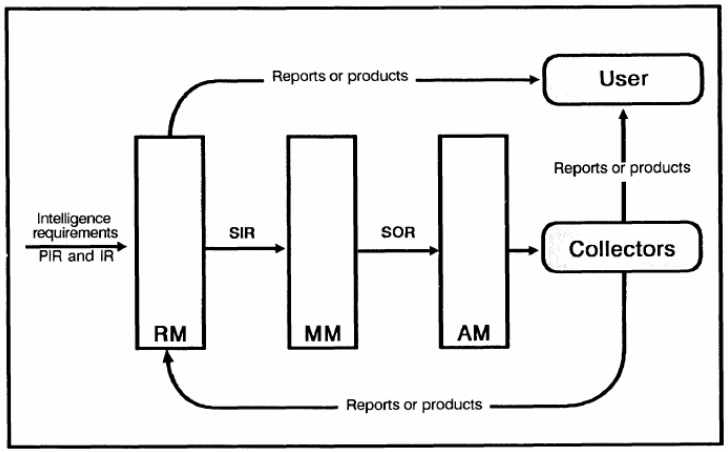
Doctrinal Information Management Processes



from Army FM 34-2



from Army FM 34-2

Information Management Activity (FM 101-5)
Collecting: Acquiring relevant information by any means from the environment
Process: transform data to information by filtering, fusing and prioritizing
Store: retain relevant information for timely retrieval
Display: represent relevant information in a usable audio or visual form disseminate: communicate relevant information from one place to another; broadcast or point-to-point

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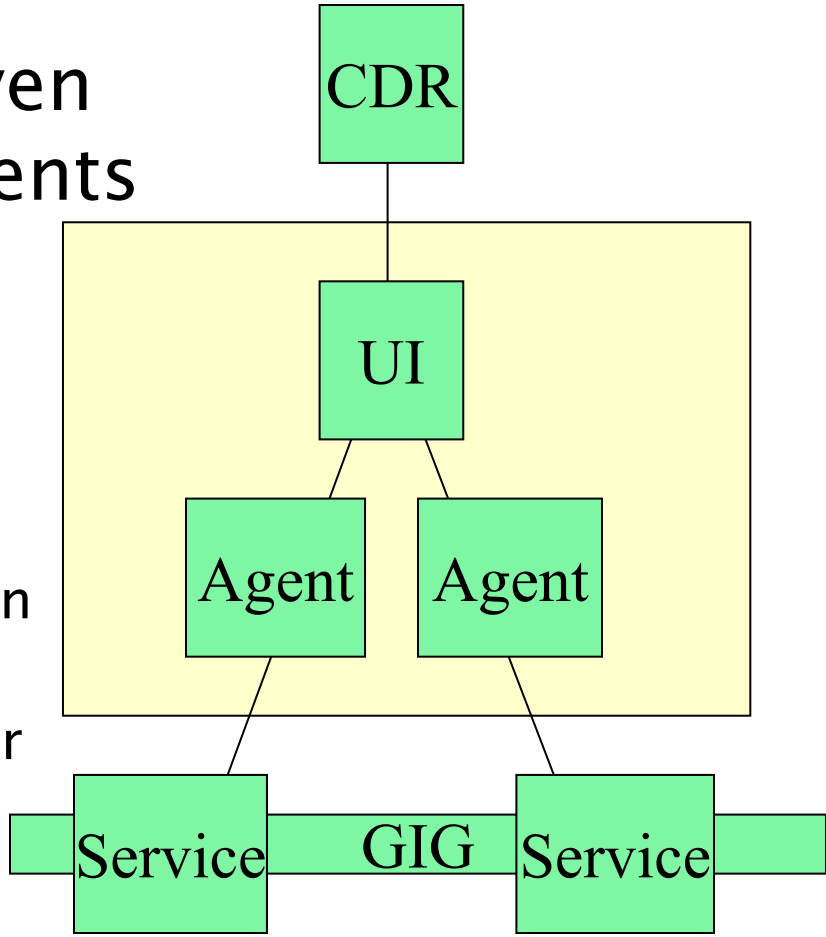
Approach: Intelligent User Interfaces

- Interactions with user driven by intelligent interface agents
  - Mediate user interactions
  - Interact with user and GIG services to perform IM:
    - Elicit information from user
    - Develop and execute collection plans
    - Deliver information to the user



- Requires *Knowledge Rich* agents

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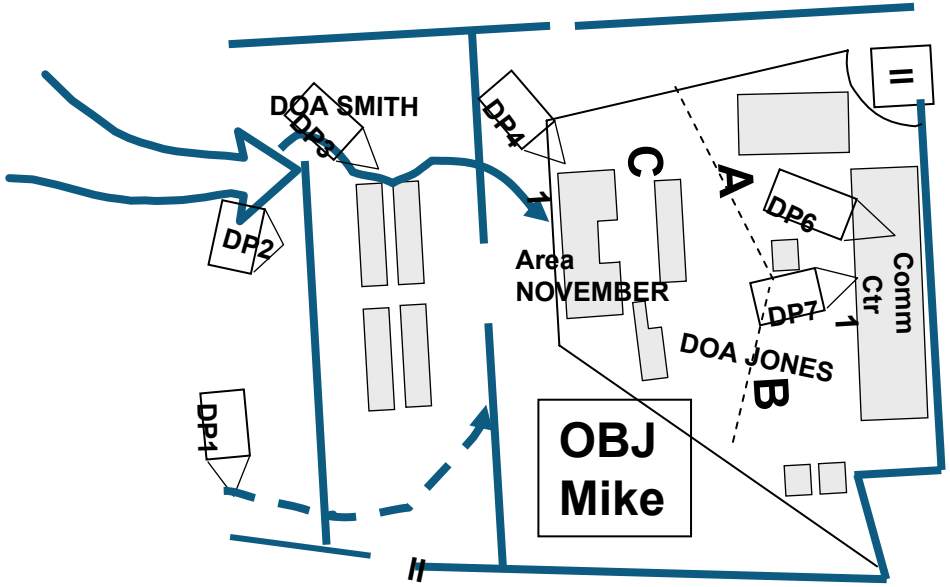
Example Mission

OPORD:
1st PLT patrol OBJ Mike for enemy activity 1300 – 1700 25 Jul 04



DP1: Commit 2nd PLT to Obj Mike to support 1st PLT patrols

CCIR 1	(PIR)	Report patrols being canalized toward/away particular areas
CCIR 2	(PIR)	Report any enemy contact
CCIR 3	(FFIR)	Report any friendly unit or lag status below 50%

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Knowledge Requirements for Info Mgmt

Knowledge Type	Definition/Purpose
Situation Knowledge	Essentially, METT-TC
Doctrinal Knowledge	Standard operating procedures; Common operational terminology & concepts and relationships between those concepts; etc.
IR Knowledge	To transform information requirements between their different forms (PIR to SIR, indicators to PIR) and relate them to the mission
Planning Knowledge	Ability to generate reconnaissance and surveillance plans, and fit them into existing OPORDs.
User Knowledge	A constantly updated understanding of the user, including current goals and tasks, workload, etc.
Display Knowledge	Knowledge about how to present information to the user.

MUST BE DIGITALLY AVAILABLE!

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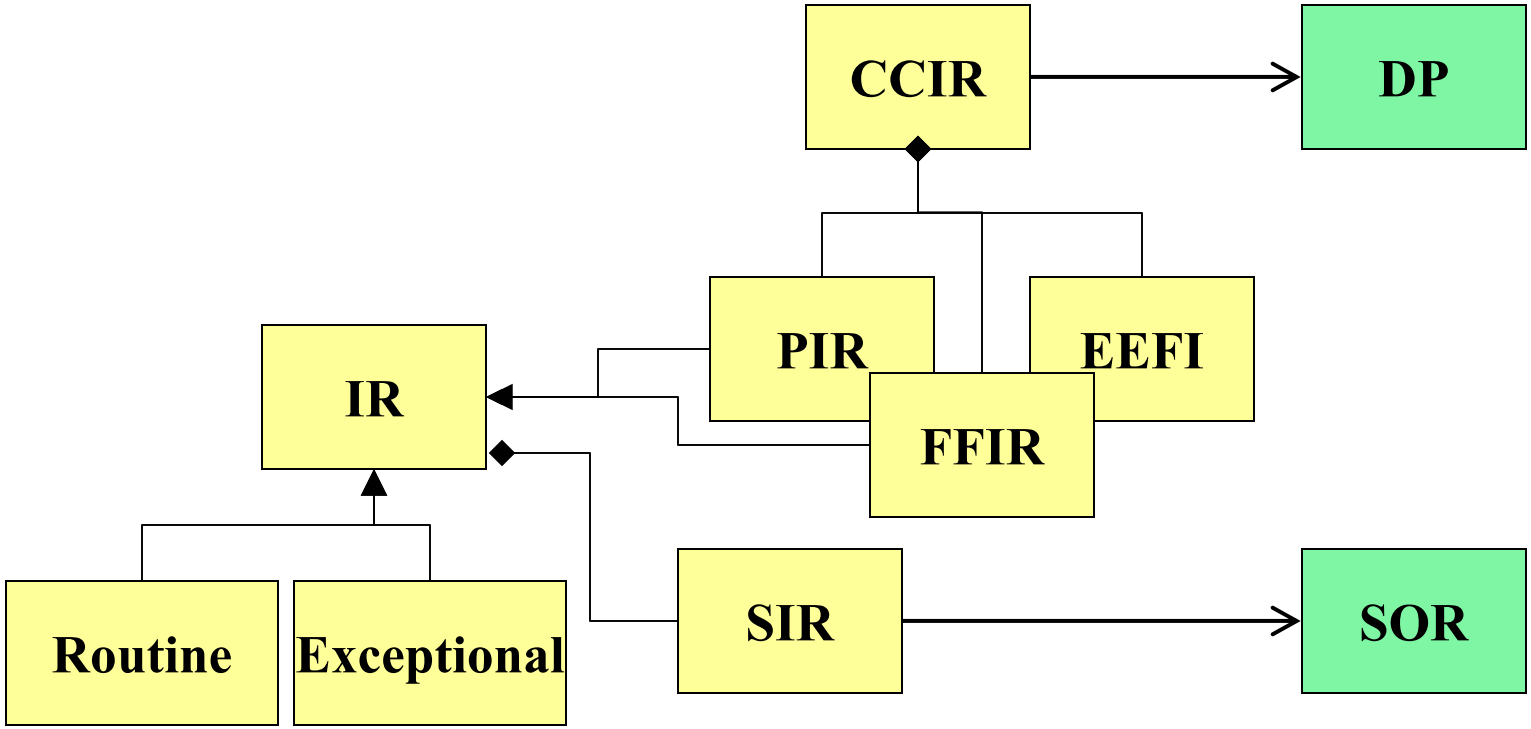
Information Requirements



CCIR: info required by commander for decision-making
PIR: anticipated IRs from wargaming process
FFIR: info about available friendly forces
EEFI: info to protect from enemy
SIR: specific, actionable information requirements
SOR: specific order derived from SIR

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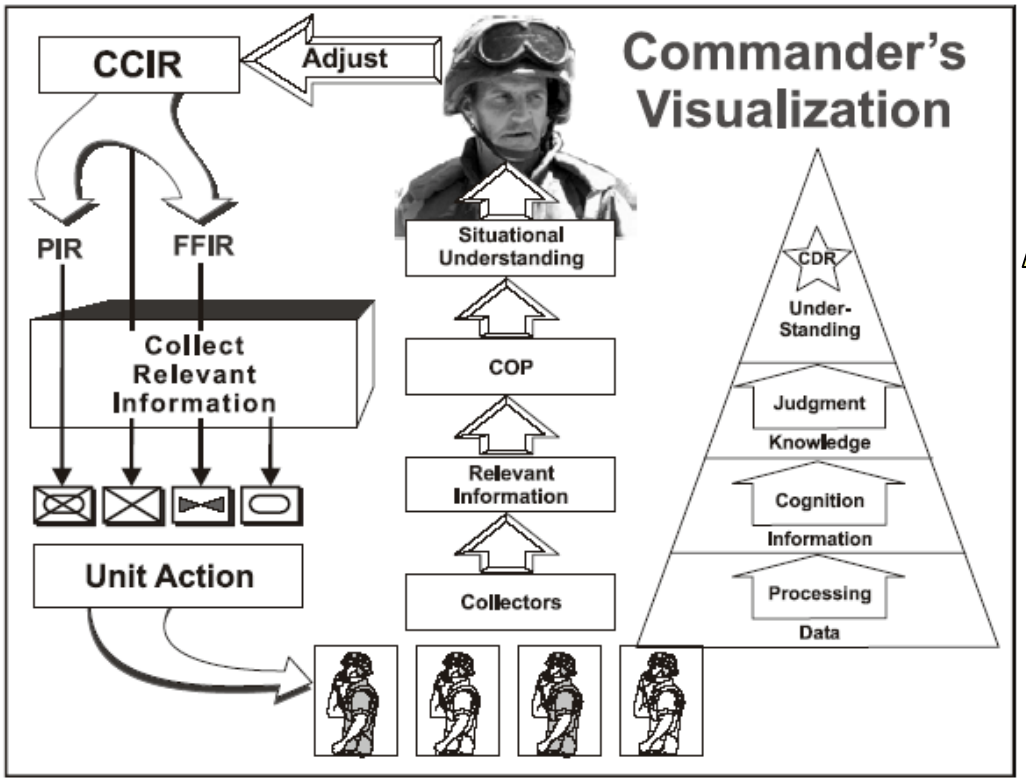
Dual Information Management Processes

"Decision Fission"



"Data/Info Fusion"

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CCIR Understanding: "Decision Fission"

Decision: Commit 2nd PLT to Obj Mike to support 1st PLT patrols.

CCIR: Report if movement is being canalized toward or away from particular areas.

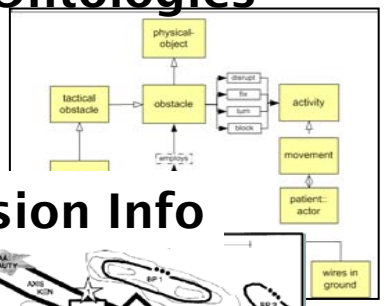
to restrict operations to a narrow zone…by use of obstacles – FM 101-5-1

any obstruction designed or employed to disrupt, fix, turn, or block – FM 101-5-1

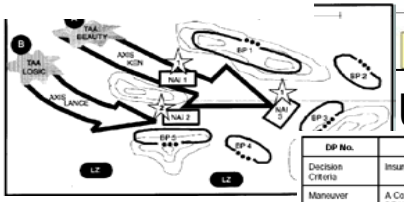
OPORD:
1st PLT patrol OBJ Mike for enemy activity
1300 – 1700 25 Jul 04

Knowledge Sources

Ontologies



Mission Info



User Model

DP No.	1	2
Decision Criteria	Insurgent Camp is in NAI 1 or 3.	Insurgent Camp is in NAI 2.
Maneuver	A Co receives 3/B, occupy TAA BEAUTY, O/O movement to CATK along AXIS KEN.	A Co occupies TAA BEAUTY, O/O occupy BPs 1, 2, and 3.
FS	Priority: A, B, C.	Priority: C, B, A.
M-CM-S	1/A/13th Engr to A.	1/A/13th Engr to C.

SIR: report all evidence of IEDs in and around OBJ Mike – upturned earth, suspicious packages, loose wires sticking out of ground -- LTIOV 1700 25 Jul 04

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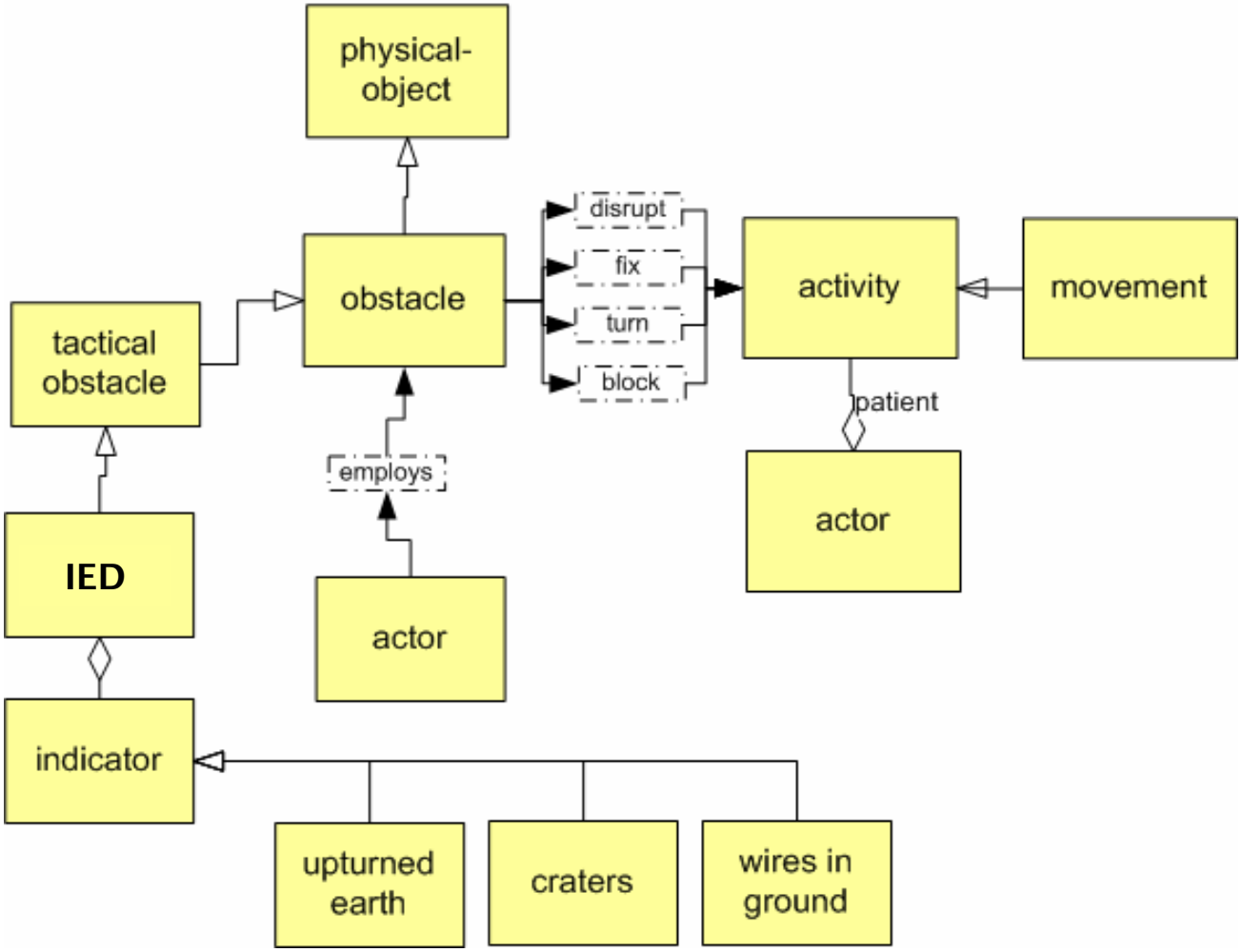
Obstacle Ontology

Obstacle (JP 1-02) – any obstruction designed…to disrupt, fix, turn, or block the movement of an opposing force…



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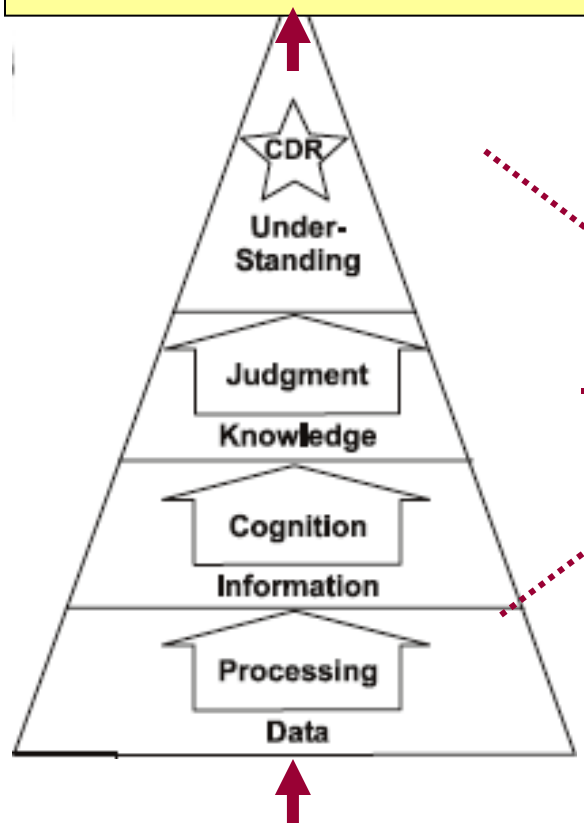
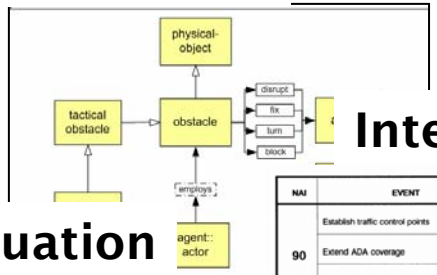
CCIR Understanding: "Information Fusion"

Decision – Activate 2nd PLT



Knowledge Sources

Ontologies

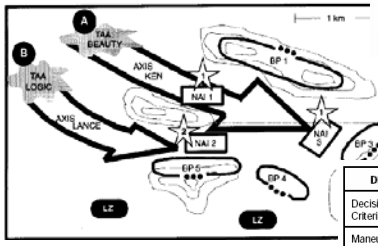


Intel Reports

NAI	EVENT	NET	NLT	SUPPORTS
90	Establish traffic control points	H+1	H+4	IR 9, 11 COA 1, 2, 3
	Extend ADA coverage	H+4	H+7	IR 9, 11 COA 1, 2, 3
	Begin convoy movement of reserve units to TAI 999	H+5	H+7	IR 9, 11 COA 1, 2, 3
	End convoy movement of reserve units TAI 999	H+29	H+31	IR 9, 11 COA 1, 2, 3

Figure 4-6. Partial event matrix.

Situation



User Model

ground

DP No.	1	2
Decision Criteria	Insurgent Camp is in NAI 1 or 3.	Insurgent Camp is in NAI 2.
Maneuver	A Co receives 3/B, occupy TAA BEAUTY, O/O movement to CATK along AXIS KEN.	A Co occupies TAA BEAUTY, O/O occupy BPs 1, 2, and 3.
FS	Priority: A, B, C.	Priority: C, B, A.
M-CM-S	1/A/13th Engr to A.	1/A/13th Engr to C.

SITREP – 1434 Freshly Dug Earth adjacent road area November

SITREP – 1445 lone enemy Hit and Run area north of area November

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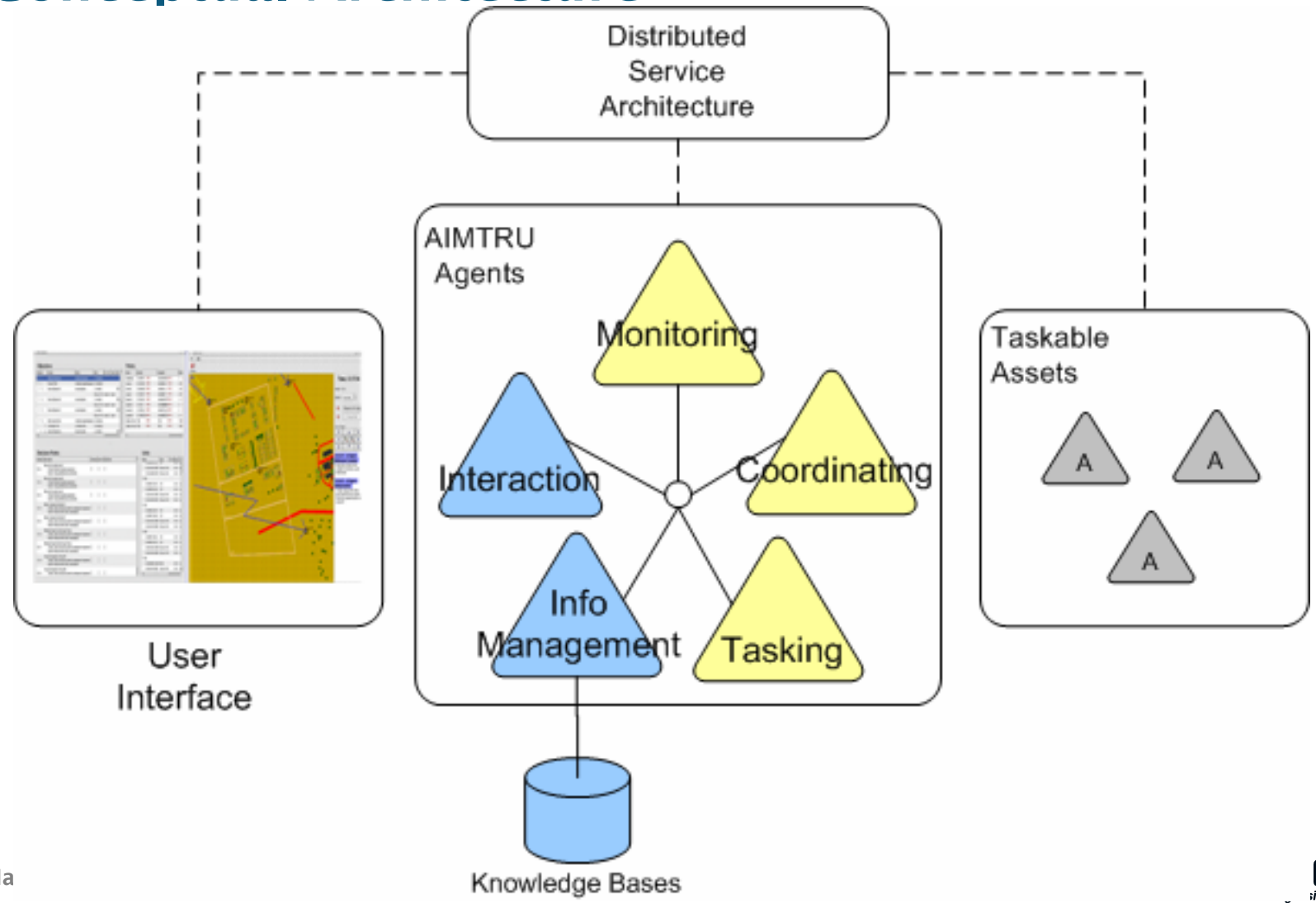
Agent-based Information Management for Tactical Reasoning and Understanding (AIM-TRU): Conceptual Architecture



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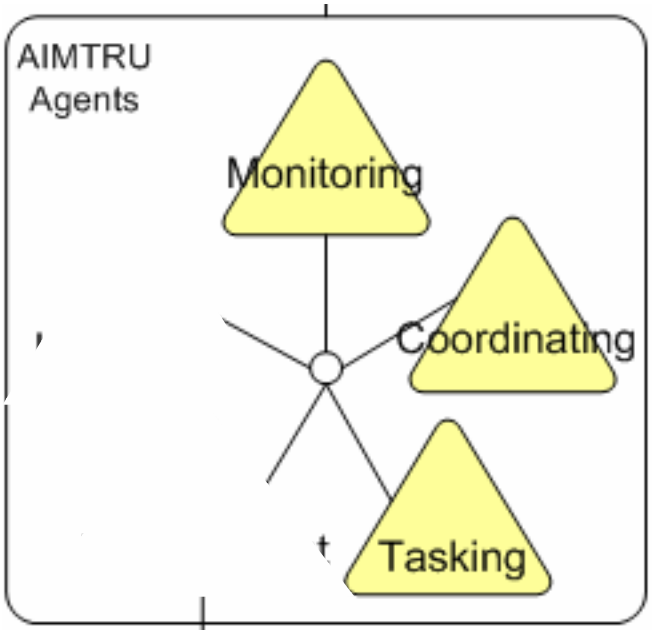
AIM-TRU Agents: CIANC^3
(presented CCRTS 2004)

- Embody Command, Control, Communication elements:
  - **Tasking**: planning to achieve objectives
  - **Monitoring**: requesting info, gauging situation
  - **Coordinating**: establishing details of plan execution



- Generally:
  - Explicit notions of team roles and responsibilities

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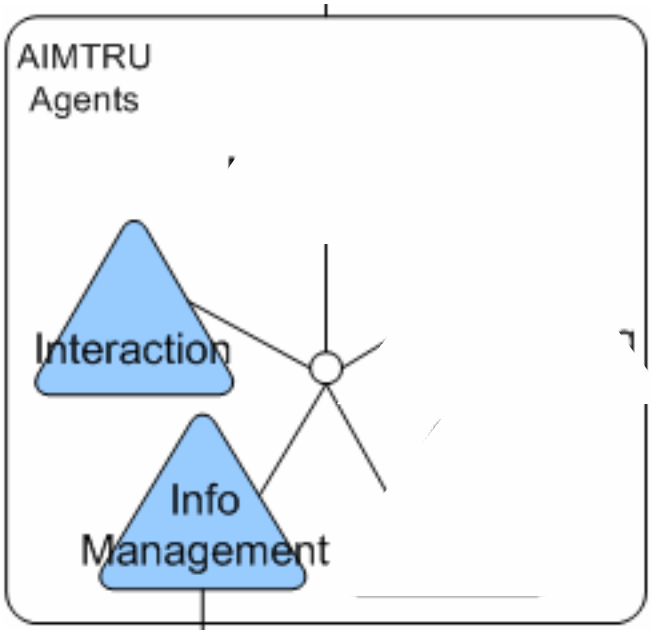
AIM-TRU Agents: Info Management and Interaction Agents

- Information Management Agent:
  - Manage CCIRs
  - Disaggregate/Aggregate info related to CCIRs (fission/fusion)
  - Disseminate CCIRs to other agents for collection
  - Update User (through Interaction Agent) on CCIR status
- Interaction Agent:
  - Elicit CCIRs/approval from user
  - Update Execution Status Display
  - Interact with other agents to obtain information for user
  - Disseminate user information to other agents



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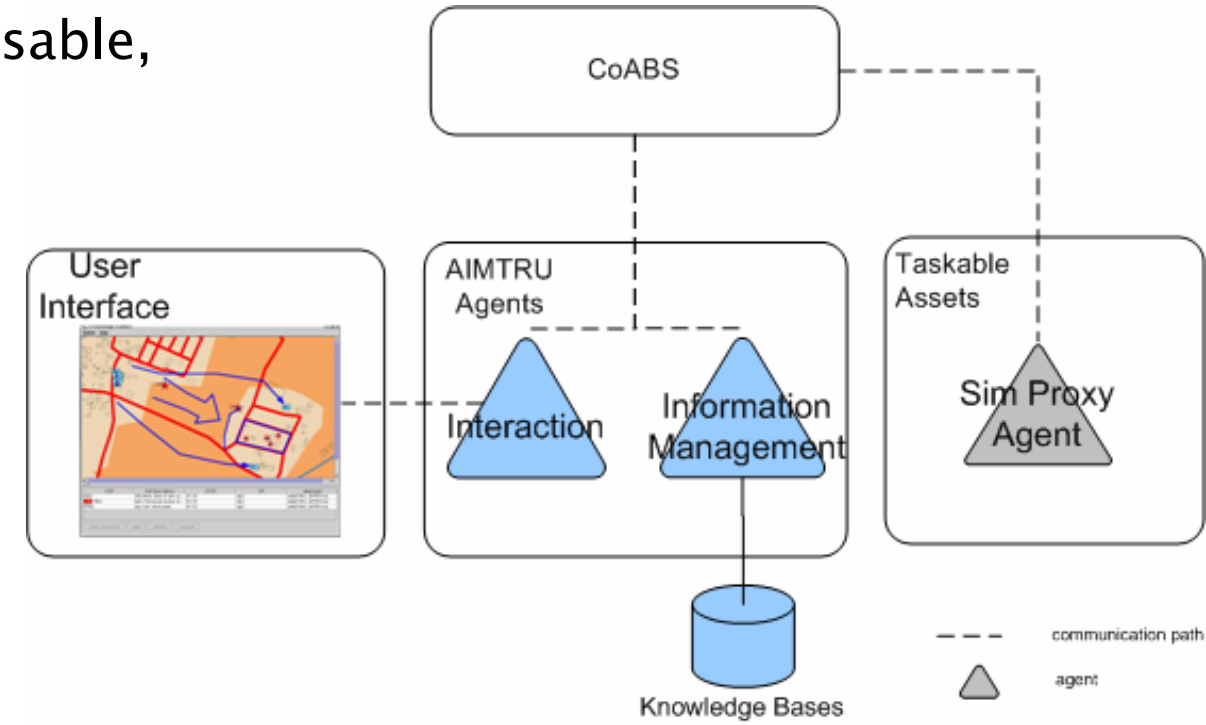
Demonstration Prototype

- Simplified architecture
- UI for CCIR enable/disable, user notification, mission continuation
- Pre-defined mission
- CoABS infrastructure
- "Live" Interaction and IM Agents
- Scripted enemy/friendly units and supporting agents
- Minimal ontologies for fission/fusion



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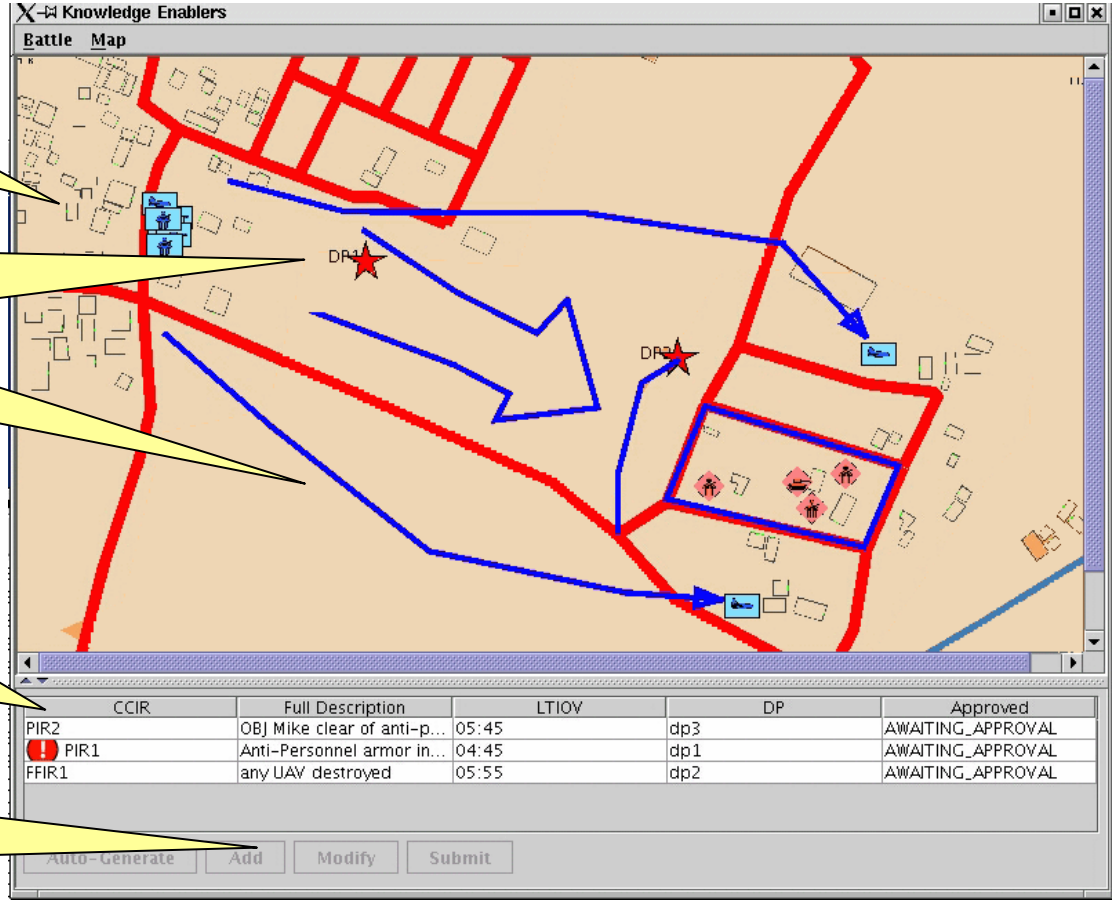
Demonstration Prototype

COP-like view of Blue and (known) OPFor

Mission markup, eg. Decision Support Template, graphic overlays, DPs, etc.

CCIR display with status for each, including those that need user attention

User interaction to enable/disable/modify CCIRs



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Discussion

- In this work, we have --
  - Defined a vision for tools to enable Battlefield Visualization using agents for Information Management
  - Defined requirements for automating the Information Management processes
  - Described how knowledge-rich agents can assist in the process of *Decision Fission*
  - Developed simple prototype to illustrate concept and overall vision

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Conclusions

- This type of technology is ESSENTIAL to deal with the proliferation of data and information
- Information management must fit human/military decision-making needs to enable “Blink”-like rapid cognition
- Technology like this will also enable (and be required for) the transformation to a continuous MDMP with running estimates

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Acknowledgements

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Thanks also to SME Mr. Scotty Abbott (LTC US Army-Retired)

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Extra Slides

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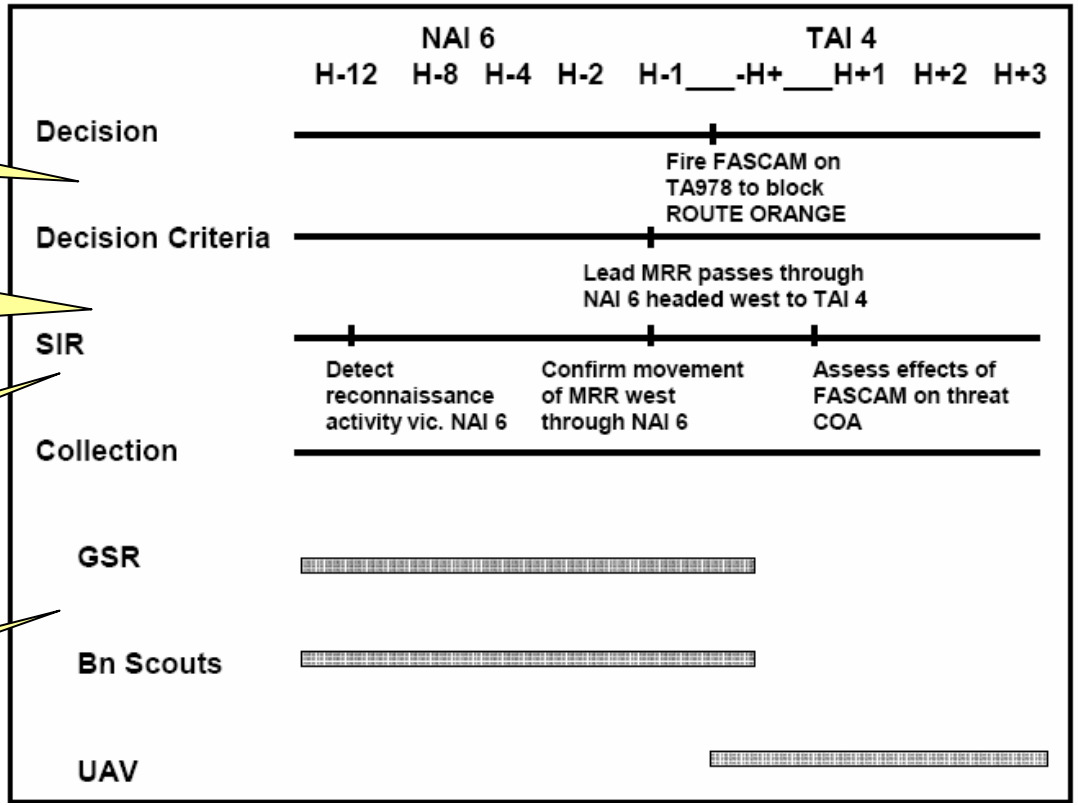
Information Management and Decision Making

Decision specifies a reaction to situation

Criteria defines conditions under which decision is made

SIRs derived from criteria define specific info to collect

Assets tasked with SORs to collect info



Intel Portion of Synchronization Matrix

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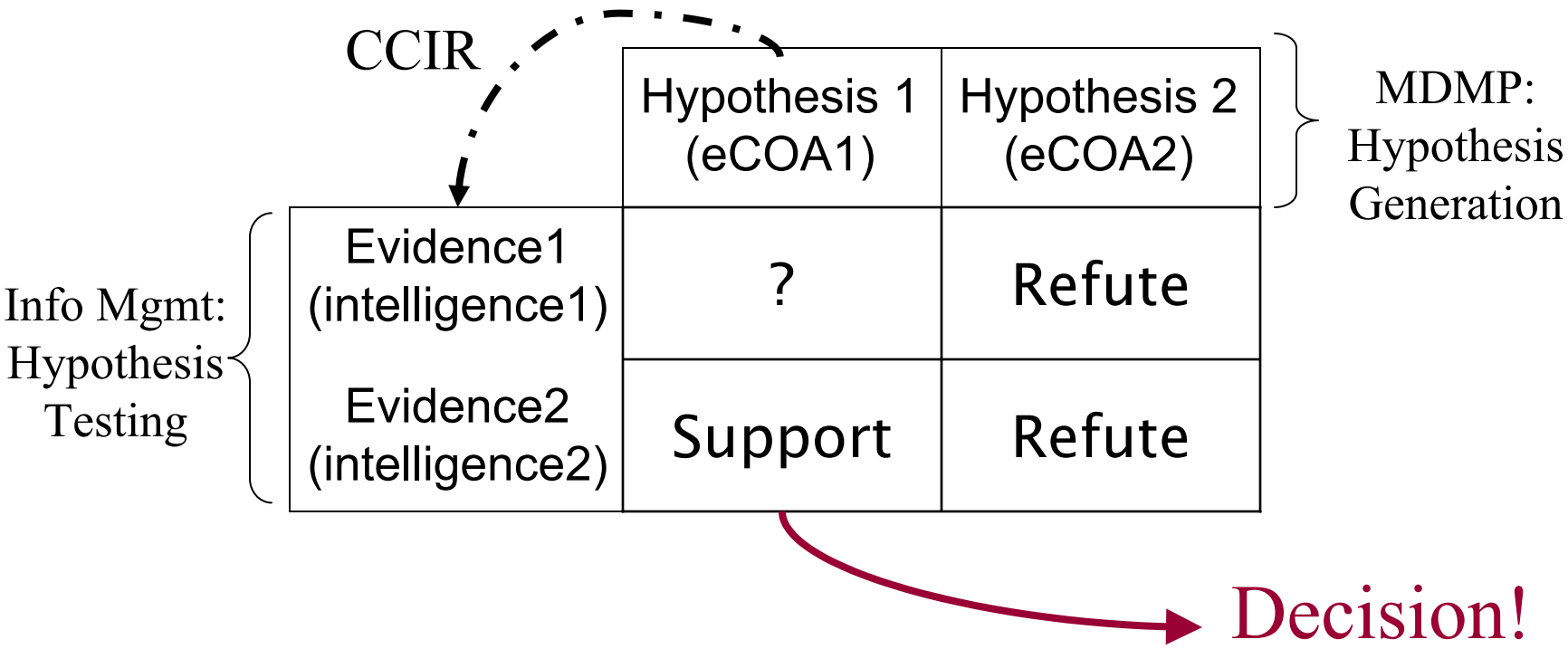
Intersection of MDMP & Info Management:
C^2 as Creative Problem Solving



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