System Level Investigation of Cognition in Incident Management Teams for Adaptive Coordination

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1. Background

Large scale disasters have highlighted the significant consequences of coordination breakdowns **within as well as between** multidisciplinary incident management teams (IMTs).

<u>Critical Need</u>: To better understand how IMTs coordinate and cognitively function together at the system level

Although **cognition in teams** (or team cognition) has emerged as a coordinating mechanism at the team level, little is known about **cognition in IMTs** as a coordinating mechanism at the system level.

2. Overall Research Aims

Aim 1: ***Provide a description of how IMTs function as cognitive systems of systems***
Aim 2: ***Identify interactive behavioral patterns of IMTs' component teams***
Aim 3: ***Enable an integrated view of cognitive transitioning among perceiving, diagnosing, and adapting at the system level***

3. Methods

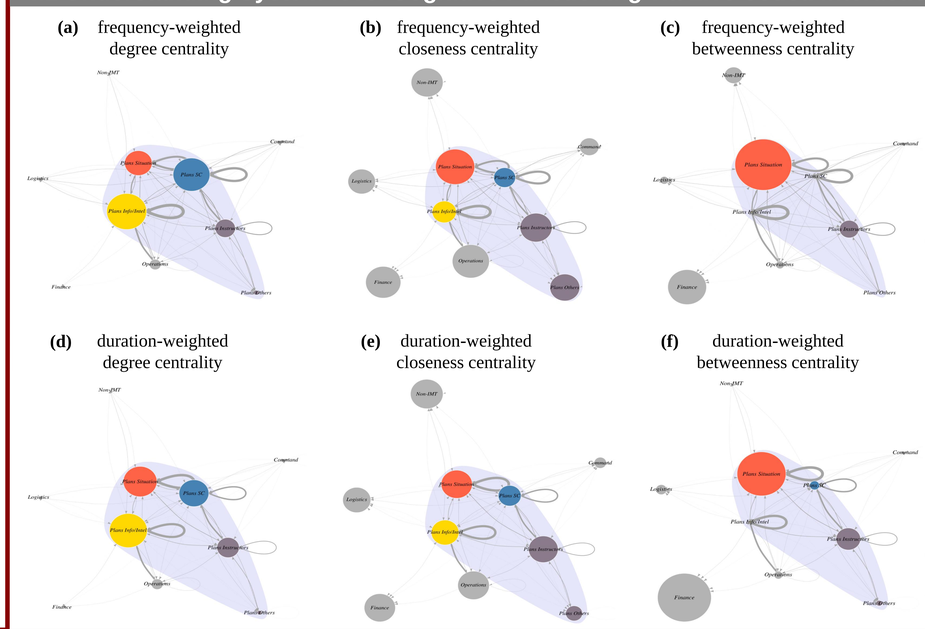
<u>Conceptualized cognition in IMTs via literature review</u>, i.e., *"a collective cognitive process serving as an open communication platform for adaptive coordination which manifests itself as nonlinear, interdependent, and dynamic interactions among humans, teams, and technologies to achieve the system-level goals of perceiving (P), diagnosing (D), and adapting (A) to information"* (Moon, Peres, & Sasangohar, 2017)

<u>Operationalized cognition in IMTs via naturalistic observations of interactions</u> at a high-fidelity simulator - the emergency operations training center (EOTC), College Station, TX.

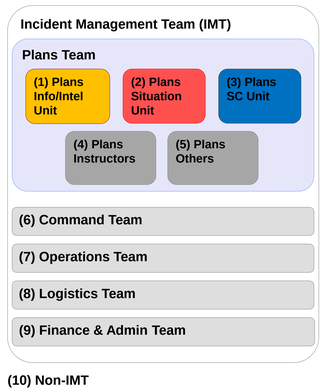
Context			Content	Characteristics	
Initiator	Receiver	Technology	Purpose	Frequency	Duration
Who's initiating interaction	With whom	Using which technology	For what purpose and what's communicated	How often (% of all interactions)	How long (% of all interactions)

4. Results

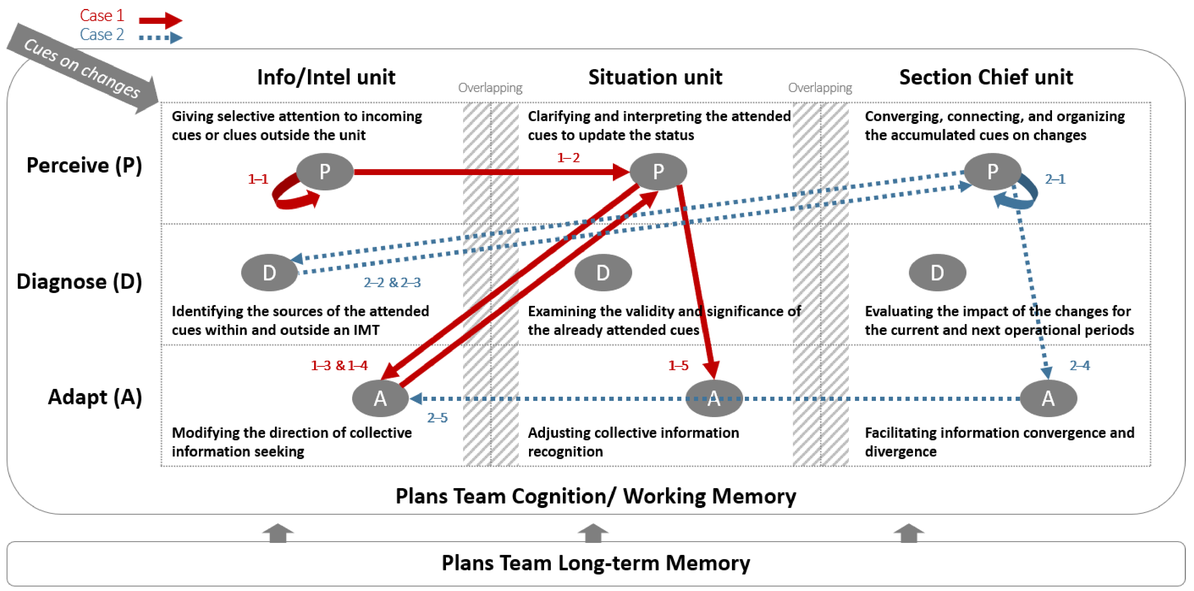
4.1 Understanding System-level Cognitive Functioning via Live-coded Interaction Networks



We found that three Plans sub-teams contribute to an IMT's system-level cognitive functioning in different ways; therefore, each deserves to be treated as a cognitive system.



4.2 Proposing a Methodological Framework to Model System-level Cognitive Functioning



- **The proposed P-D-A model posits the following three premises:**
  1) A Plans team is **a cognitive system** where its team cognition is interactions of team members to complete a cognitive task
  2) Team cognition for each of the three sub-teams of a Plans team is tied to **the context-specific cognitive tasks of perceiving (P), diagnosing (D), and adapting (A) to the changes** in the status of critical elements
  3) Team cognition for a Plans team is manifested as **nonlinear, interdependent, and dynamic interactions** within and among P, D, and A of the three sub-teams of the Plans team.

5. Discussion/Future Work

5.1. Interactive System-level Cognition from a Network Perspective

- An IMT functioned as cognitive systems-of-systems where cognition emerges through interactions at its multiple levels, i.e., within and among its component teams as well as between its inside and outside.
- Our preliminary findings highlight potential benefits of adopting an interactionist approach, incorporating systems perspective, and employing network centrality measures, particularly for the purpose of investigating multiteam systems' cognitive functioning.
- A live-coding approach, however, did not allow us to investigate the contents of interactions; therefore, limited to exploratory research phases aiming for hypotheses generation (rather than hypotheses testing).

5.2. Role of the P-D-A Model

- The proposed P-D-A model serves as a proof-of-concept that illustrates the benefits of viewing team cognition as interaction within and among a cognitive team-of-teams, for context-specific tasks of P, D, and A.
- The model effectively captures the nonlinear, interdependent, and dynamic nature of team cognition as interaction in complex socio-technical systems.
- Technology (e.g., whiteboard, a large display) can be interpreted as a contributor to team cognition, viewed **as a Plans team working memory or a platform technology** that enables the team to interact without the need to memorize every details of what's communicated.
- As a future work, the model will be further developed with a network/content analysis and validated through interviews with SMEs involved in the Hurricane Harvey.

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