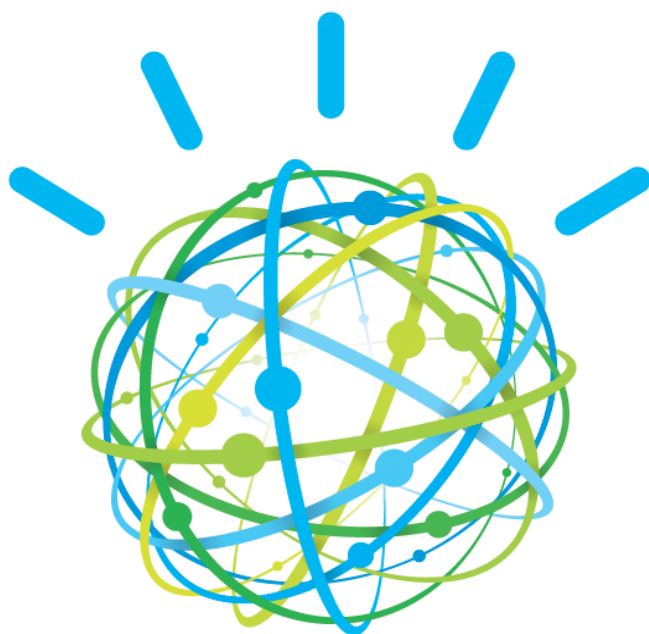


# *Using IBM's Watson in the Airline Operations Center*

Richard Mogford, NASA Ames,  
Christopher Codella, IBM Watson



# Watson in the Era of Cognitive Computing

*Tabulating  
Systems Era*

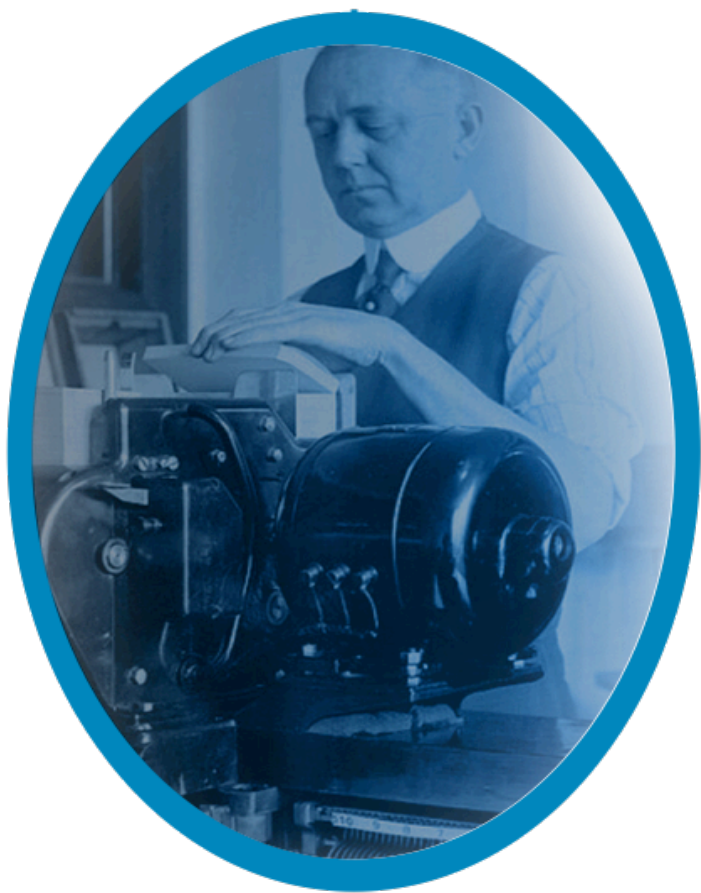
*Programmable  
Systems Era*

*Cognitive  
Systems Era*

1900

1950

2011



# What is Cognitive Computing?

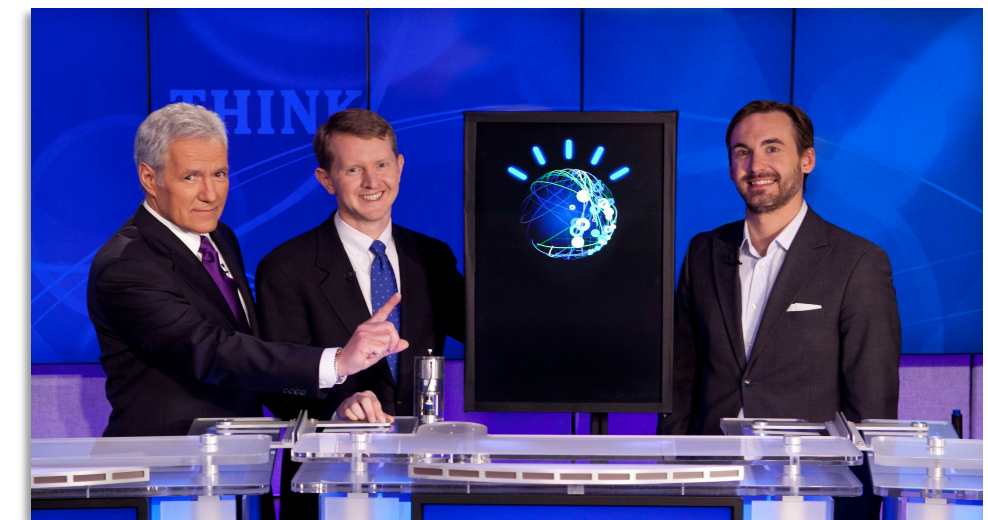
- Cognitive systems are able to learn their behavior through *education*
- Support forms of *expression* that are more natural for human interaction
- Whose primary value is their *expertise*; and
- That continue to *evolve* as they experience new information



... and does so at **enormous scale**.

# Watson Started with a Grand Challenge

- Chess – Deep Blue (1997)
  - A finite, mathematically well-defined search space
  - Limited number of moves and states
  - Grounded in explicit, unambiguous mathematical rules
  
- Human Language – Watson (2011)
  - Ambiguous, contextual and implicit
  - Grounded only in human cognition
  - Seemingly infinite number of ways to express the same meaning

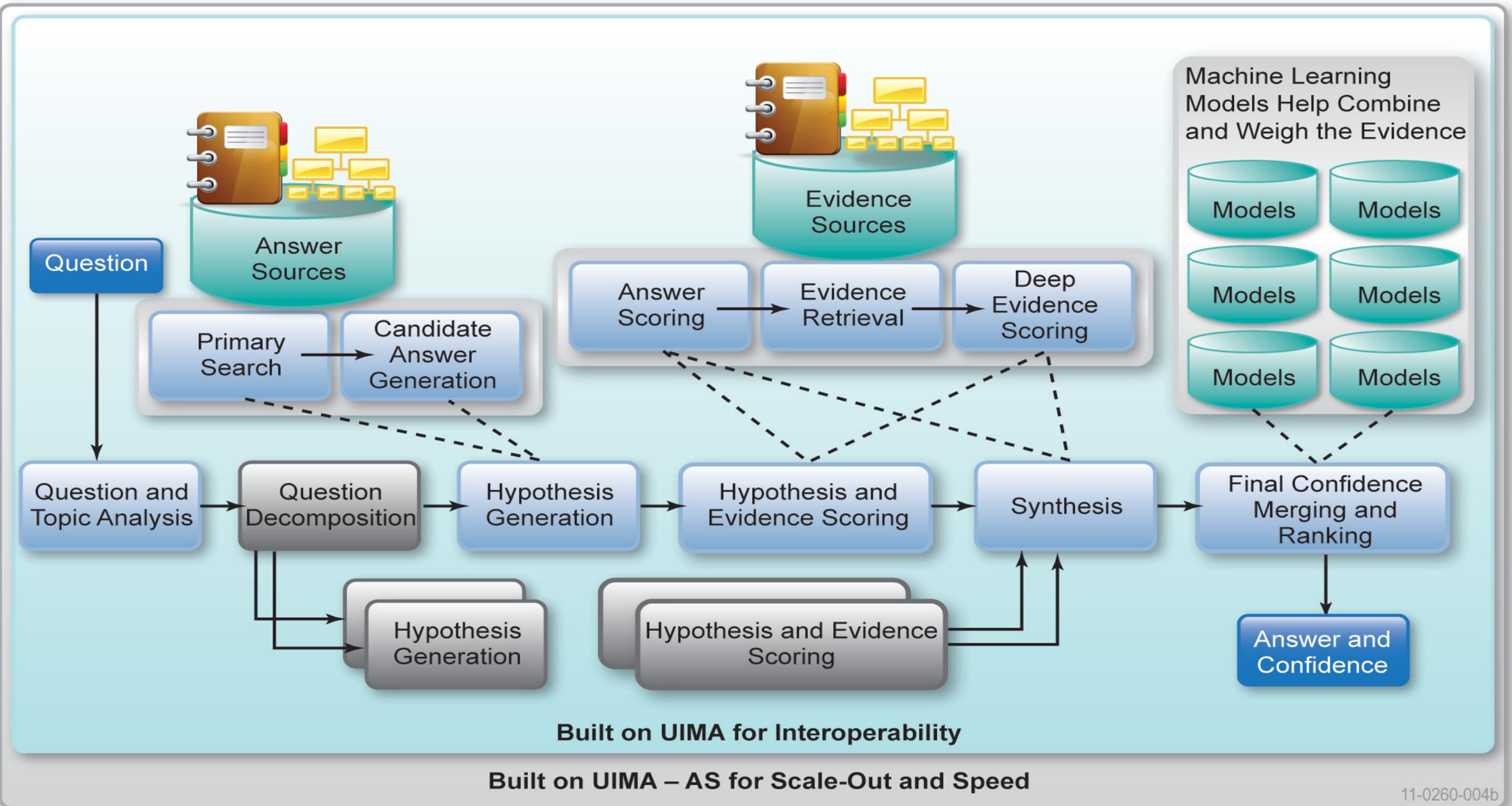


# Automatic Open-Domain Question Answering

*A Long-Standing Challenge in Artificial Intelligence to emulate human expertise*

- Given
  - Rich **Natural Language Questions**
  - Over a **Broad Domain of Knowledge**
  
- Deliver
  - **Precise Answers:** Determine what is being asked & give precise response
  - **Accurate Confidences:** Determine likelihood answer is correct
  - **Consumable Justifications:** Explain why the answer is right
  - **Fast Response Time:** Precision & Confidence in <3 seconds

# Inside Watson: Massively Parallel Probabilistic Evidence-Based Architecture



# Watson APIs



<p>AlchemyAPI IBM</p>	<p>Concept Expansion IBM BETA</p>	<p>Concept Insights IBM BETA</p>	<p>Language Identification IBM BETA</p>	<p>Machine Translation IBM BETA</p>	<p>Message Resonance IBM BETA</p>
<p>Personality Insights IBM</p>	<p>Question and Answer IBM BETA</p>	<p>Relationship Extraction IBM BETA</p>	<p>Speech To Text IBM BETA</p>	<p>Text to Speech IBM BETA</p>	<p>Tradeoff Analytics IBM BETA</p>
<p>Visual Recognition IBM BETA</p>	<p>Cognitive Commerce™ Third Party</p>	<p>Cognitive Graph Third Party</p>	<p>Cognitive Insights™ Third Party</p>		

# Relevant Information Discovery: Search vs. Expert Q&A

## Decision Maker

- Has Question
- Distills to 2-3 Keywords
- Reads Documents, Finds Answers
- Finds & Analyzes Evidence

## Search Engine

- Finds Documents containing Keywords
- Delivers Documents based on Popularity

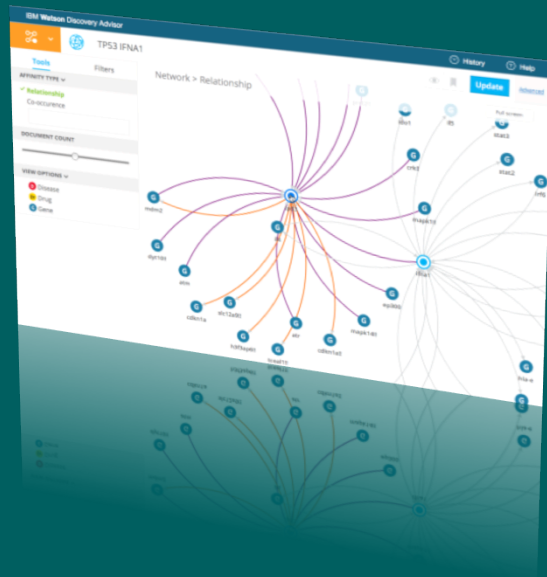
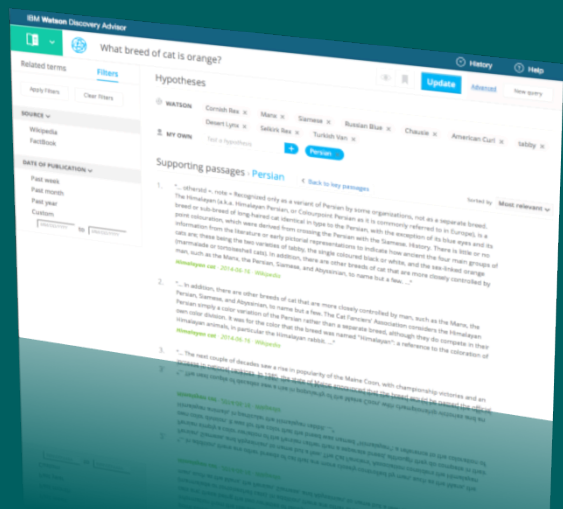
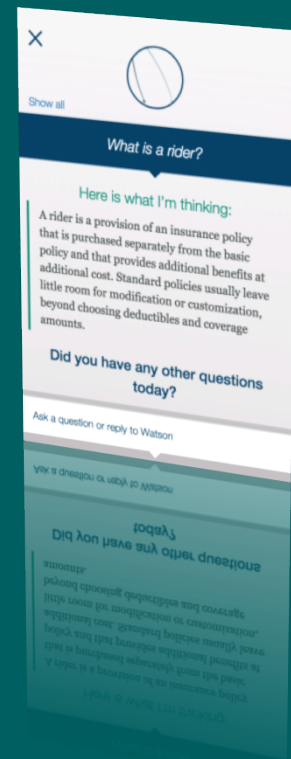
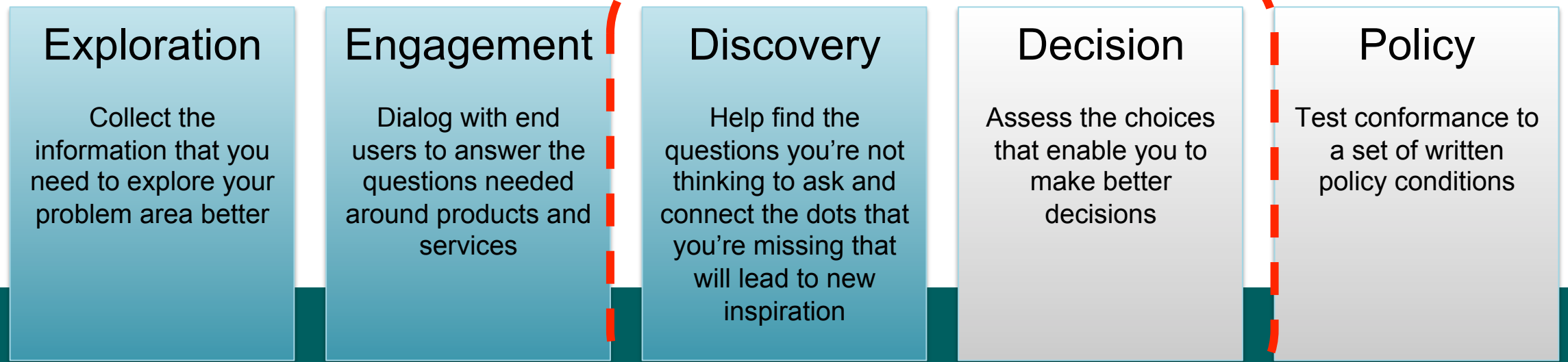
## Expert

- Asks NL Question
- Considers Answer & Evidence

- Understands Question
- Produces Possible Answers & Evidence
- Analyzes Evidence, Computes Confidence
- Delivers Response, Evidence & Confidence



# Use Case Patterns

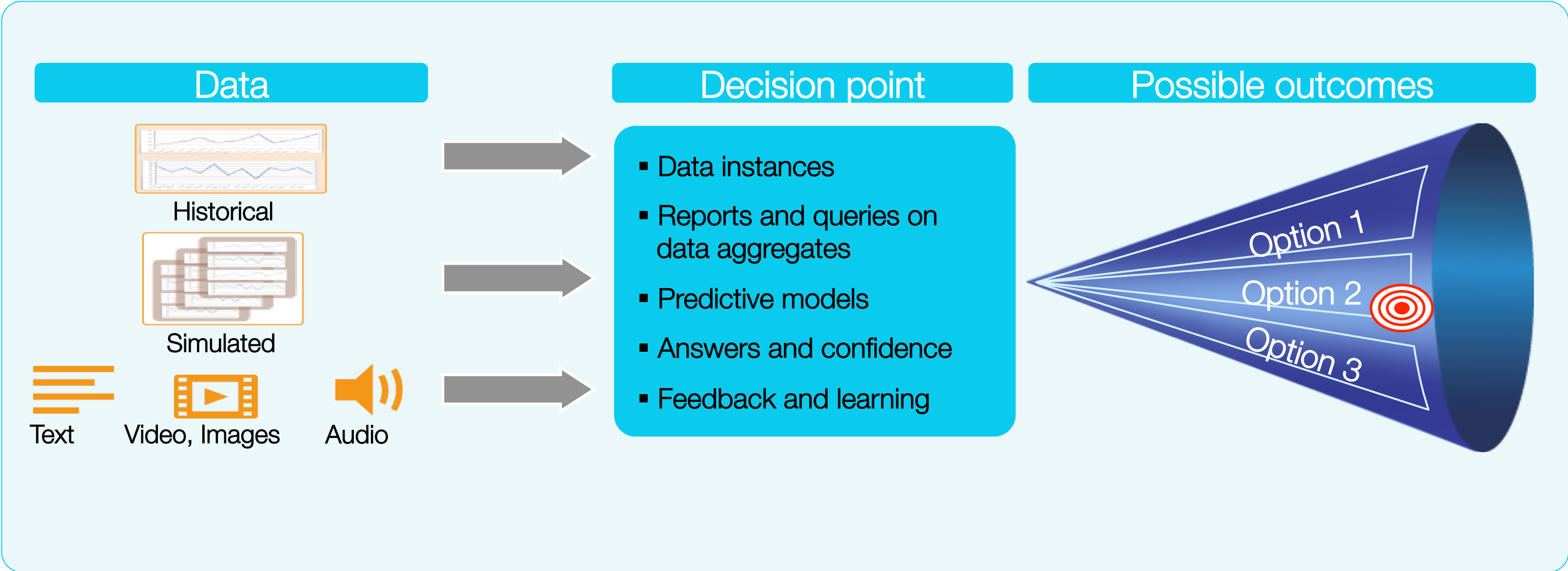


# Dimensions for Classifying Use-Cases

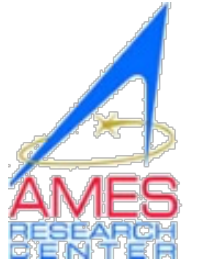
- Corpus size and complexity
- Special user interface
- Integration with external analytics
  - Use results from Watson (e.g. visualization)
  - Provide knowledge to Watson (e.g. from streams, RDBs)
  - Trigger a question to be asked
- Time sensitivity, volatility, dependence
- Question type
  - Simple, free-form question or assertion
  - Question with context (e.g. a case file)
  - Standing (persistent or watched) question
  - Template question
- Number of users (e.g. 10s, 100s, thousands, millions)
- Dialog capability necessary



# Evolution of Watson in Analysis and Decision Support



# How Can Watson Help Decision Making in Operations Centers?







# Applying Watson within Airlines Operations Centers (AOCs)

- The team explored objectives:

## Get informed faster

Can we help the Airline AOC find information and answers to their questions more quickly, diagnose issues sooner, and therefore make flight management more efficient and effective?

management more efficient  
therefore make flight  
issues sooner, and

## Spot issues earlier

Can Watson help play a critical role in helping the AOC (e.g., dispatcher) spot emerging issues (e.g., mechanical), connect the dots of seemingly unrelated data points, and speed up the decision making process?

points' and speed up the  
of seemingly unrelated data  
mechanical) connect the dots

## Obtain a complete picture

Can Watson help aggregate data sources relevant to AOC actors to present a more comprehensive view in order to optimize in-flight decision making?

order to optimize in-flight  
comprehensive view in  
business world

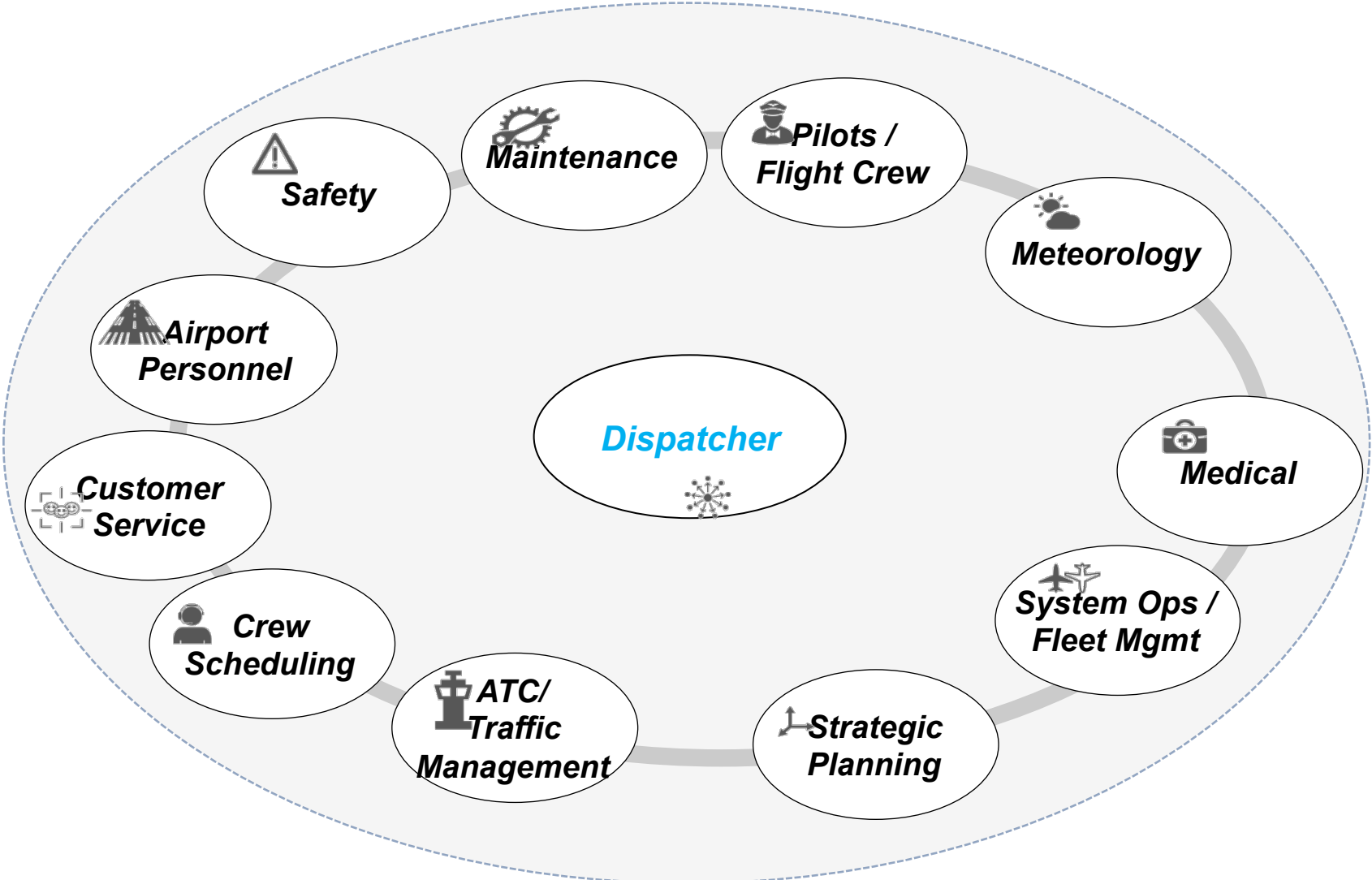
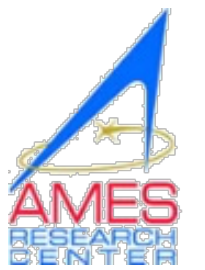


# To understand the processes within the Operations Center (OC)

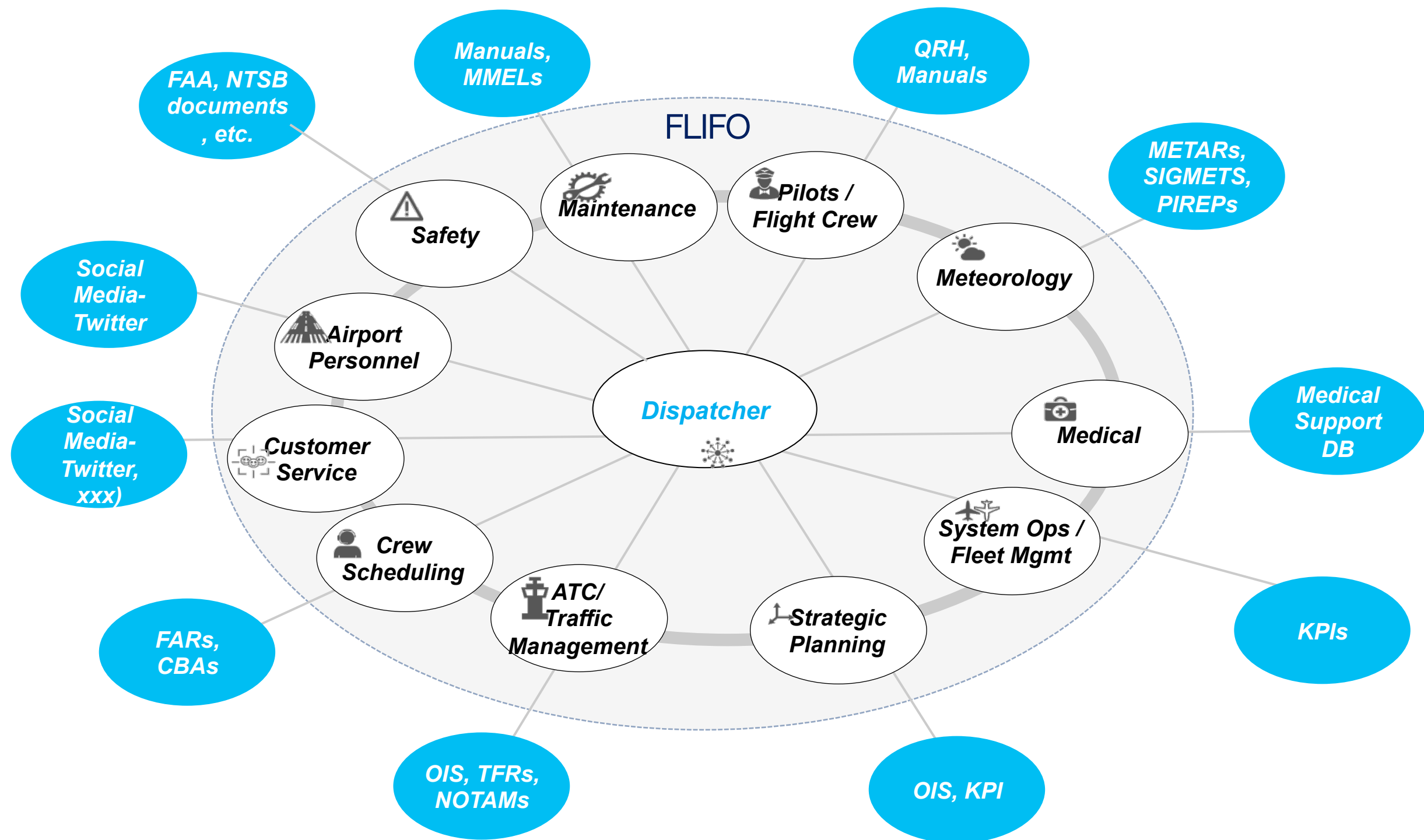


- Conducted discussions with domain experts at NASA
- Gathered issues and challenges from dispatchers within OCs
- Visited United and Delta OCs to observe and interview
- Discussed “Day in the life” of various actors in the OC (e.g. dispatcher, maintenance, crew schedule, fleet, weather, ATC)
- Reviewed data sources (e.g., notices, operations manuals, equipment docs, weather)

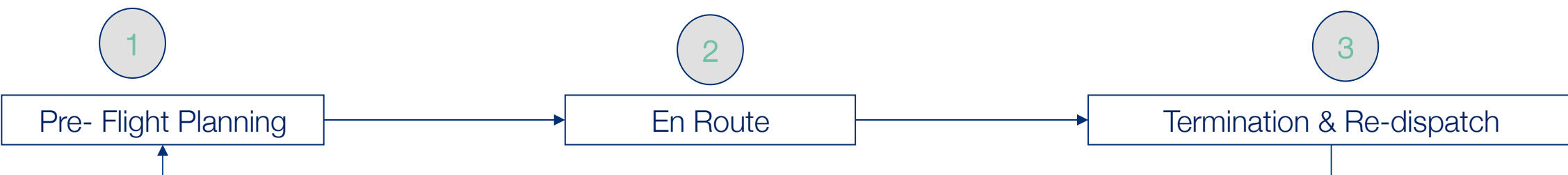
# Collaboration and Actors in the OC



# Various Sources of Information for Support Decisions



# Data Issues and Common Challenges



Inconsistent Information

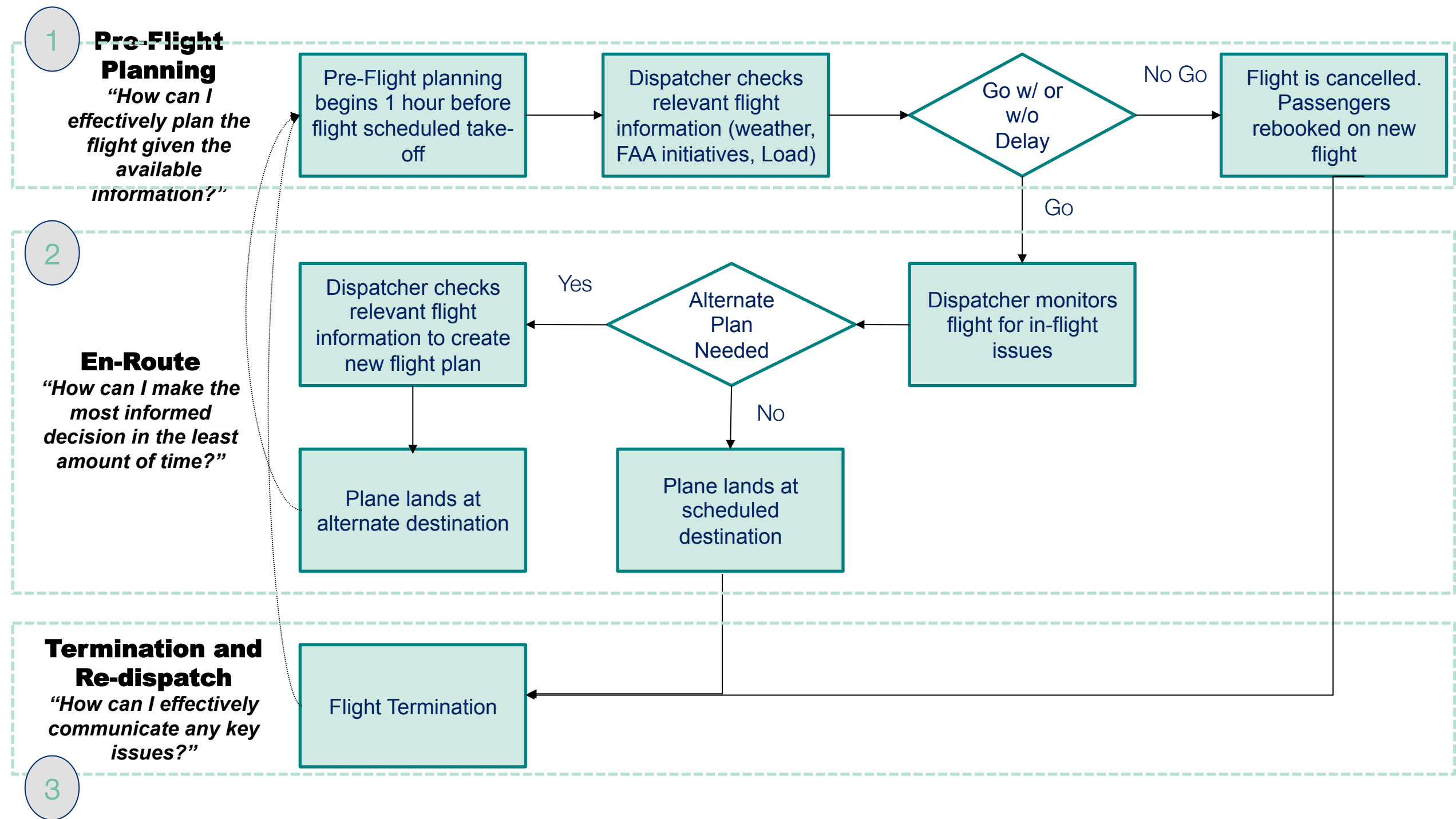
Rapidly changing circumstances

Large amounts of data

Incomplete picture

- Untrustworthy software
- Weather storms
- Security events
- Un-forecasted weather
- En-route mechanical issues with safety considerations
- Creeping maintenance delays
- Information is too spread out
- Locating information is time consuming

# Example: Interacting Decision Processes

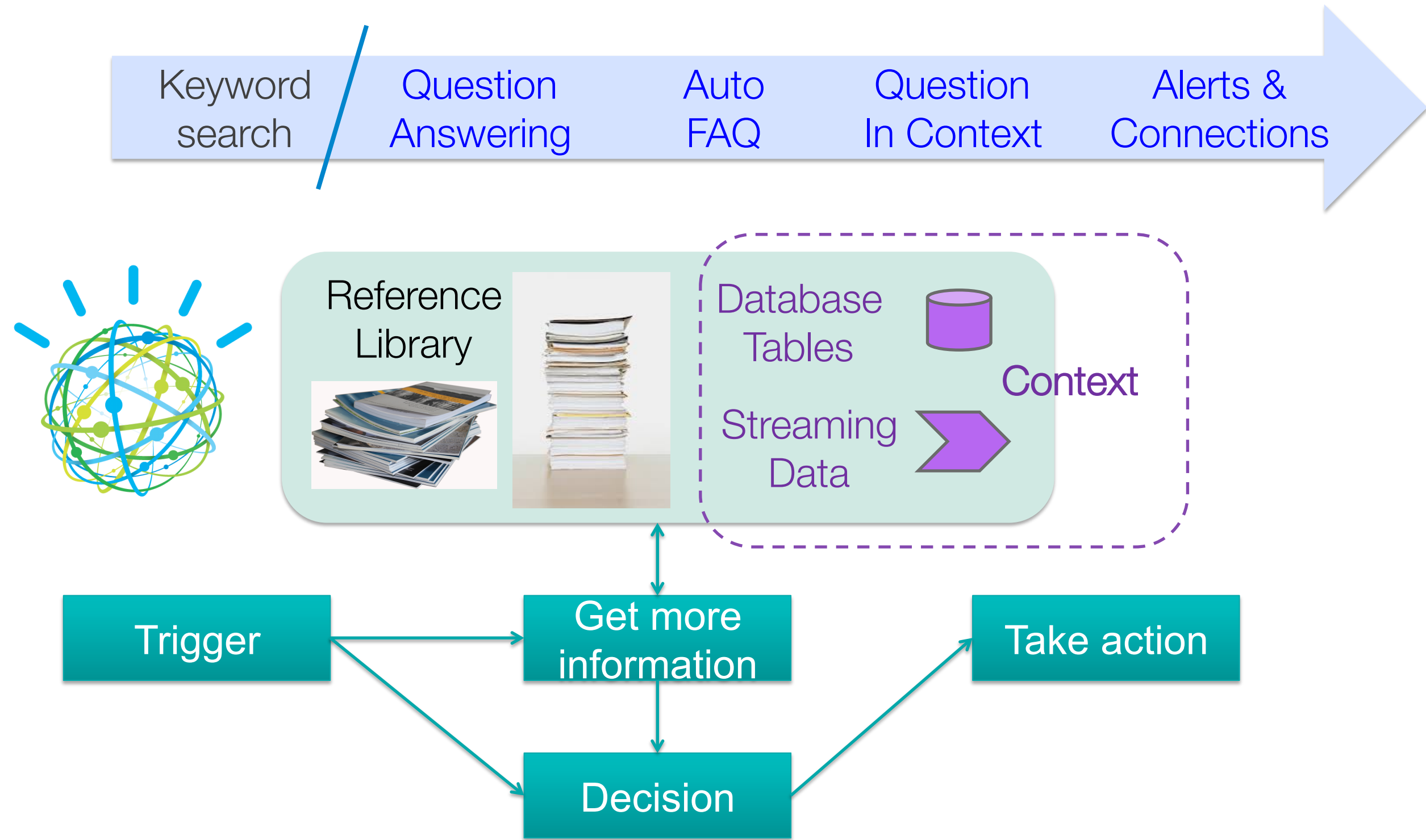
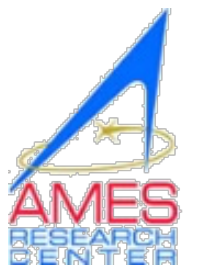




# Explicit vs. Implicit Triggers

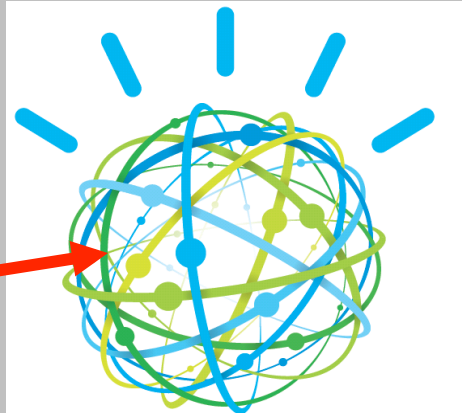
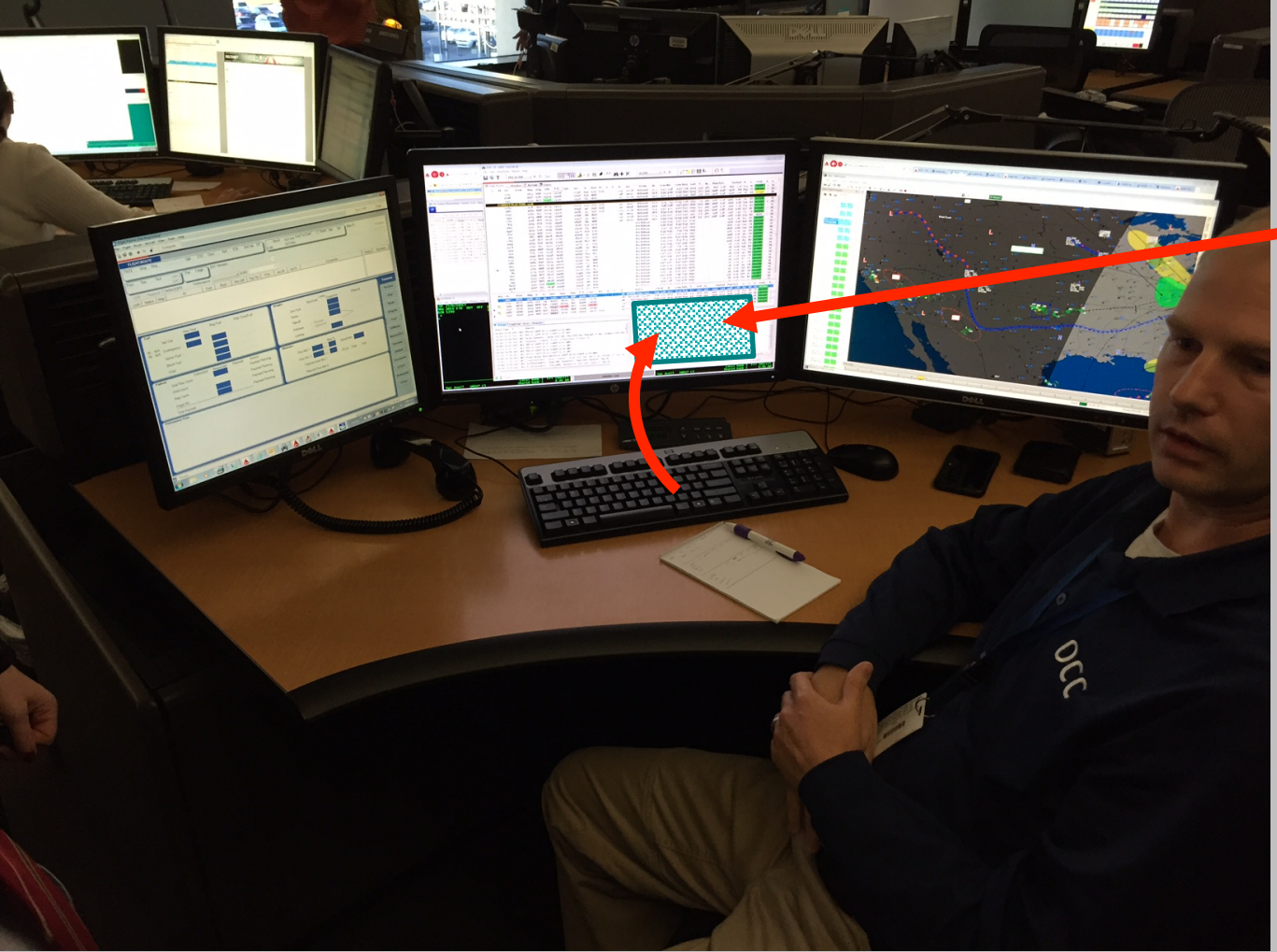
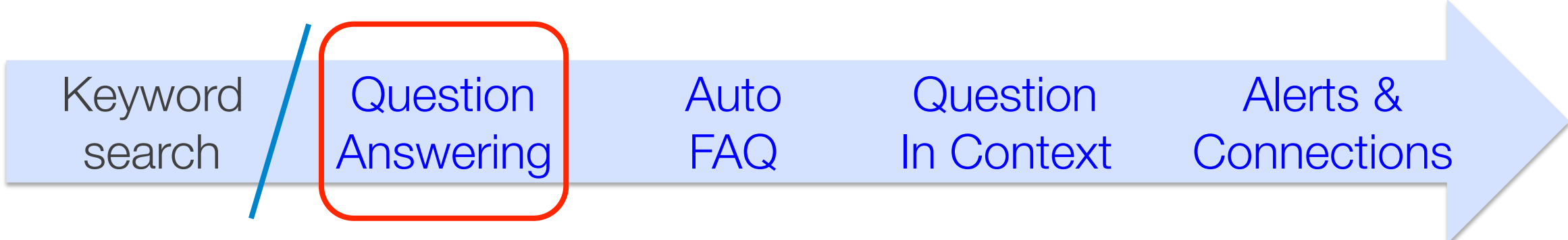
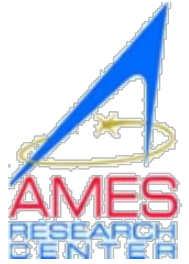


# Staged Application of Watson in an Operations Center

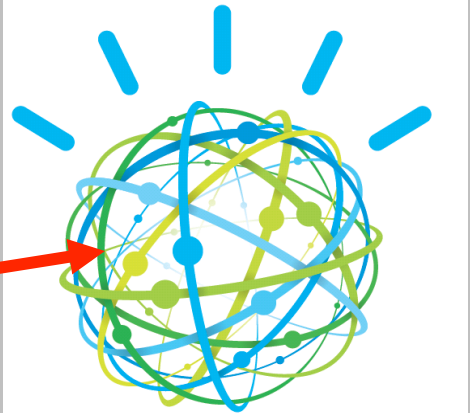
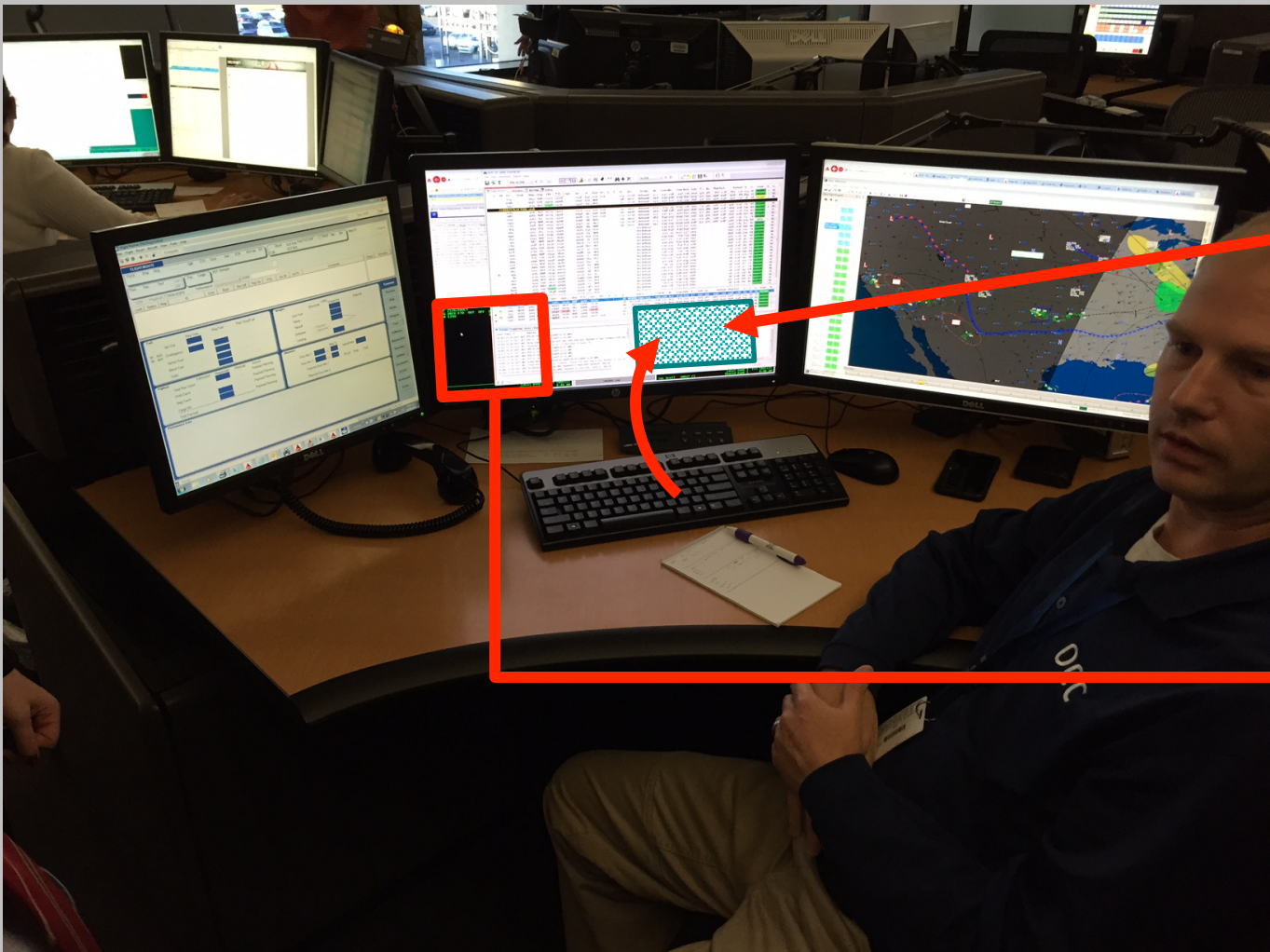
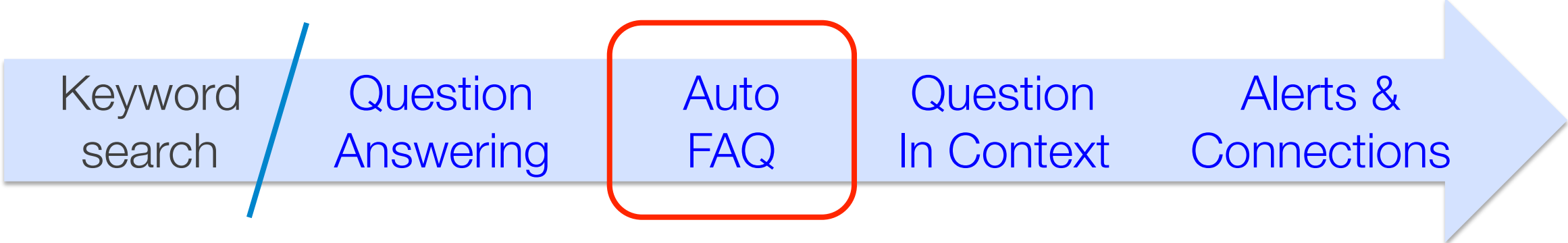




# Staged Application of Watson in an Operations Center

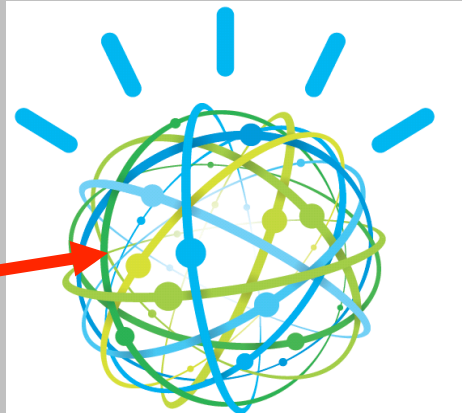
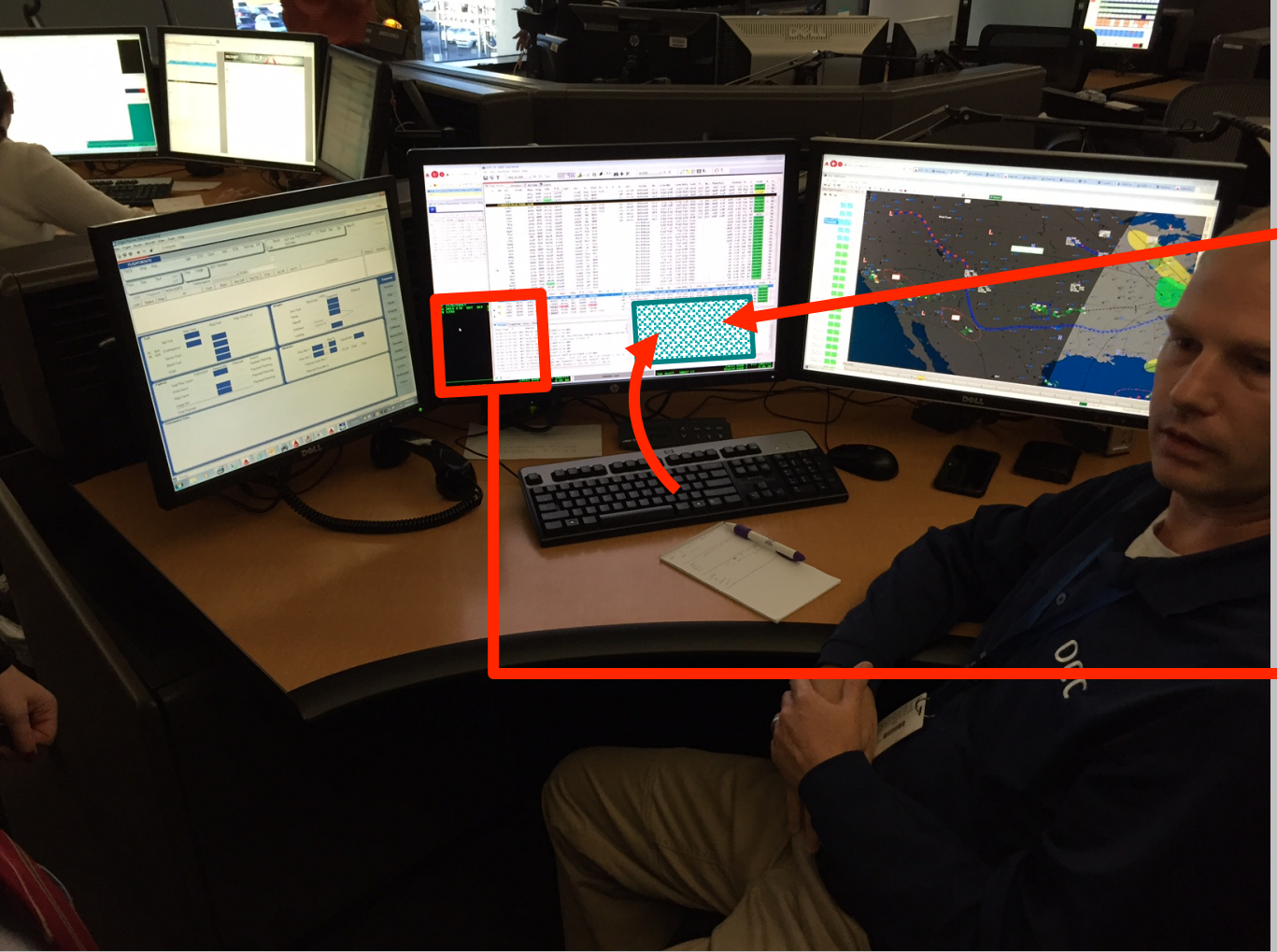
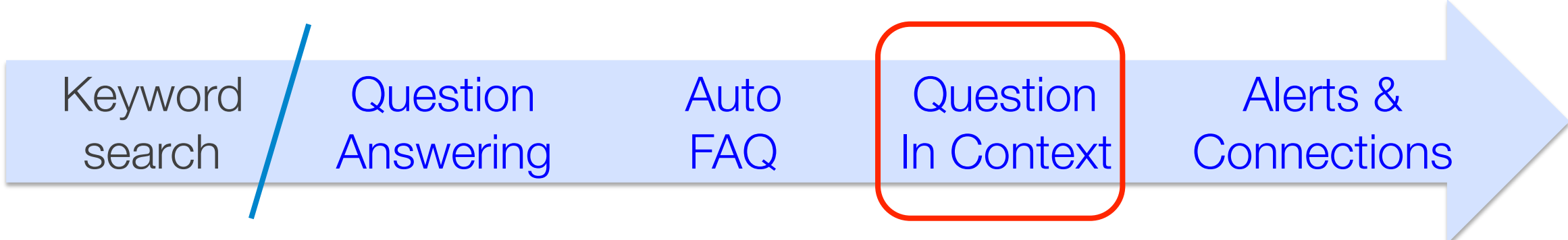


# Staged Application of Watson in an Operations Center



Question  
Templates

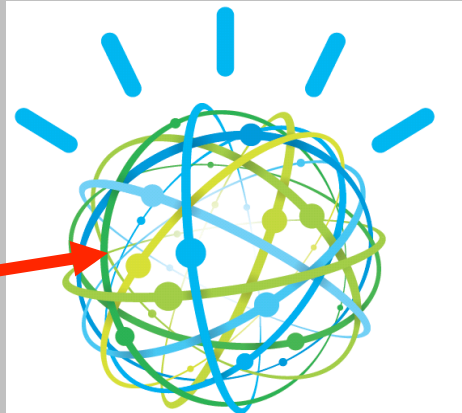
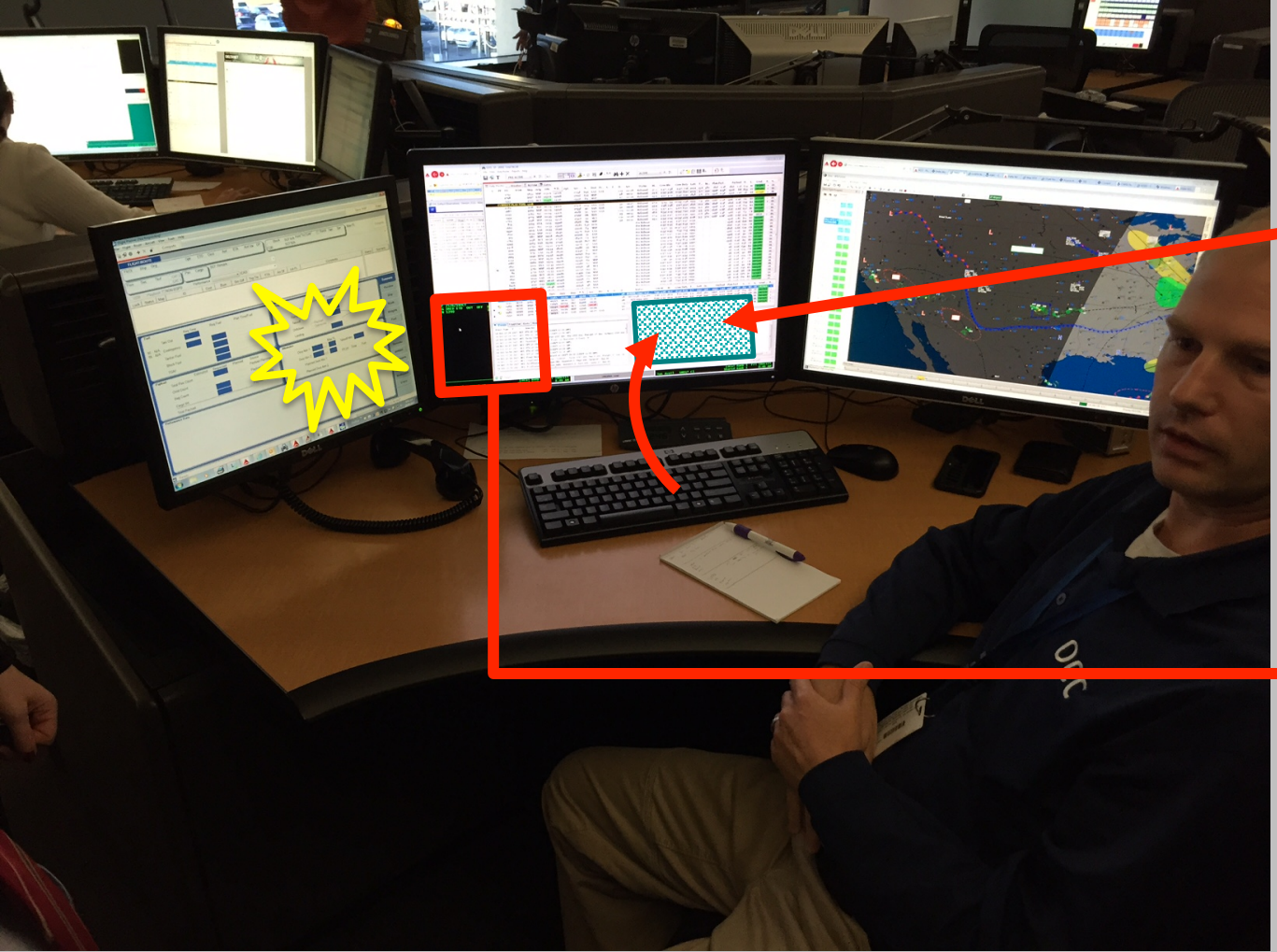
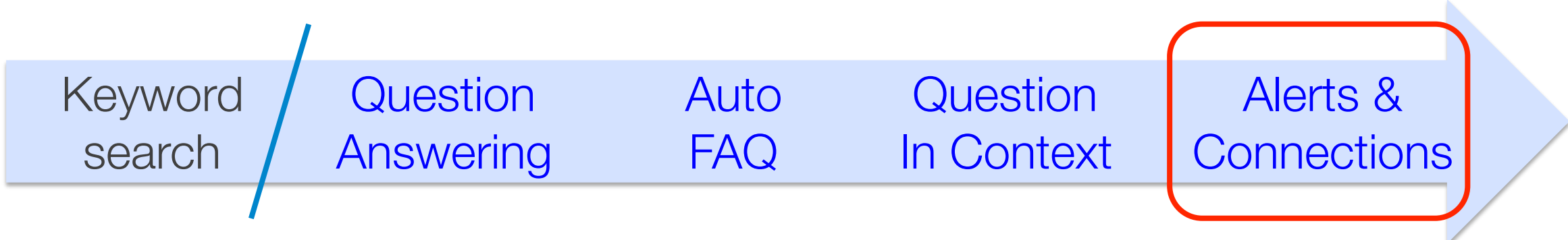
# Staged Application of Watson in an Operations Center



Question Templates



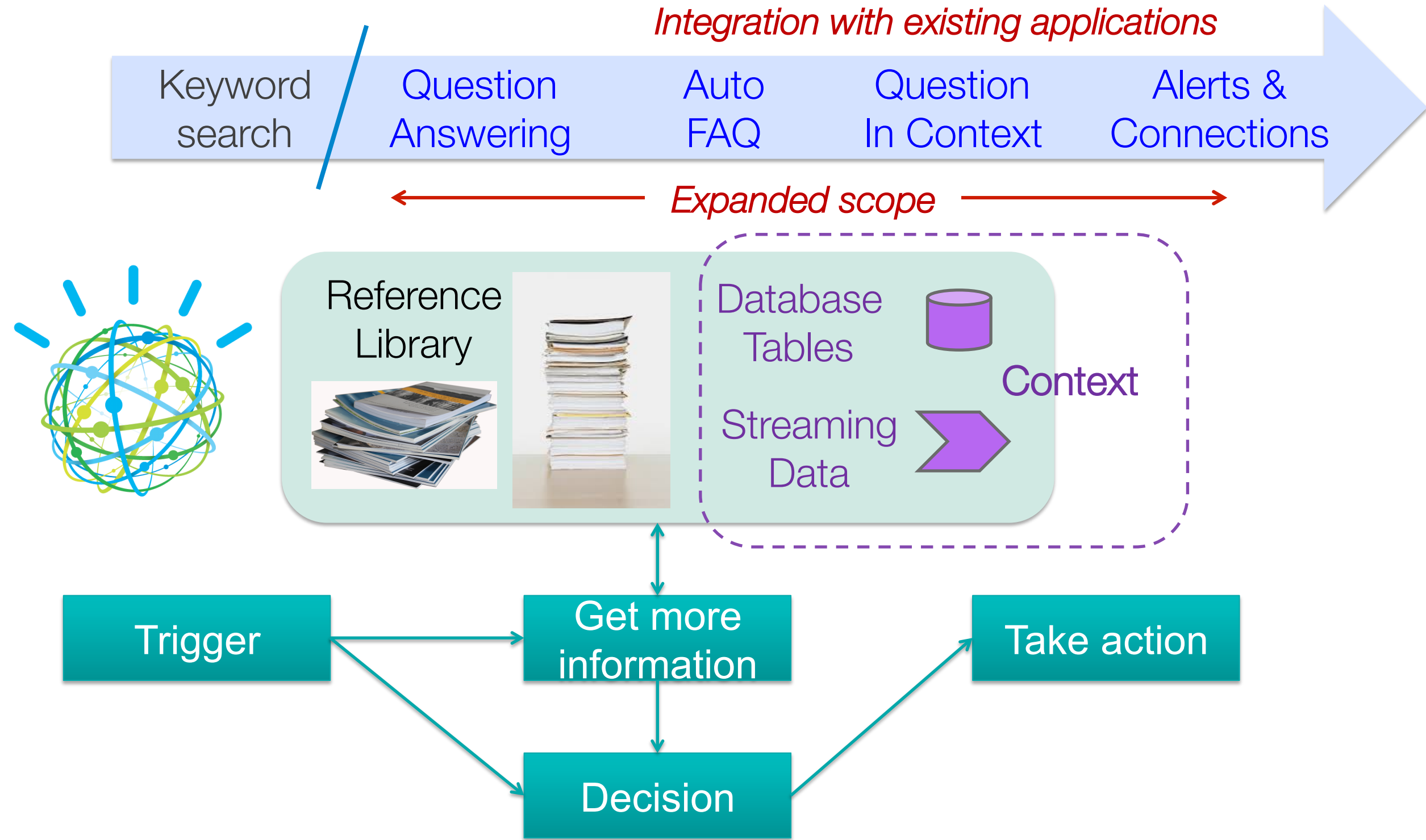
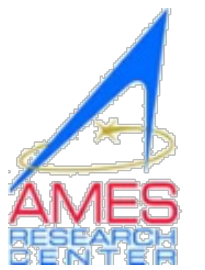
# Staged Application of Watson in an Operations Center



Question Templates



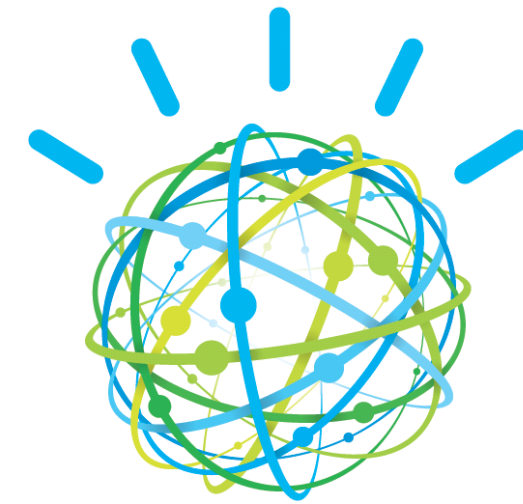
# Staged Application of Watson in an Operations Center



# Challenges to Take Advantage of Cognitive Computing

- Opening the aperture:
  - What other sources of information might be useful but haven't been tried?
  
- Optimizing the human-computer interaction
  - Make the collaboration seamless
  
- Specialization support
  - By role





**THANK YOU**