International Technology Alliance
in
Network & Information Sciences

Anytime Cognition

An information agent for emergency response

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MINISTRY OF DEFENCE

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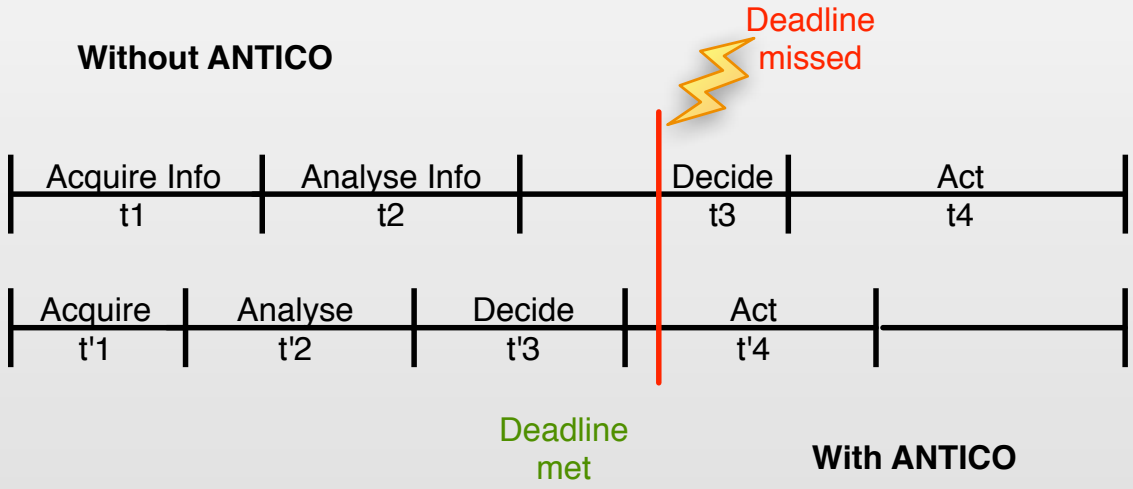
Motivation

- Planning is challenging:
  - Under time-pressure
  - Relying on uncertain information
- Humans under significant cognitive workload
  - Result in missed deadlines

- Anytime Cognition concept:
  - Generic information assistant architecture
  - Maintains a manageable cognitive workload

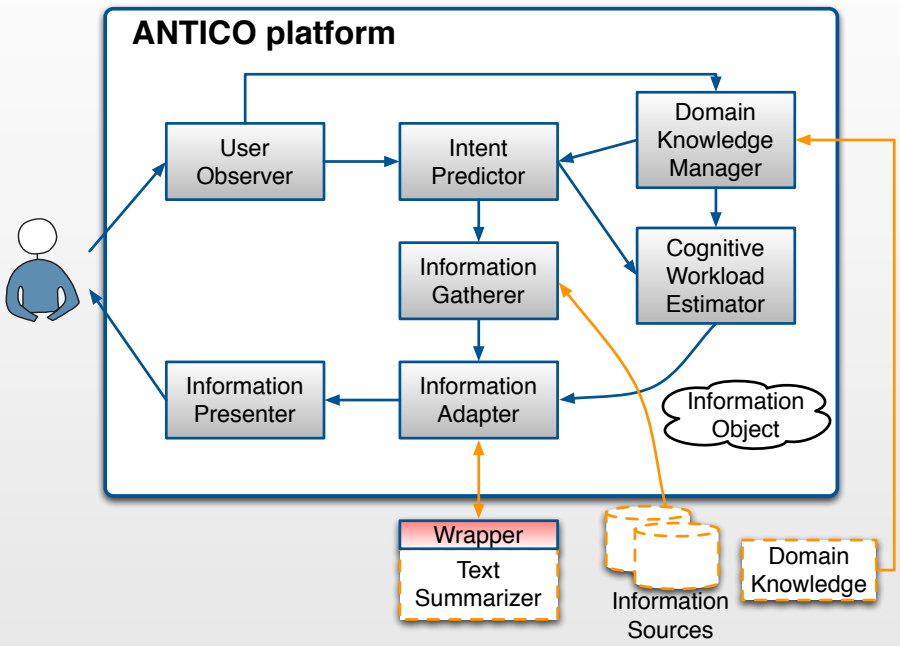


Scenario Description

- Based on the National Planning Scenarios developed by the DHS
- ANTICO focuses on six areas:
  - Emergency Assessment/ Diagnosis
  - Emergency Management/ Response
  - Incident/Hazard Mitigation
  - Public Protection
  - Evacuation/Shelter
  - Victim Care

- Attack Scenario
  - Based on the nerve agent scenario
  - Deployment of multiple Sarin Gas Canisters into a public building in DC
- Initial phases of the response are critical
  - Conflicting diagnosis info
  - Potential for additional casualties from first responders

ANTICO Architecture



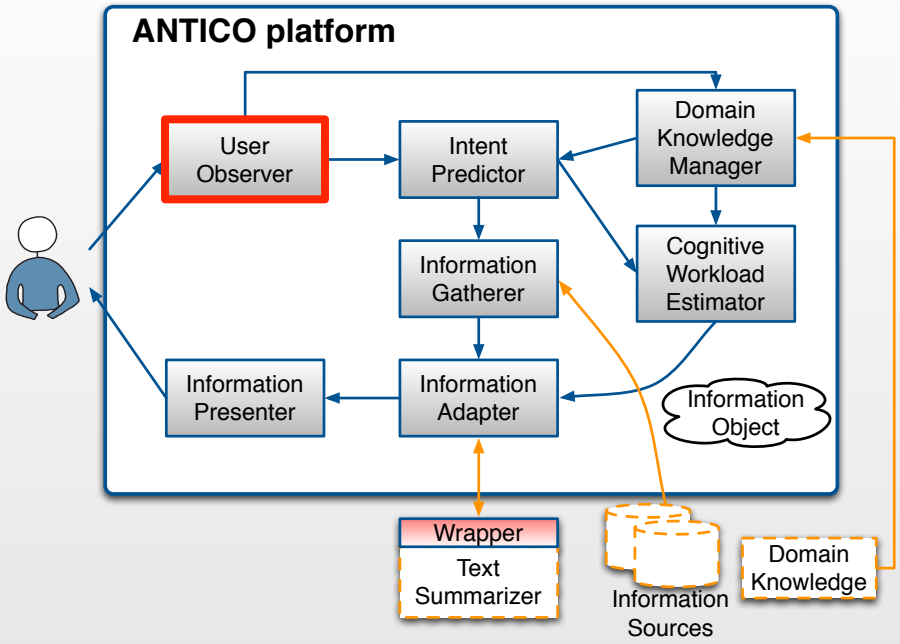
- Generic assistance architecture
  - Integrates multiple AI components
  - Modularized to allow different techniques to be used
- Main objectives
  - User activity recognition
  - Unobtrusive assistance

ANTICO Domain Description Language (ADDL)

- Designed to be generic and applicable to various problem domains
- XML-based
  - Human-readable
  - Network friendly
- Domain description includes:
  - User Workflows
  - Information Sources

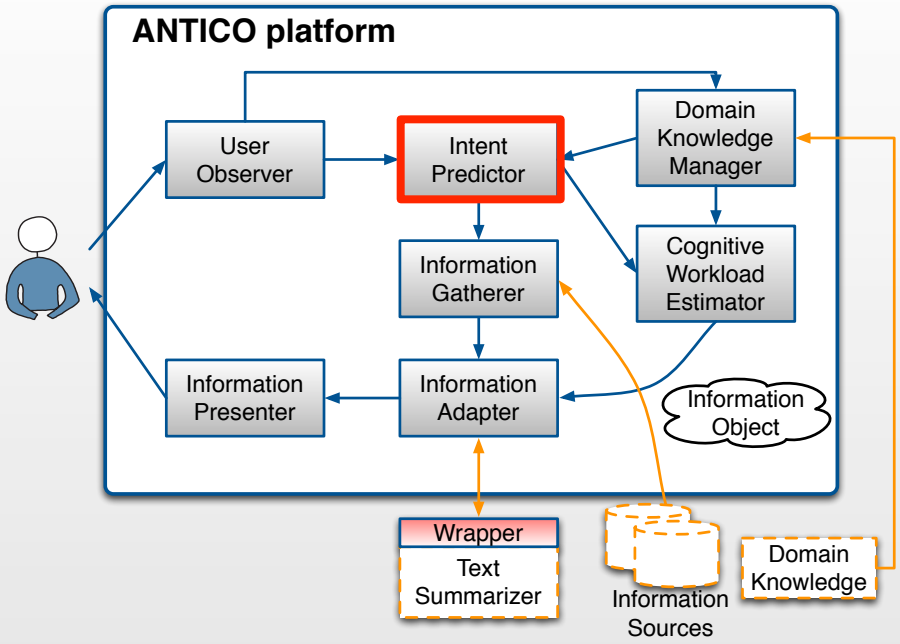
```
<?xml version="1.0" encoding="UTF-8"?>
<anticoDomain>
  <stateVariables>
    <variable name="zip-code"><domain type=numeric min=15201
max=15295/></variable>
    <variable name="hazmat-dispatch"><domain type=boolean/></
variable>
    ...
  </stateVariables>
  <activities>
    <activity name="callHazMat">
      <observations>
        <observation name="dialedXYZ" prob=".5" />
        <observation name="lookedContacts" prob=".5" />
      </observations>
      <infoObject>
        <query value="select phone from Contacts where
name=`HAZMAT' and zip=$(zip-code)$" />
        <constraints>
          <deadline value="17:00 02-06-2011 GMT" />
        </constraints>
        <retrieval status="queried" source=Contacts" timestamp=""
data="" />
        <presentation><zoom-coords="" /></presentation>
      </infoObject>
      <effects>
        <variable name="hazmat-dispatch" value="true" prob="0.9" />
      </effects>
    </activity>
    ...
  </activities>
</anticoDomain>
```

User Observer



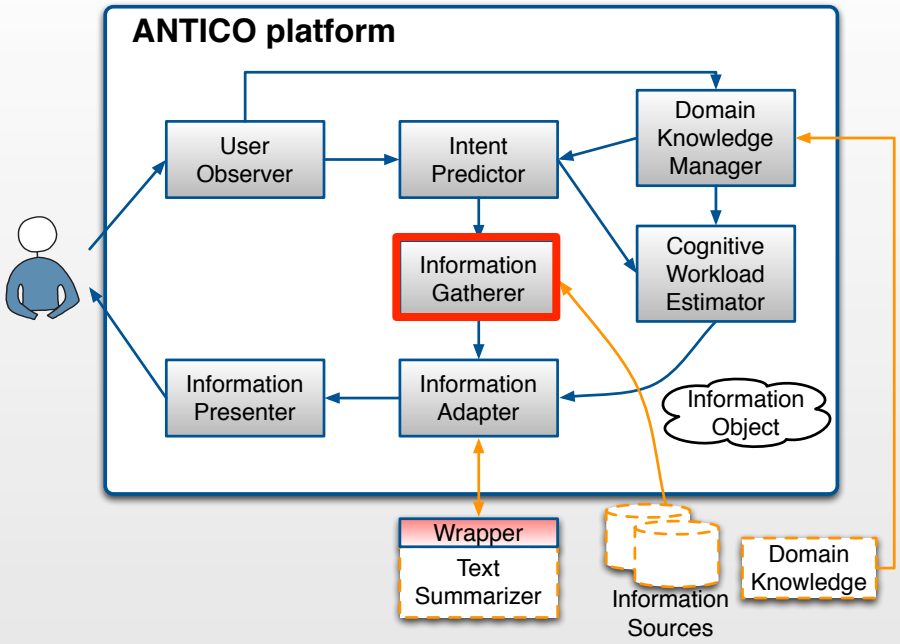
- Obtains and interprets
  - User activities
  - Messages from the field
- Multiple observer objects specialized in specific observation types, e.g.
  - UI activities
  - Input devices
  - External messages

Intent Predictor



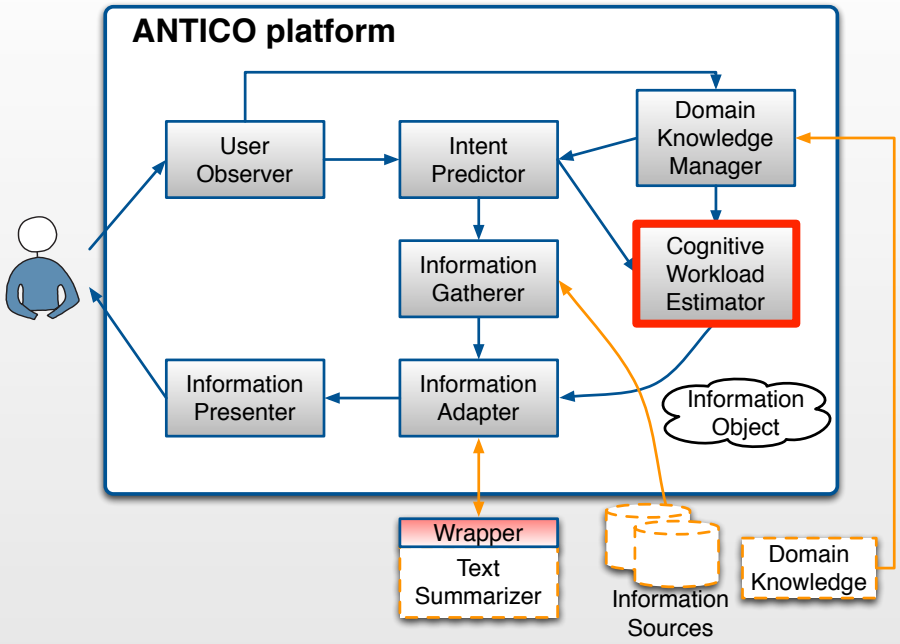
- Uses a domain description in ADDL
- Analyzes observations from User Observer
  - Generates a set of information requirements
  - Employs HMM-based intention recognition

Information Gatherer



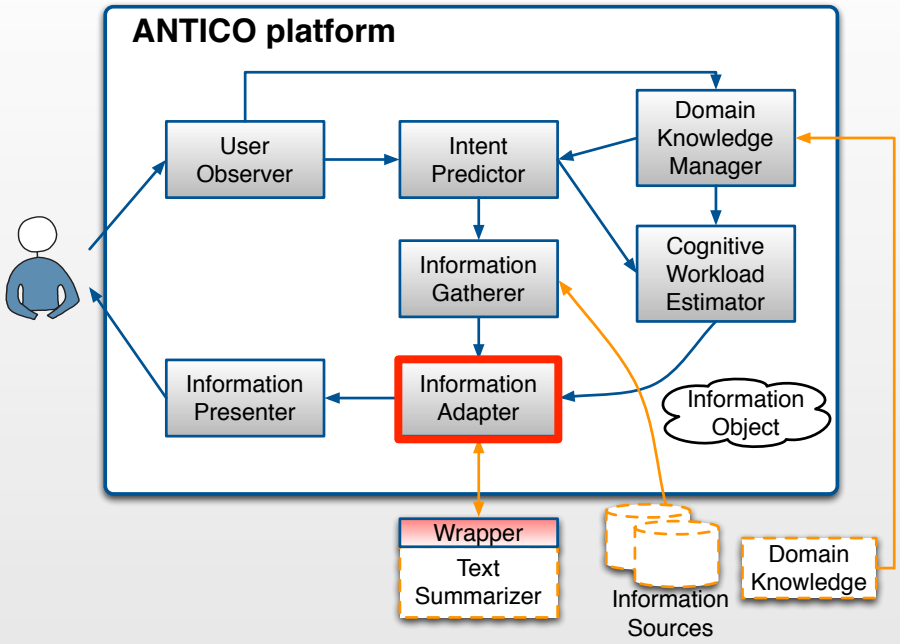
- Using the information requirements from intent predictor, determines:
  - Which information to be gathered
  - When to gather information
  - How to cope with resource restrictions

Cognitive Workload Estimator



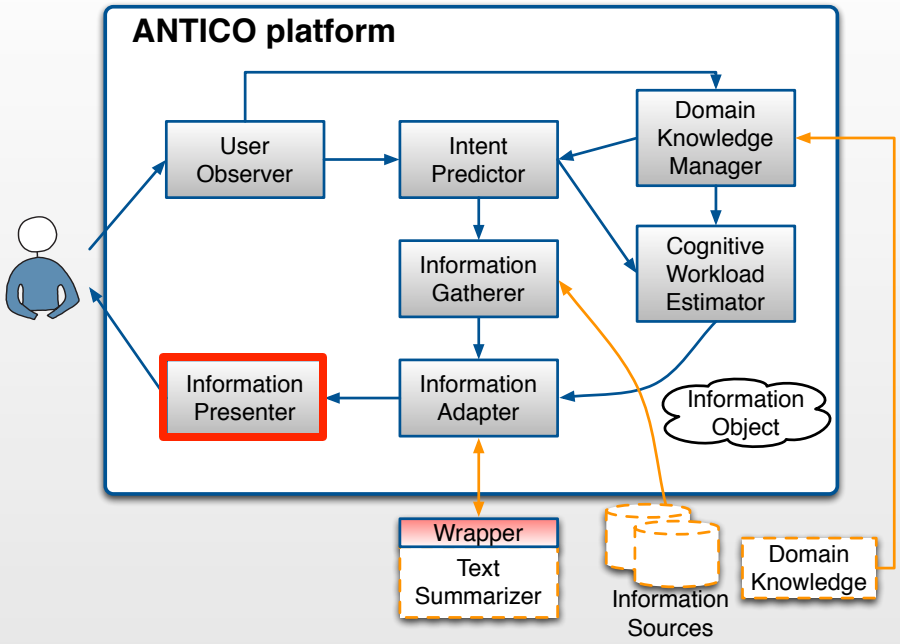
- Calculates cognitive workload
  - Based on the number of tasks executed by user
  - Queuing model for user workload
- Estimates the maximum amount of information to be presented

Information Adapter



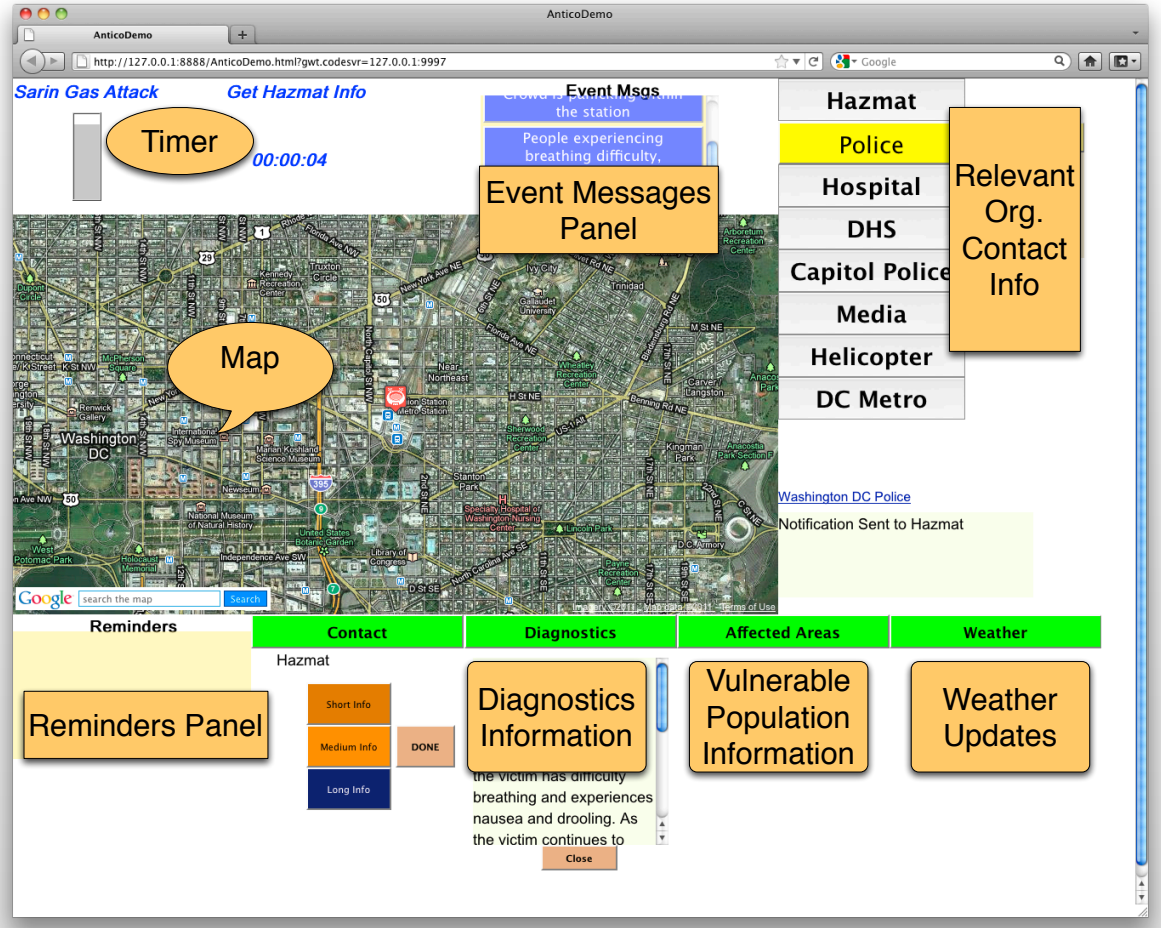
- Adapts information before presentation to appropriate level of detail
- Level of detail of presented information depends on:
  - Cognitive workload
  - Time available for user

Information Presenter



- Presents information to the user
- Uses current belief state to determine optimal time for presentation
- Monitors when and whether information has been used to improve future presentation

Application Description



Contributions

- Mitigation of user cognitive workload
- Adaptive presentation of time and context-sensitive information
- Proactive management of information requirements
- Generic XML-based domain description language
- Integration of several AI techniques:
  - Probabilistic plan recognition
  - Constraint optimization
  - Domain independent

Current Work

Current Work by CMU

- Integration of ANTICO with CPOF Sandbox
- Aimed at:
  - Testing of agent assistance for CPOF users
  - Refinements to information assistance in a realistic environment
  - Great potential for technology transition

CPOF Sandbox

- Developed by CERDEC
- Replicates UI functionality of CPOF in a “Sandbox” environment
  - Uses simulated data plus human interaction
  - No access to sensitive data
  - Aimed at usability studies in a controlled environment

Integration with CPOF Sandbox