Distributed Coordinated Collaboration Spaces (DCCS)

ONR STTR N04-T026: A Human-Centric Architecture for Net-Centric Operations

-STTR Phase I Summary
-STTR Phase II Plan & Progress

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Modern Command and Control ...

Requires communication, collaboration, and coordination among US (and Coalition) forces

Is synchronous *and* asynchronous; tactical *and* strategic in nature

Team members often co-located *and* distributed

- **Geographically / Organizationally / Functionally**
- **Focus / purpose / schedule / resources**

Complex related issues

- **Technologies / Infrastructure**
- **Policy / Process / Business Rules / Doctrine**
- **Cultural effects (organizational, national, etc.)**

Research strongly suggests modern C2 benefits greatly from:

- **Shared Mental models and goals / shared understanding of context**
- **Shared Situation Awareness**
- **Transactive Memory and Communities of Interest**

Re-Visit of Operational Problems

Stove-piped collaboration, situation awareness, and decision support tools = inefficient info exchange, sub-optimal SA

Difficult / impossible to explicitly relate spatially- and non-spatially relevant information

Identification / resolution of related, similar, or redundant conversations / exchanges

Awareness of current or emerging "channels" and shifting or splitting of locus of communication / collaboration

Related and overlapping information "spaces"

– Geospatial, temporal, contextual, etc.

Separate methods of communication / collaboration

– Verbal, textual, visual, etc.

Communication and collaboration process, usability, and utility issues…

Overall STTR Project Goals *(Phases I-III)*

1. Consider / adapt / apply appropriate cognitive, information exchange and processing, and decision making theories (e.g., ONR's CKM Program)

2. Combine / leverage / adapt *existing* communication and collaboration technologies, infrastructure, and tools with cognition-based information, knowledge management, and decision support tools

3. Design, develop, validate, and commercialize a *Distributed Coordinated Collaboration Spaces* (DCCS) tool to improve modern C^2

4. Develop totally new theories, technologies *only as necessary*

DCCS Applies Latest Cognitive Science

Stages of collaboration

- Knowledge building, problem solving, consensus building, evaluation and revision

Team situation awareness

- Everyone maintains awareness of the evolving situation…
- …While maintaining the ability to focus on own issues

Coordinating representations

- The DCCS collaborative workspaces and common integrated database provide a coordinating representation for collaboration

Encapsulation and organization

- The DCCS analysis space is designed to show each collaborator's contribution to the evolving analysis

Core and slot analysis

- The DCCS analysis space is designed to support the Core and Slot model / analysis process

Transactive memory

- The DCCS database and interface organizes data sources and human expertise for efficient access and consultation
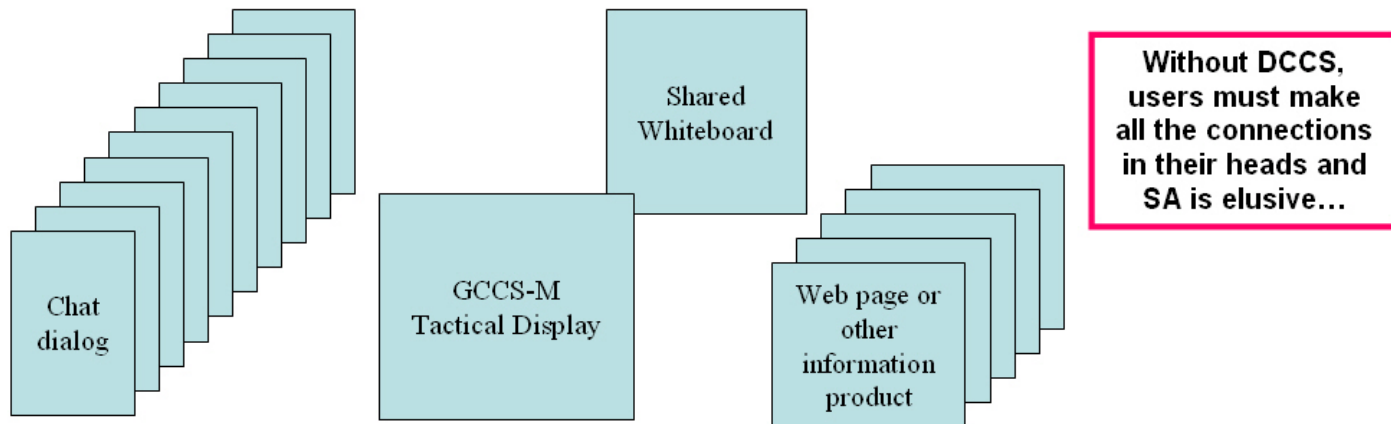
Ontology and semantic web

- An integrated DCCS database is based on an ontology of concept relationships to support future intelligent agent functions
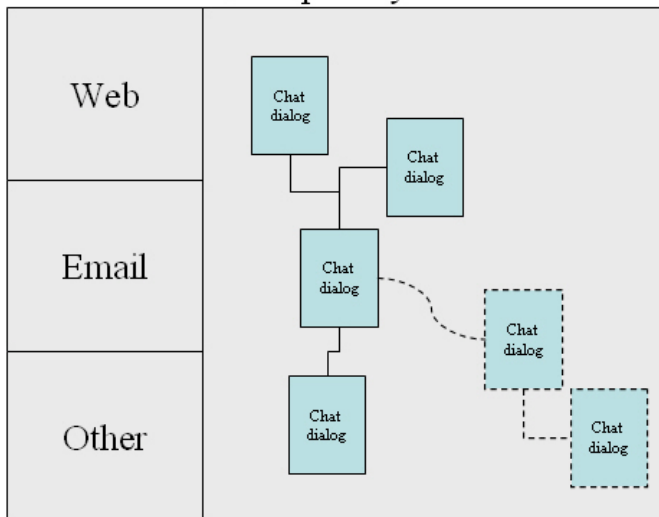
Change awareness and history

- Message encapsulation to manage database and analysis changes
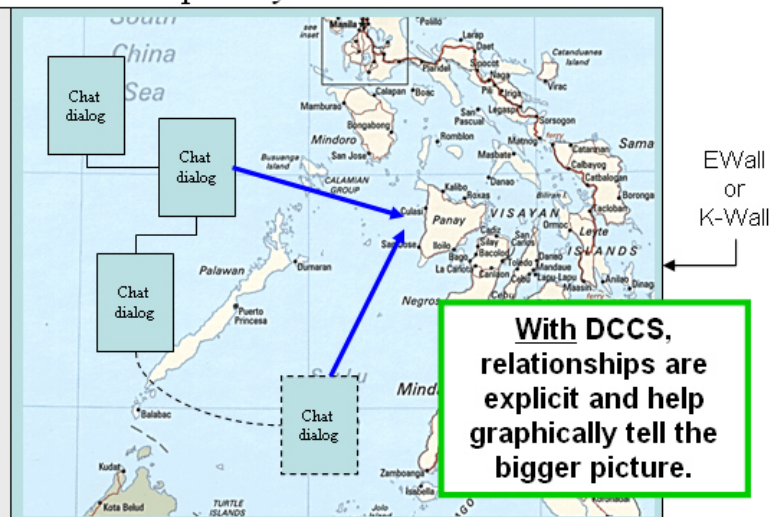- Change history and authorship to manage asynchronous collaborative analyses

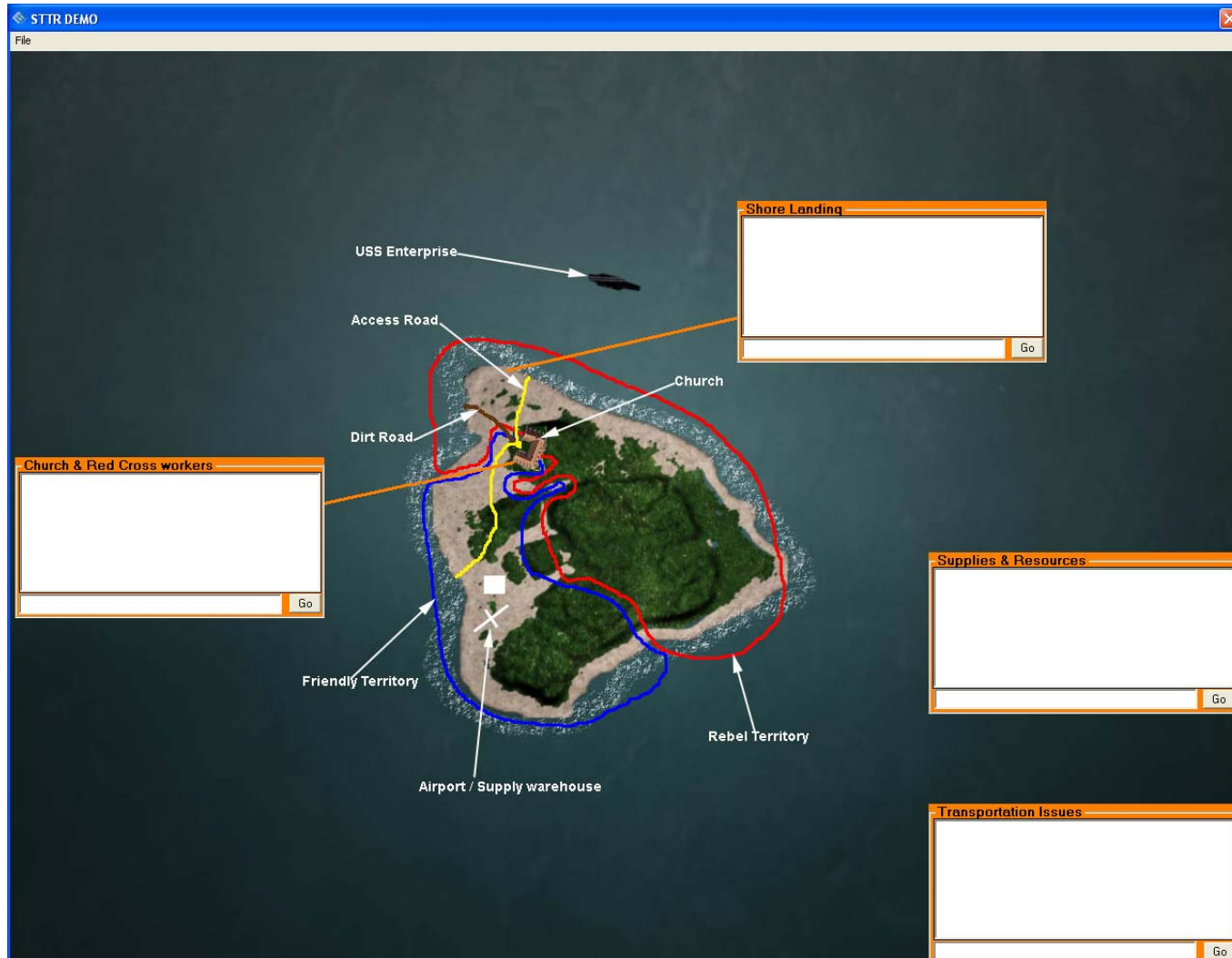# Early DCCS Concept Storyboard (circa early 2004)

Phase I Demonstration: DCCS Support Tools

Transactive Memory Map

Collaboration Context & Content Aid

Environmental Expert

Atmospheric Conditions
- Precipitation
  - (Rain, Fog, Snow)

Oceanographic Conditions
- Tides
- Beach conditions
- Wave height

Terrain Information

Resources…

Special Forces Expert

Special Forces methods / tactics
Weapons
SOF Capabilities and limitations
Rules of Engagement / Orders / Policies & Procedures

Resources…

Supply / Logistics Expert

Platforms
Ships / Boats
Planes / Helicopters
Trains
Food
Other Supplies

Resources…

Medical Expert

Medical supplies
Medical procedures
Medical considerations
Psychology / Physiology
Human capabilities & limitations

Resources…

Planning Issues	Considerations
Beach Landings	Tides Visibility Surf Obstacles Beach conditions
Helicopter use	Range Capacity Noise Armament Speed
Traversing mountainous terrain	Climate Terrain Altitude Physiological effects Speed
Indigenous wildlife	Edibility Dangers Number and type Health concerns

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Phase I Highlights

1. Adopted *Transactive Memory* and *Shared Mental Models* as key concepts for improving efficiency and effectiveness of collaboration
   - Challenge was to *operationalize* these concepts
   - Several supporting / related theories adopted …
2. Identified / developed / used operationally-relevant metrics to measure collaboration activities
3. Developed materials and software to conduct demonstration and hold discussions to further develop concept
   - Shared and expert data sets (adapted from NEO scenario)
   - Transactive Memory map
   - Collaboration Context & Content aid
   - Demonstration collaboration software

Phase I Summary

Navy experts and CSU demonstration participants agree: *DCCS concept has merit with regard to improving collaboration and SA*

First steps successfully taken toward developing real tool / capability

Various issues / challenges identified, and preliminary plans developed to deal with them …

Connections made with researchers and operational community that could facilitate Phase II efforts

The Concept Evolves (circa Jan. 2005): Phase I Option Modified Storyboard

Textual Transactive Memory Pane

Chat Pane

Shared Task Pane

Cmdr. Joe Cannon – OrgJ-4 (Sydney)   ★★★★ (297)

- Supplies/Resources available (e.g., food, water, weapons, medical supplies, etc.) in the Pacific Theater
- Transportation resources (e.g., trucks, ships, planes, etc.) including strengths, limitations, and capabilities in the vicinity of Drapo Island
- Transportation time required by type of resource used
- Availability/condition of local roads, trails, bridges, etc. on Drapo Island

LOGISTICS: yeah, parachutes would be good :-)
LOGISTICS: the heli is equipped with machine guns and a missile launcher also
LOGISTICS: It's called a US Navy Seahawk (SH-60)
SOF: the weapons that team 3 has are M-16's and M-60's and each has their own side arm
LOGISTICS: are there any other medical conditions we may encounter with them?
INTEL: how far can they shoot
INTEL: nope
SOF: 500 yards
LOGISTICS: for the heli, it just says air to air and air to ground support
INTEL: good, thats way farther than they can shoot
SOF: and small fire arms can disable low flying aircrafs
LOGISTICS: Seahawks are located on the USS Enterprise or at the airport currently
SOF: actually team 3 doesn't have m-16s they have a sniper riffle, a M9 pistol, and 3 m-60s
SOF: we would want to use the seahawk on the USS Enterprise because that is where our troops are at
LOGISTICS: Yep
ENVIRONMENTAL: would that be faster
LOGISTICS: we could use other helis for additional support, if necessary

LOGISTICS: I think we should have the SEALS land here.   [Go]

Geographic Transactive Memory Cueing Pane

Phase II Challenges

How do we make the DCCS concepts and technologies real?

- – Fully operational and compatible with others technologies
- – Easy-to-use
- – Reliable
- – Useful

How do we prove the DCCS actually helps the warfighter?

- – Operationally-relevant metrics
- – User-accepted validation

How do we transition DCCS concepts and tools to real warfighters?

- – Political hurdles
- – Long-term supportability issues
- – IATO / ATO
- – SSAA

High-Level Phase II Plan

Use DARPA's ongoing FastC2AP project at CNE-C6F as venue

– FastC2AP is using software agents to facilitate operations in C6F Theater Maritime Fusion Center & Intelligence Center

– Theater Maritime Fusion Center (TMFC) is enthusiastic about DCCS concepts within a FastC2AP context

Conduct Phase II Work

– Continue "connect the CKM dots" work …

– Work with CNE-C6F to "grease the skids" for STTR work as part of FastC2AP Prototype Development

– Supporting Model / Infrastructure Development

– Integration Work

– Lab Evaluation / Data Collection

– Pre-Transition-Related Efforts

– Field Evaluation / Data Collection

– Technical Report

C6F Problem

Command center coordination

- Information is distributed – hard to find, hard to know about
- Knowledge applications are not aware of each other – redundancy, interoperability problems
- Too much message traffic
  - » Much of it of questionable relevance
- Miscommunications among (extended) team members
- Data and task coordination

Specifically:

- Develop, maintain, and share regional SA / MDA
  - » Maintain multiple US and coalition COP systems
- Track ships, look for "anomalies"
- Mine multiple databases for information
  - » Requesting, integrating, analyzing, conflict resolution, etc.

C6F Problem in Cognitive Terms

Players may not know what information exists or where to obtain it
  – Transactive memory: who knows what

Players may not understand information requirements of others and push/pull inappropriately
  – Transactive memory: who needs to know what?
  – Message relevance and redundancy

Players may not share situation context, ontology (frame, world view), speech acts (culture-language)
  – Interoperability problem
  – Grounded transactions, Shared situation awareness

Senders may assume background knowledge in communications is or is not shared (mutual grounding problem)
  – Receivers may infer information incorrectly or fail to infer
  – Or, senders may be forced to make assumptions explicit and waste time

DCCS Solution

Communal workspaces and user-defined views

- Supports efficient viewing of vessel data and core-slot reasoning
- Supports collaboration consensus building
  » What I know, what you know, what we agree on
- Supports grounded transactions
  » Context for messages and questions

Communal database - ontology

- Reduces redundancy by providing all users with a common content and context

Machine-readable knowledge

- Supports agent-based data processing, including anomaly detection and integration of new data

Block Diagram of DCCS (circa Aug. 2005)

Direct User Input

Data Scrapers & Handlers

Email, chat, data bases, web pages, etc.

Raw Data Repository

Collaborative Space & Processed Information

Structure based on Ontology

Anomaly Detectors & Other Data Processors

User Views *(templates & saved views)*

Graphical or text-based; high-level summaries and detailed "drillable" data
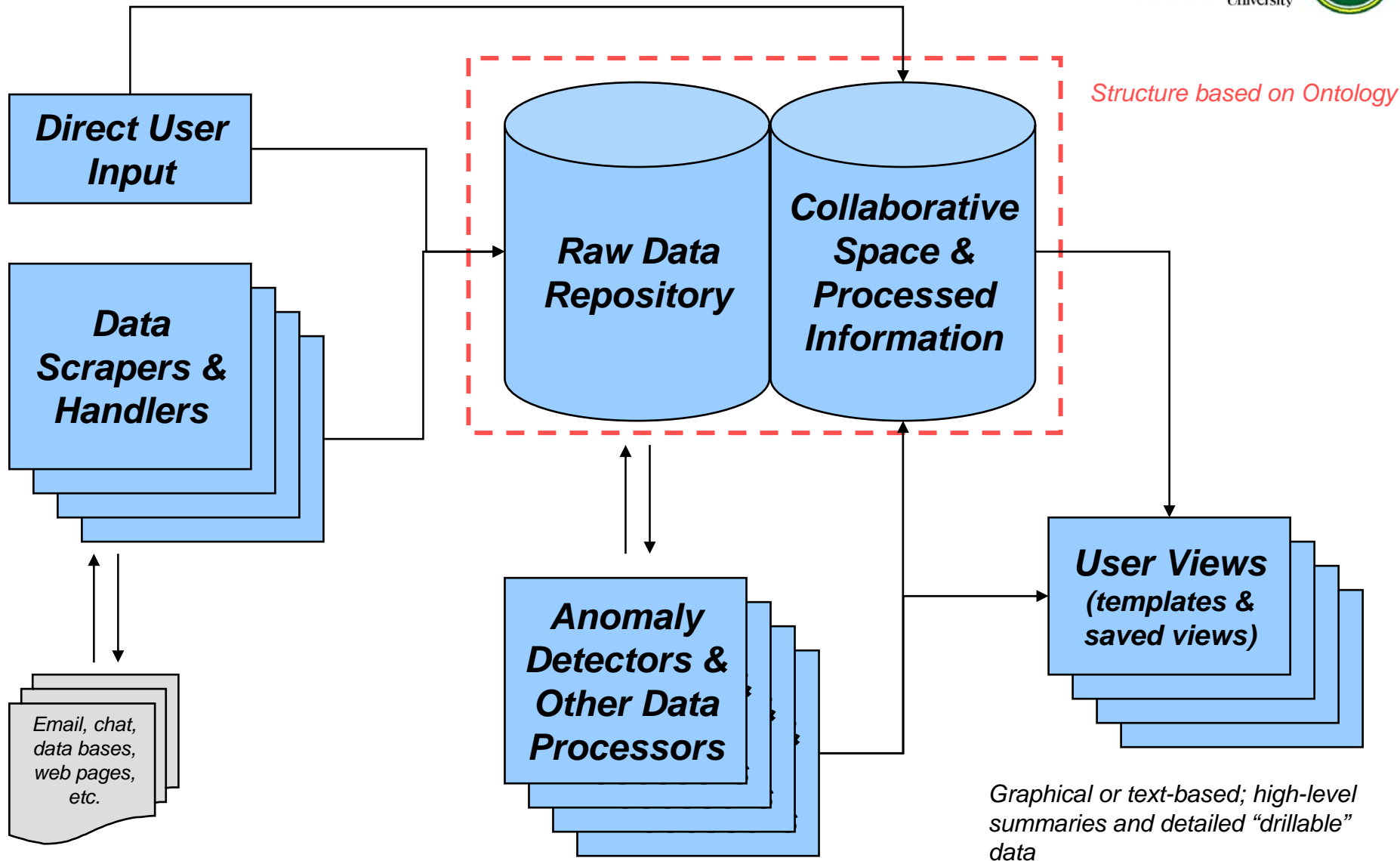
Key Concepts for Phase II

Continue Phase I direction of providing distributed, coordinated collaboration

Use formalized "Coordinating Structures" as a means to facilitate more efficient and effective communication and collaboration

- Ontology-guided database of C6F-relevant info
- Merge and formalize a number of C6F information feeds and products as an underlying coordinating structure
- Reduce redundant information entry and handling
- Provide user-customizable views into ontology / database

"Componentize" technologies

Software "agents" do much of the mundane work

Phase I Demonstration Collaboration Aids as inspiration for Ontology

Transactive Memory Map

Collaboration Context & Content Aid

Environmental Expert	Special Forces Expert
Atmospheric Conditions - Precipitation - (Rain, Fog, Snow) **Oceanographic Conditions** - Tides - Beach conditions - Wave height **Terrain Information** **Resources…**	Special Forces methods / tactics Weapons SOF Capabilities and limitations Rules of Engagement / Orders / Policies & Procedures **Resources…**

Supply / Logistics Expert	Medical Expert
Platforms Ships / Boats Planes / Helicopters Trains Food Other Supplies **Resources…**	Medical supplies Medical procedures Medical considerations Psychology / Physiology Human capabilities & limitations **Resources…**

Planning Issues	Considerations
Beach Landings	Tides Visibility Surf Obstacles Beach conditions
Helicopter use	Range Capacity Noise Armament Speed
Traversing mountainous terrain	Climate Terrain Altitude Physiological effects Speed
Indigenous wildlife	Edibility Dangers Number and type Health concerns

Ontology Goals

Support single integrated database / multiple user views with vessel data relevant to a variety of core tasks

Tasks include:

- Track update:
  - » basic position data, what else?
- Data / Database interaction:
  - » more in-depth data for each vessel
  - » Integration across databases and agencies
- Intelligence analysis / investigation
  - » Most detailed, analyses and hypotheses about vessel, actions taken or to be taken
- Message content and pedigree analysis, alerting, archive, etc.
  - » Chat, email, message traffic system

Example Vessel Ontology Content

Purpose
- Platform
- Owner
- Current mission

People
- Captain, crew, passengers
- Skills, histories, needs

Route
- Past, present, future
- Ports, fishing areas
- Times, courses

Cargo

Resources (people and data)
- Allied navies
- Port managers
- Shipping agents
- Crew manning supervisors
- Sea farer's unions
- Satellite photos (ship, ports)
- Timetables
- Knowledge about ports, cargoes, routes, etc.

Stories: all data must align to create a consistent story

Collaborative Ontology Workspace

Multiple inter-related representations of vessels, e.g. maps, timetables, crew data

– Data for individual vessels are paths through the ontology network

Discussions of

– interpretations,

– pedigree issues, patterns among multiple ships,

Flagged vessels

– Why flagged? Gaps and what needs done? Report what to whom?

Context for

– Questions

» The why of the question (available on demand)

– Activity

» Who is working on what and needs what info?

CSU Task & Research Supporting Analysis of Text-Based Collaboration
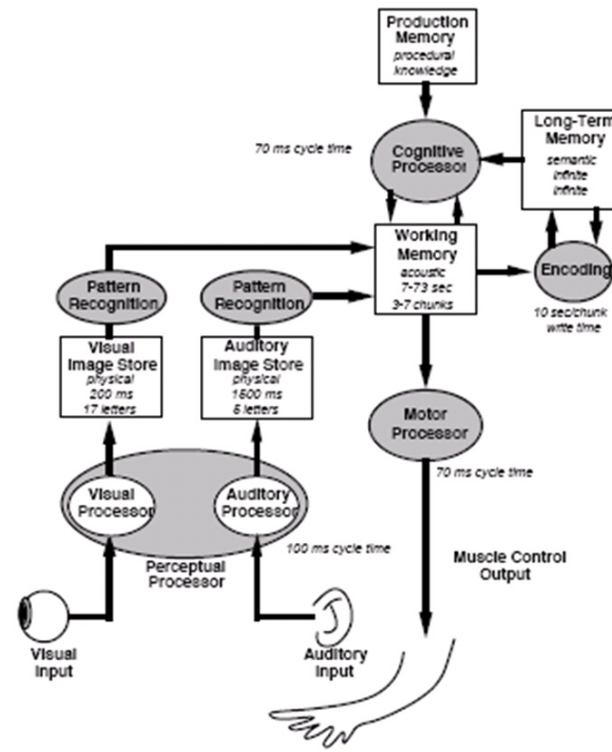
Researching and developing a text/transcript searching tool as a component of DCCS

Researching and adding to a cognitive model to support team collaboration and information processing and sharing

Stay tuned: CSU to describe this work in more detail during their presentation on Thursday…

Recent Cognitive Model

From Kieras, 2005

COP with track data

Vessel Grid with track data

Region of interest is defined on the map

The Grid displays vessels from that region and other relevant information from underlying database

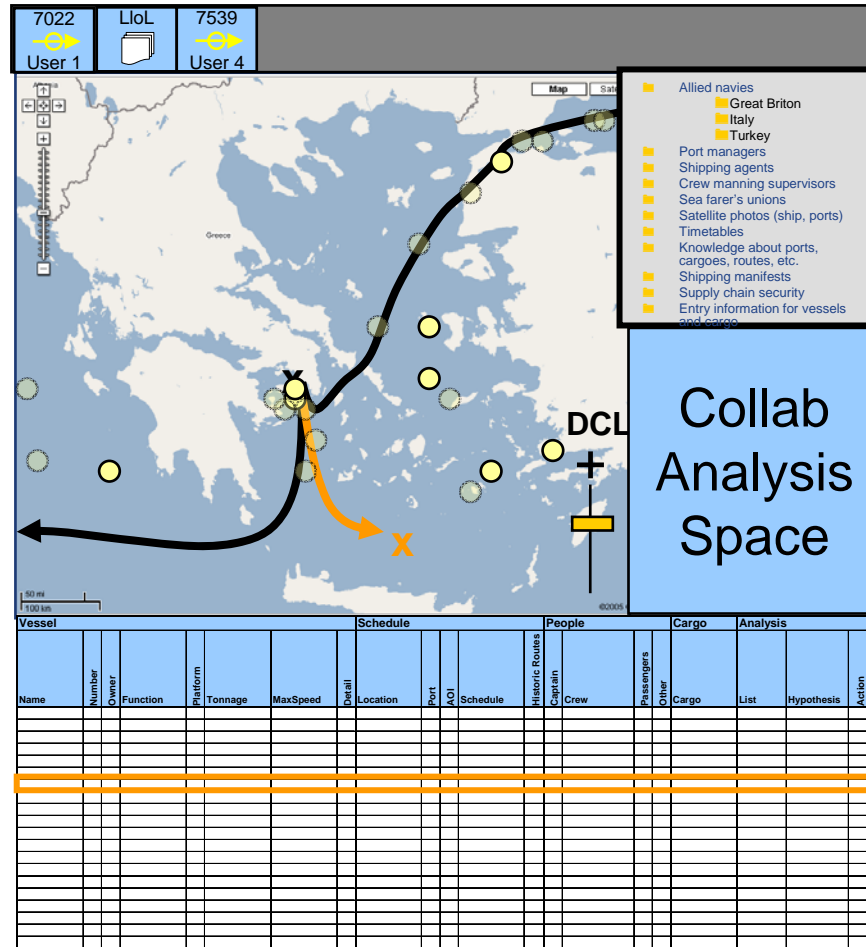Users select a track or specific data element and access shared database / collaboration space

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Example DCCS Interface Modules

Map with Assisted Focus

Spatial Annotations

Vessel Grid

Team News Ticker

Trans-active Memory Map

Analysis Space

Small Sample of CKM / ONR Concept Transitions

Spatial annotations

SLATE

Shared awareness of evolving message context

CJA

Search and compare resource grid

CSSS

EWall newsreader and shared workspaces

EWall

Transactive memory and ontology

DCCS

Core & Slot analysis Text analyses

DCCS

Collab Analysis Space

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Vessel Grid CONOPS

Problem

- Users frequently resort to "hunt and peck" to find a vessel with a particular attribute on a situation display

Multi-vessel data display

- Coordinates all vessel data into searchable grid
- Each row is a vessel
- Each column is an attribute

Vessel search and comparison

- Search for all vessels with a particular attribute or attribute range within a map region
  - » E.g. tonnage, origin, path, owner, crew member
- Search for combinations of attribute values
- Retrieve data and analyses

Imagine Grid filled with data

Linked to map

Vastly superior to "hunt and peck" on a map

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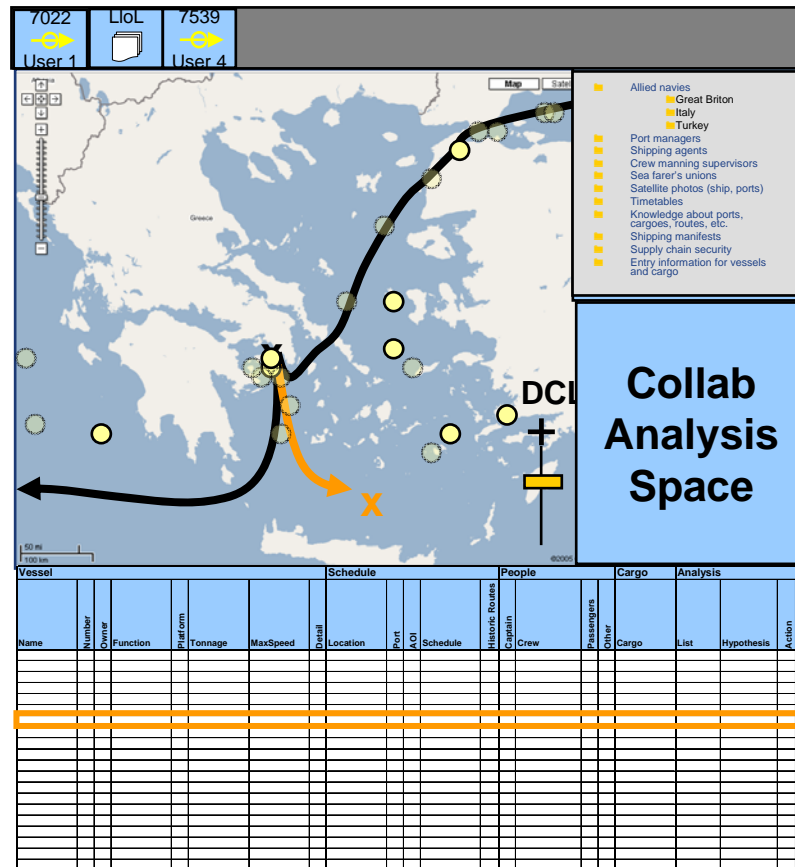
1. Define a region

COP with track data

Vessel Grid with track data

Define a region of interest on the map

The Grid will only display vessels from within the region

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2. *Map zooms in to defined area*

Map shows vessel in region

Grid shows data for vessels in region
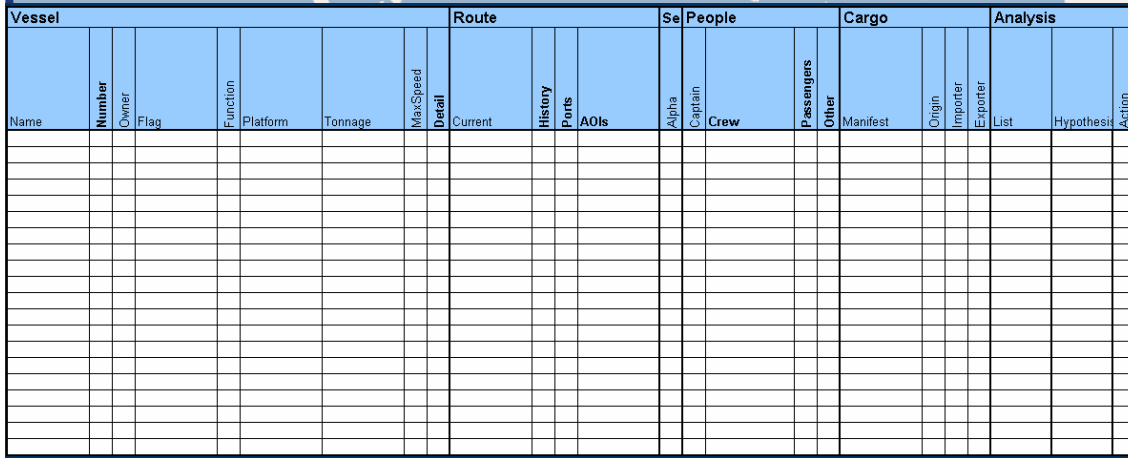
3. Define attribute filters/sorters

Define tonnage (range)
Any other filters/sorters
– Pop-up definition menu

The Grid sorts or filters according to the criteria

4. *Choose attributes to display*

Vessel									Route				Se	People					Cargo					Analysis		
Name	Number	Owner	Flag	Function	Platform	Tonnage	MaxSpeed	Detail	Current	History	Ports	AOIs	Alpha	Captain	Crew	Passengers	Other	Manifest	Origin	Importer	Exporter	List	Hypothesis	Action

Choose which attributes to show (expand) and which to hide

Limited space dictates hiding some attributes
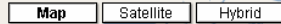- Or expand entire Grid by viewing on a full monitor

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5. View drop down lists

Some attributes have many subcomponents (in bold)
- E.g. vessel numbers, passengers, route

Pop-up table shows values
Select row to display in Grid or to use as sorting criterion

6. *Select vessel to highlight*

One or multiple vessels may be highlighted

– Map and Grid are dynamically linked

Highlighting can occur in both directions

Additional Grid Ideas

Pre-defined views

- Radio buttons that min/max columns to a pre-defined view with one click – possibly for different tasks or analyses

Simplified manual min/max

- Click a box in each column to maximize, and system assumes all others should be minimized

Action and hypothesis map display

- Could show locations of actions and H's along the course of a track

Grid should also contain information about friendly vessels

- Resources and sensors available
- Locations and availability to respond to calls for actions

Assisted Focus

Concept

- Assistance to the user for focusing attention toward a specific set of tracks
  - » Pre-defined list, user-defined attributes, heuristic-defined "suspicious" tracks
- Function
  - » Locate on maps
    - Decluttering of other tracks by fading, etc.
  - » Access to data
    - Highlighting on map, in Vessel Grid, filtering in Grid
    - Search, compare, update

High Priority tracks

- Predefined list
- Select list to show one or more tracks from list
  - » on map, Vessel Grid, etc.

Attribute decluttering

- User defines (de)selection criteria, e.g. platform, tonnage, port

Heuristic decluttering

- One or more defined heuristic algorithms for identifying suspicious tracks
  - » Heuristic rather than foolproof
  - » Use to id tracks for further monitoring or analysis
  - » User-defined threshold

AF for Hot Tracks

Restrict Grid to just the designed "hot tracks"

- E.g. HIV, VHI
- Select list in Grid for filtering

Declutter

- Select declutter method
  - » Faded
  - » Turned to dots
  - » Removed

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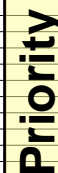
Hypothesis Capture and Discussion – StoryBuilder Concept / Storyboard

Three primary components:

- **Report / Assertion / Conclusion** *(our intended message)*
  - » **Answer**
  - » **Position**
  - » **Assertion**
  - » **Info Analysts' Opinion**
- **What We Know**
  - » **Supporting evidence / facts**
  - » **Respected / accepted:**
    - – **Opinions and analyses**
    - – **Reasoning / Logic**
- **What We're Not Sure Of…**
  - » **Conflicting evidence**
  - » **Counter-arguments**
  - » **Missing info**
  - » **Assumptions**

about:blank - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back • Search Favorites History

Address

Assertion Mt. Mayon has been active many times in the last several years. Experts believe that it will remain active for the foreseeable future. The danger to civilians is quite high. **More…**

What We Know There have been 45 recorded eruptions from Mt. Mayon since 1616. The most recent series of eruptions began in 1999 and continue today. Much of the volcanic eruptions have… **More…**

Over 100,000 people live within 15km / 9.3 miles of Mt. Mayon. Over 5,000 of these people live on the slopes of the volcano; these people are considered to be at extreme risk. **More…**

Learn more here…

Mt. Mayon Volcano Primer   **Volcano Primer**
Philippine demographic data   **Emergency Response resources in area**
US Plans and Policies regarding HA/DR

What We're Not Sure Of… There is no way to determine exactly when the next major eruption might take place. Further, there is no reliable way to predict the strength of the next eruption. Some experts believe… **More…**

An untested emergency evacuation plan has been developed… **More…**

Done   Internet

REALITY CHECK – Are we taking on too much?

Answer: No! Because we are only tackling part of the problem…
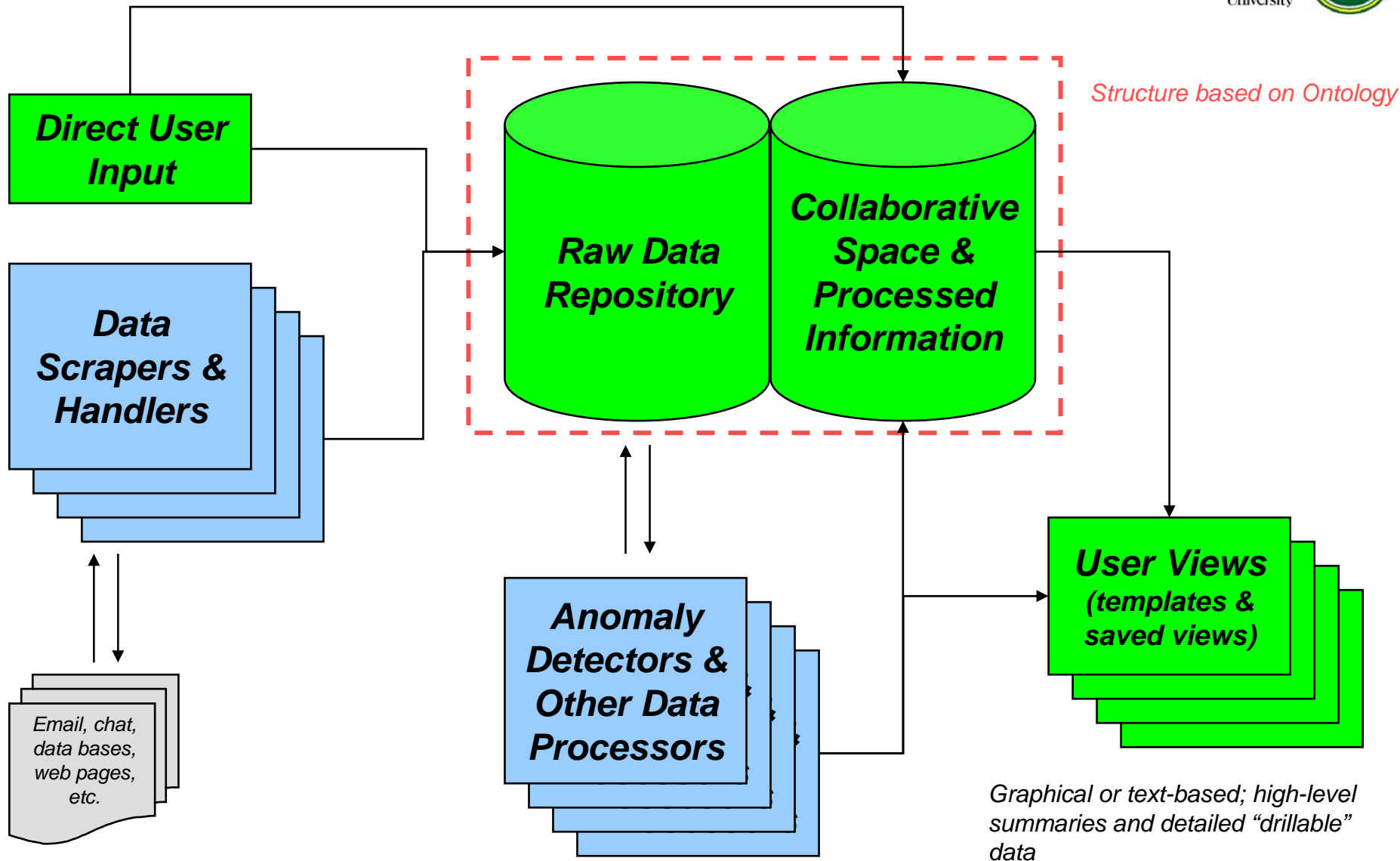
STTR will focus primarily on:

- Track data management, coordination & collaboration regarding tracks, and reporting
- Defining operationally-relevant ontology for C6F
- Consolidating *existing* data, information products, and business rules into single database based on ontology
  - » Use existing, already accepted technology such as MS Access
  - » Build interface that allows easy data entry into, and then viewing of data from Web
- Reduce current workload

Leverage Fast C2AP technologies such as data scrapers and anomaly detectors using open-source "Grid"

Other STTR "bells and whistles" come later…

Realistic STTR Focus

Structure based on Ontology

Direct User Input

Data Scrapers & Handlers

Email, chat, data bases, web pages, etc.

Raw Data Repository

Collaborative Space & Processed Information

Anomaly Detectors & Other Data Processors

User Views *(templates & saved views)*

Graphical or text-based; high-level summaries and detailed "drillable" data

Prototype Development

DCCS tool will be

- Web-enabled; some aspects Web-based
- Some aspects may be embedded / integrated vice stand-alone
  - » i.e., embedded in other application(s) such as C2PC, Outlook, various collaboration tools

DCCS development will adopt an iterative, componentized / modularized approach

- "pieces and parts" sooner, rather than completely finished "shrink-wrapped" suite later

Development will be done using established environments, APIs, protocols, and current software development best practices

Effort will be made to accomodate emerging CKM-associated technologies

Evaluation / Data Collection

Lab-based

- – Conduct demonstration / evaluation effort at CSU, PSE, and CNE-C6F once "critical mass" is achieved with developing tools
- – Validate broader results with active-duty SMEs within representative domain
- – Results used to fine-tune ongoing development

Field-based

- – Conduct final Phase II assessment / validation at target transition site(s)

Milestone Chart
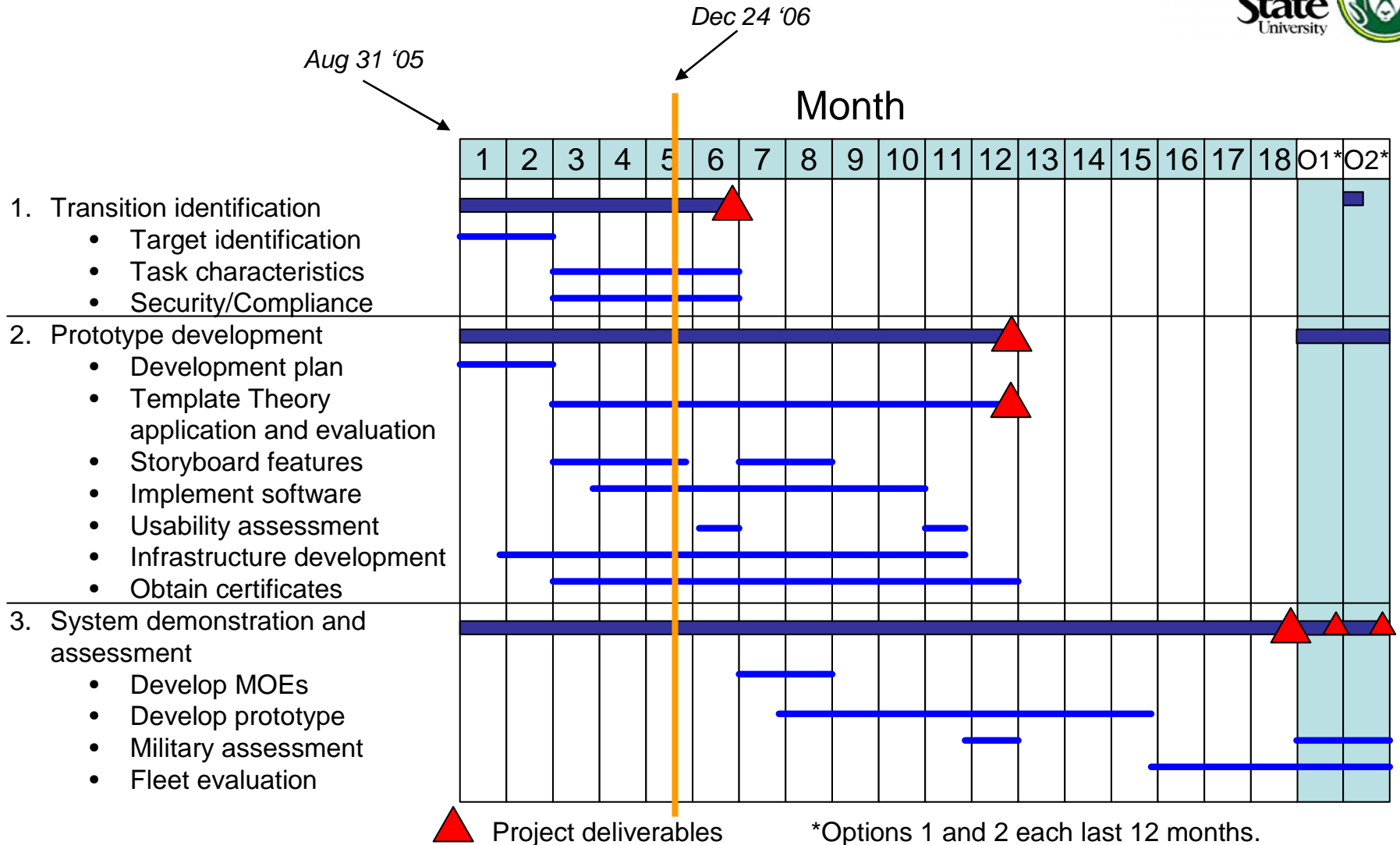
End of brief…

Questions? Comments?

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