General, Maintainable, Extensible Communications for Computer Generated Forces

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CGF Communications

- Requirements
  - Model human communications
  - Provide status and decision rationale
- Our approach
  - Unified & flexible communications infrastructure
- Benefits
  - Consistency, maintainability, extensibility, customization

Communications in TacAir-Soar

- TacAir-Soar: A real-time, entity-level simulation of military aircraft

- Challenges presented by former design
  - Utilize different implementations for generating communications
  - Generate multiple messages for same communication event
  - Couple message meaning and syntax
  - Little user customization for communications

Design

- Design elements
  - Unified communications knowledge
  - Language for communicating events
  - Message transport infrastructure
  - Handlers for specific communications devices

- Life cycle of a communication event
  - Intention→Generation→Customization→Transmission

Unified Communication Knowledge

- Consistent and reusable implementation
- Interface between behavior and communication knowledge
- Separation of computationally inexpensive generation of communication and computationally expensive generation of the final message
  - Always suggest an intent to communicate and then decide whether message should be sent
- Context-free message delivery knowledge

Example: Intent to Communicate

Intention→Generation→Customization→Transmission

IF

Goal: request-position-from-partner

Partner-name: ?partner-name (“eagle3”)

Mission-radio: ?radio (“radio-a”)

THEN CREATE

Communication

- **Name**: where-are-you
- **Content**:
  - **Partner-name**: ?partner-name (“eagle3”)
- **Previous-communication**:
  - **Radio**: ?radio (“radio-a”)
  - **From**: ?partner-name (“eagle3”)

Language for Communication Events

- Catalog of message types
  - Templates define syntax and parameters for each message
- Simple attribute-value content language
- Simple taxonomy of messages
  - Complex utterances

Example: Message Generation
Message Template

Intention→**Generation**→Customization→Transmission

Message-definition: where-are-you

Requires: partner-name

Parameters:

Type: single-value-utterance

Radio call-sign?: yes

Performative: ask-one (KQML) [see next slide]

Content:

Partner-name: ?partner-name

Message Transport Infrastructure

- Agent communication languages
  - KQML, FIPA-ACL
  - Performative: attitude of the speech-act
    - tell, ask, order, reply, did-not-understand, ...

- KQML Message:

  Performative: ask-one

  Sender: eagle1

  Receiver: eagle3

  Language: attribute-value description

  Ontology: FWA-Operations

  Content: (where-are-you (partner-name eagle3))

Handlers for Specific Communication Devices

- Format message for particular communications device
- Separates device specific knowledge from agent's task knowledge
- Translation can occur outside agent's knowledge base

Example: Registration of Device

Intention→Generation→**Customization**→Transmission

IF

Communication

Previous-communication:

Radio: ?radio ("radio-a")

THEN CREATE

Communication

Device:

Radio: ?radio ("radio-a")

Type: radio

Example: Message Handler

Radio

Intention→Generation→**Customization→Transmission**

IF

Definition

Type: single-value-utterance

Name: ?name (“where-are-you”)

call-sign?: yes

Content: ?attribute (“partner-name”)

Device

Type: Radio

Radio: ?radio (“radio-a”)

Content:

?attribute ?value (“partner-name:eagle3”)

THEN CUSTOMIZE & TRANSMIT MESSAGE

Device: ?radio (“radio-a”)

Utterance: “?my-call-sign ?name ?value”

(“eagle1 where-are-you eagle3”)

Example: Message Handler

Agent Window

Intention→Generation→**Customization**→**Transmission**

IF

Definition

Type: single-value-utterance

Name: ?name (“where-are-you”)

Content: ?attribute (“partner-name”)

Device

Type: Text

Name: agent-window

Content:

?attribute ?value (“partner-name:eagle3”)

THEN CUSTOMIZE & TRANSMIT MESSAGE

Device: agent-window

Utterance: “======= TEXT MESSAGE ========“

“ ?my-call-sign: ?name ?value”

“==============================“

Costs

- Performance: Now a two-step process
  - Slight delay between message generation and communication
  - Not perceptible to humans
- More knowledge required to manage delay
- No formal evaluation yet

Benefits: Methodology and Infrastructure

- Common methodology
  - Consistent implementation
  - Easier for developers
  - Offset performance cost
- Maintainable communications infrastructure
  - Lower maintenance costs
  - Separation and encapsulation of communication generation from device messaging
  - Provide supporting resources and tools like the declarative message catalog

Benefits: Extensibility and Customization

- Extensible framework for communication
  - Extend message catalog
  - Intent to communicate in task knowledge
  - Message handlers for new devices

- User customization
  - Lookup tables and graphical tools will enable customization
  - Improvement over previous labor-intensive approach

Conclusions

- Communications requirements for CGFs are broader than just human communications
- Design for these requirements from the beginning
- Anticipate a lot of different communications requirements
- Put in place an infrastructure to handle these requirements

Conclusions

- Take advantage of existing technology: Work of the agent-based community
  - New work was not around when TacAir-Soar was designed
- Standardization of communications technology
  - Less expensive to customers

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