I-Room: a Virtual Space for Emergency Response for the Multinational Planning Augmentation Team

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ABSTRACT
An I-Room is an "intelligent room" which can act as a knowledge aid to support collaborative meetings, especially those involving sense-making about the current context, planning and considering options, and decision-making. It can be used to provide an Emergency Response Virtual Collaboration Centre in a Virtual World. The I-Room will provide a generic technology basis for a wide range of potential collaborative applications and uses. As a specific application its potential use to support multi-national multi-agency operations by the Multinational Planning Augmentation Team (MPAT) is described.

1. INTRODUCTION
An I-Room is a room for intelligent interaction. It can provide support for formal business meetings, for tutorials and project meetings, and for discussion groups and informal gatherings. The I-Room can be used to organise the display of information gathered in advance or coming from sensors and real-time feeds. It can also be used to communicate with others to record and action the decisions taken.

Using a virtual world to provide a realisation of an I-Room for this kind of purpose is a powerful concept. Avatars can meet each other 'face-to-face' in a virtual world when their human counterparts cannot. Some of the benefits of a real-world meeting are retained through immersion in the virtual world. In some cases, virtual-world meetings may be more effective than other alternatives to face-to-face meetings such as teleconferences and videoconferences.

The I-Room can be used as a mechanism to deliver intelligent systems support to meetings and collaborating groups. In particular, the I-Room is designed to draw on I-X Technology [11] which provides intelligent and intelligible (to the human participants) planning aids to participants and, through their "I-Space" view of those around them, allows them to interact and collaborate with a number of people, and to utilise a range of manual and automated capabilities in a coherent way. The participants share meaningful information about the processes and products they are working on through a common conceptual model called <I-N-C-A> [13].

2. BACKGROUND
Some may think that virtual worlds and the social networking aspects they contain have their origins largely in computer game technology. While 3D game engines and powerful personal computer graphics cards are a vital aspect of their make-up, their roots go back further than these. Earlier work, starting in the late 1970s, on multi-user persistent spaces was already exploring aspects of collaboration, object sharing and chat for aspects of collaborative systems [1]. The addition of object-oriented programming to script or control the objects in the shared space expanded the possibilities. A popular version of such a multi-user object-oriented virtual space is LambaMOO [8] which dates from 1990.

Such work has continued over a period of two decades with the emerging environments being used alongside video- and teleconferencing, and instant messaging with agent presence and status information. A good example is the Collaborative Virtual Workspace [5], originally built by Mitre Corporation between 1994 and 1999, which uses a 'buildings and rooms' metaphor for persistent storage of documents and shared assets used in collaborations. Many videoconference support systems use the idea of setting up a virtual workspace 'room' to give context to a particular presentation or meeting. Extensions to this within the I-X Research Programme [11] have been proposed as the foundations of the I-Room project [10] to make use of intelligent planning and collaboration aids alongside CVW.

A number of research programmes at DARPA (the US Defense Advanced Research Projects Agency) have also utilised MUD/MOO style collaborative spaces alongside other forms of collaboration. An unfunded programme to create 'habitats' that display such persistent collaborative areas and to give a state-based context for assisting in active support for collaboration was also outlined [12]. A number of descriptions of a room for intelligent team-based interaction or a room that itself could act as a knowledge-based asset to a group have been proposed over the last 10 years (e.g. [10]). Some of these concepts were explored in the Collaborative Advanced Knowledge Technologies in the Grid (CoAKTinG) project [2].

3. MULTINATIONAL PLANNING AUGMENTATION TEAM
The initial spur to the development of virtual I-Room technology arose through work on the "Helpful Environment" [14], and more specifically through the use of online collaborative planning and task-support systems for search and rescue teams and emergency response [17]. One focus of this work has been to demonstrate the potential of I-Room virtual world and intelligent systems

technology to the Multinational Planning Augmentation Team (MPAT) to support multi-national multi-agency operations.

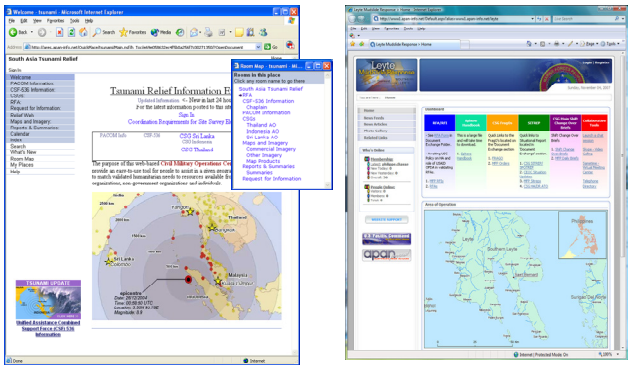

Figure 1. Examples of MPAT Web Portal and Access to Collaboration Tools.

MPAT is an organization consisting of 31 Pacific Rim nations that has developed shared knowledge and procedures (the Multinational Forces Standard Operating Procedures –MNF-SOP) to assist in coordinating more effective responses to regional crises [16]. MPAT trains for and responds to devastating events such as the 2004 Asian Tsunami, during which MPAT helped the affected countries access the specialized capabilities of responding organizations more effectively. The archived data from MPAT support to that event and to the Southern Leyte Mudslides in the Philippines in 2006 have been made available for further study. Figure 1 shows examples of the MPAT collaboration web pages and virtual operations centres related to these events.

At the start of a new mission, it is typical for a collaborative web area to be set up, immediately providing a point of focus for information that is being gathered and shared. Links allow users to download open-source and freely available collaboration and communications tools. A server provides the facility to set up "rooms", which act as foci for storing and retrieving information specific to different areas of operations, etc.

4. MPAT VIRTUAL OPERATIONS CENTRE REQUIREMENTS

Coordination with the MPAT Secretariat office suggests that the concept of a Virtual Operations Centre may have potential for MPAT if it can be designed in a manner to provide 'value added' benefits via the Internet to the ongoing cooperative efforts of military, governmental agencies, and the international humanitarian community prior to and during crisis response situations. The initial working requirements of such a Virtual Operations Centre would consist of:

- It is important to really capture the essence of the "operational environment" and its standard operating procedures. These need to be supported via the content and interfaces provided.
- It is important that people can enter easily via the Internet, that there is good control of who enters, to ensure we know who is on the other end of the pipeline.
- There must be simultaneous support of chat, virtual aids, Voice over IP (VoIP), and the ability to put in other "working boxes" of information (charts on areas of a disaster, updates, recent photos, needs assessment, etc.). This has to allow user access for updates as well as viewing.
- Quality voice is necessary, including the ability for people in the field to link in via cell phones and such.
- There is a need to support limited bandwidth access whereby the key elements of the cooperation are accessible including voice. In a crisis there will be some countries that have high-bandwidth access, but others that are restricted due to national limitations and due to the impact of the crisis itself.
- The tools should be free (or cheap) for a large number of the potential participants to attract users.
- "Operator" comments on the facilities offered will be the key for turning the virtual capabilities into very useful tools.

The concept should extend to a day-to-day "non-crisis" capability, through which one has full access to communication and collaboration tools immediately from anywhere in the world. The facility should be designed to allow use of the Centre in non-crisis periods for cooperation, training and mission preparation. This is a key requirement since MPAT participants do not have time to train during a crisis.

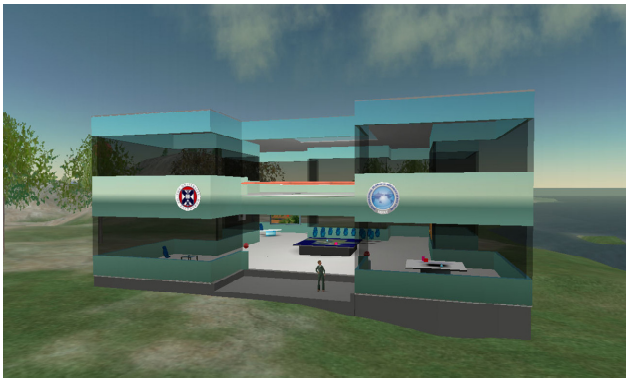

Figure 2. Emergency Response Virtual Collaboration Centre.

5. MPAT E-RESPONSE I-ROOM

Based on (and inspired by) discussions with MPAT co-ordinators, and analyses of their tasks and processes and the information that surrounds these, we have developed a prototypical Virtual Collaboration Centre for MPAT-type operations. Our aim is to demonstrate intelligent collaboration, process management, "to do" list and planning capabilities that could operate alongside the mix of collaboration tools and web support already used by MPAT. We hope that these might initially be suitable for preparedness training exercises and rehearsals, and later for real missions.

The Virtual Collaboration Centre has been realised in Second Life[1], one particular virtual world (as shown in Figure 2), and the

[1] Second Life™ - See http://secondlife.com

Open Source equivalent, OpenSim[2]. However, the underlying concepts are intended to be independent of specific deployments.

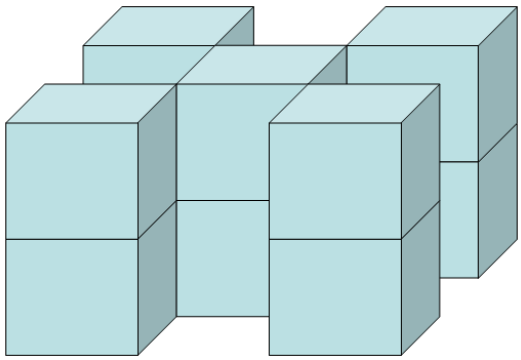

Figure 3. Basic I-Room shape – 2 floors provide 8 work areas around a central core.

The shape of this MPAT I-Room collaboration space provides a central lobby in which meeting participants (via their avatars) can arrive and their presence be noted, and from which the unrestricted lines-of-sight allow users to gain a quick visual and non-intrusive overview of current activity in the surrounding collaboration rooms, the work areas that adjoin this central area – see Figure 3. These rooms can rapidly be specialised to support different functions or areas of operation arising during an emergency. This mirrors current collaborative systems and web-based virtual operations centre (VOC) concepts already in use by real emergency response communities and organisations, including MPAT via their web-based collaborative portal.

This I-Room building has a square central area, with rooms off each corner on two floors. This gives eight immediately visible work areas into which equipment, screens and furniture can be added. The roof provides further areas for use if needed. The central area and corridor spaces can be accessed from a front door space, a balcony on the first floor, or through an open roof space (which allows easy access directly from virtual world maps). Such an I-Room building is usually based on an area with a square plan of size 30m×30m. Each corner room has a square plan of side 10m and is open at one corner to the central space with plenty of straight wall space to show display screens, maps and posters and other equipment can be accommodated[3].

It is usual for one area of the I-Room to be set up as a mixed reality meeting space where audio-visual links can be made between a real meeting room and the participants who join via their avatars in the virtual world real meeting room and the participants who join via their avatars in the virtual world – see Figure 4.

Figure 4. I-Room - Real Meeting Space linked to a Virtual Space.

The Virtual Collaboration Centre provides a facility within which it is possible to set up and maintain a persistent set of information assets (e.g. wall posters, maps, etc.) and dynamically loaded content (such as imagery, movies, web page contents, etc.) in an area that is shared by the participants. They can access and modify these during synchronous meetings, and also at other times as the situation develops and users set about their individual tasks.

6. I-ROOM MEETING SUPPORT

I-X Technology [11] provides intelligent task support, planning capabilities and coordination between multiple agents. It provides a user interface called an "I-X Process Panel" (I-P[2]) [15] which acts as a sophisticated form of "to-do" list. An I-Room can be linked to I-X to support meetings in virtual worlds or in the real world. It can support common requirements for meetings by:

- Automatically generating a framework for the meeting including generic agenda items (e.g. review of previous actions, AOB, agree date of next meeting);
- Keeping track of actions and agenda items during the meeting itself;
- Recording decisions and taking minutes;
- Tracking existing actions and adding new ones;
- Providing access to minutes from previous meetings;
- Automatic generation of an outline of the meeting minutes.

Through a link to an autonomous object in the virtual world (the "I-X Helper") that is able to sense the presence of avatars and respond to commands directed to it, additional support can be provided in the form of:

- Monitoring the comings and goings of participants in the meeting;

[2] OpenSim – See http://opensimulator.org

[3] The shape and 30m scale of an I-Room has been adopted empirically and provides a collaboration area across which avatars can easily relate to one another. The sensed area for avatar presence can be reasonably localised to exclude unrelated activities. Technically within virtual worlds such as Second Life there is a limited distance across which text chat is seen by avatars and over which spatialized voice can be heard clearly, and that is also 30m. Typical plot areas are also 32m×16m, meaning that two adjacent ones can house an I-Room design as described. The two floor design allows for easy camera access to all areas.

- Prompting in-world 'screens' to display the meeting agenda, or any relevant images or documents at appropriate times during the meeting;
- Unobtrusively documenting the progress of the meeting and its outcomes.

While some of these tasks are simple, others can be performed well only if knowledge about meetings in general and the current meeting in particular is available to the I-Room. Linking the I-Room to real-world knowledge-based systems can potentially extend the support they offer into this virtual space, thereby distributing the knowledge they embody.

To allow such intelligent support to be offered, the I-Room is based on a number of simple, but very powerful underlying concepts.

7. UNDERLYING CONCEPTS FOR I-ROOM COLLABORATION

Underlying the use of the I-Room for collaboration and its ability to link human participants to intelligent systems support are the following concepts:

- A mixed-initiative collaborative model for refining and constraining processes and products;
- Principled communication based on sharing issues, activities/processes, state, event, agents, options, argumentation, rationale, presence information and reports;
- The use of the <I-N-C-A> ontology for representing the products that are developed during meetings;
- The use of I-X Technology and its suite of tools to provide task support;
- The use of issue-based argumentation, through the use of the Questions-Options-Criteria (QOC) methodology [4] and links to the Compendium sense-making tool [3];
- The use of agent presence models as in instant messaging and I-X "I-Space" to support awareness of agent context, status, relationships within an organisational framework, capabilities and authorities;
- The use of external shared repositories of processes, products and other objects.

8. I-X HELPER – CONNECTIVITY BETWEEN I-X AND A VIRTUAL I-ROOM

Participants in a meeting in an I-Room may connect via their I-P^{2}s or via their avatar in a Virtual World Viewer. An I-X Helper, which can be any convenient object in the virtual world, acts as a conduit for channelling communications to the participants connecting via their avatar. The I-X Helper communicates through one nominated I-X agent to the various "I-X Services" (which may be provided by one or more I-X agents) via a communications channel (which for Second Life for example, uses a mixture of HTTP requests and responses and communications via XML-RPC). Messages can be queued and sent later if the connecting I-X agent is not available.

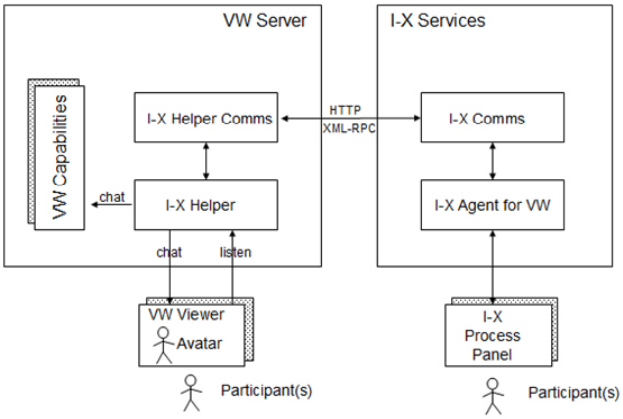

Figure 5. I-X Helper Connects Virtual World to I-X Services.

The I-X Helper can communicate to avatars in the I-Room via open chat channels. It also uses chat (usually on specifically nominated device specific channels) to communicate with and control suitable devices in the virtual world, such as screens. The I-X Helper can operate such devices within an I-Room. It does this by loading a text description of the virtual world capabilities it should know about, and how to communicate instructions to them. Specific capabilities to provide flexible display of images, external web pages, and I-X Process panel screens are also incorporated. The I-X Helper provides a sensor to find when avatars come into range, and therefore can be reported as in the I-Room or the meeting. The I-X Helper also listens on a specific chat channel for instructions which it can handle itself. This allows avatars and other objects in the virtual world to use the I-X Helper to interact with I-X Services and allows I-X agents to communicate with and control devices in the virtual world. See Figure 5.

9. Future Work

The basic I-Room concepts and technology are now being refined and made more generic. This work includes the development of generalised links to knowledge-based systems, tailored natural language generation, capability modelling to identify and exploit opportunities in the virtual worlds, and semantic tagging of the various media and communication streams that constitute a virtual meeting to allow a higher level of context-sensitive support, documentation, and indexing and playback facilities.

I-Rooms are being created on a number of virtual world platforms, with an emphasis on sharing concepts and systems support. They are also being applied to a range of collaborative tasks such as homeland security, UAV mission monitoring, product design and review meetings, scientific project regular reviews, team training, and even to tutorial support for whisky tasting! More details can be found at the I-Room project web site [7].

In other work to explore the use of intelligent systems for emergency response in general, and for MPAT support in particular, we have shown intelligent systems for brokering between requests for assistance and offers of aid utilising the MPAT data from Operation Unified Assistance for the December 2004 Asian Tsunami [6].

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