

A Novel Approach to Information Distribution in a Complex Distributed Environment

The United States Marine Corps is in the process of advancing the state of the art in battlefield information distribution. The problems they are attempting to address involve unreliable, intermittent and bandwidth varying networks and communication links, mobile and dynamic configurations, varying information needs depending on the information consumer's location, etc. Furthermore, all echelons of data consumers increasingly rely on information systems for successful operations. Rapidly established temporary command centers must be able to succinctly communicate with dispersed mobile forces through wireless networks. These networks sacrifice bandwidth and connectivity in favor of mobility, encryption and frequency hopping. However, the need to efficiently distribute critical information in a timely fashion remains. The increased use of automated information systems greatly aggravates this problem through information overload and network congestion.

Sponsored by the USMC, JPL has developed an advanced information distribution system that addresses the need to deliver the right information to the right user, at the right time. The system takes a unique approach to information distribution in a complex networked topology by treating information as a commodity. The key concept is that information has value based on relevance to a client's decision-making needs, in terms of timeliness, accuracy, interest and proximity. These needs are balanced with the cost associated with their distribution, i.e. priority and available bandwidth. The system embodies these concepts using Critical Information Requirements (CIRs) in which a client establishes a contract with the local server, defining the client's information needs and delivery requirements. If a main communication link is unavailable to a client's local server, the system continues to provide the most up to date information picture available.

In this presentation, we will describe how the system uses CIRs in terms of subscriptions, filters and priorities, and how client interests are propagated throughout the system, and we will describe the novel information flows that result from this CIR propagation. A supporting feature of the system is an adaptive communication layer that allows grouping of clients with similar information requirements on common channels for even greater network efficiency, and implements reliable delivery over unreliable protocols.



Critical Information Requirements (CIR)

- Subscriptions
 - Define types and characteristics of desired objects
- Area of Interest
 - Geographic region to further limit desired objects
- Core Attributes
 - Class-based attributes for notification and caching of objects
 - Define attributes of interest and of use
- Priority
 - Relative delivery priority for a subscription/AOI combination

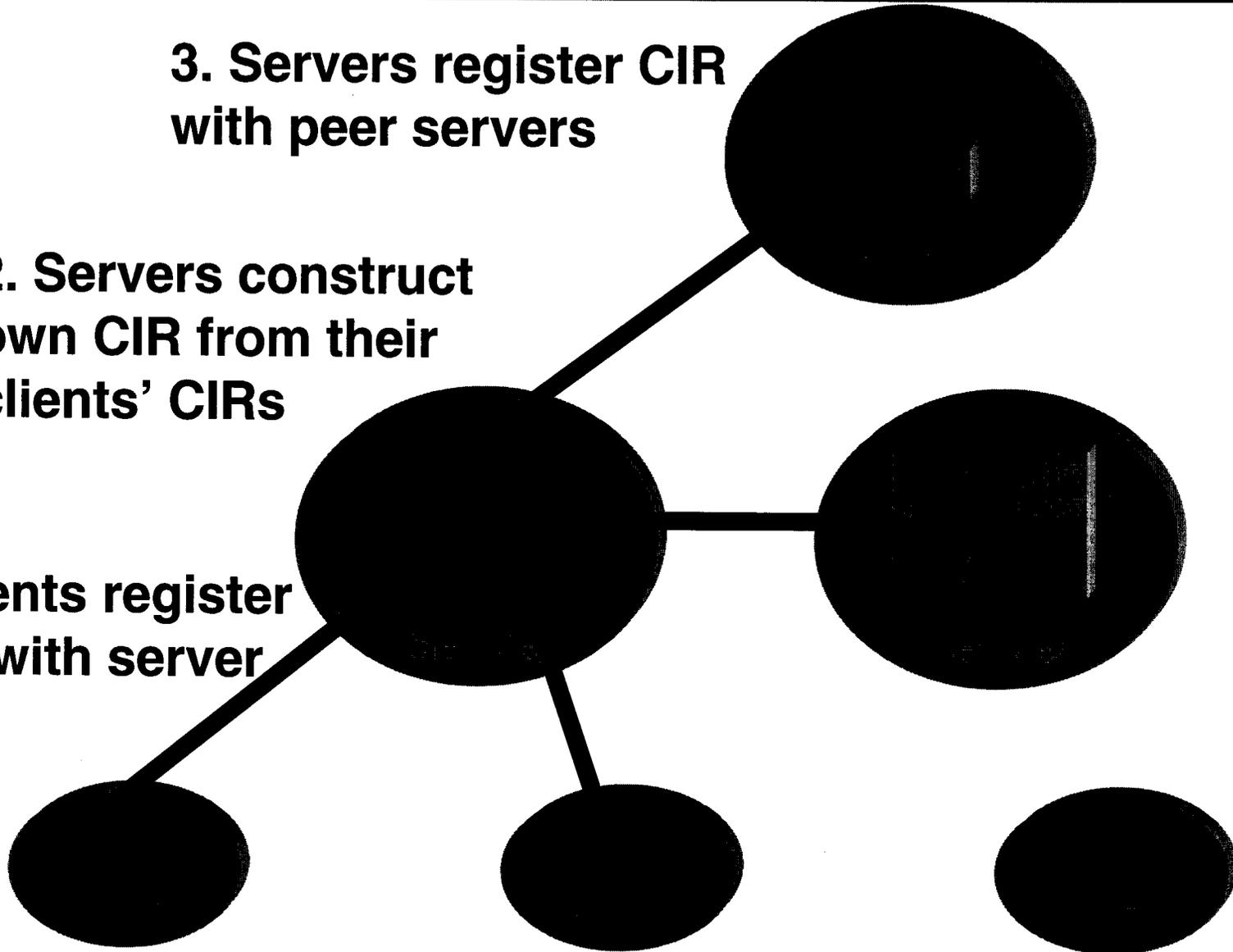


CIR Propagation

3. Servers register CIR with peer servers

2. Servers construct own CIR from their clients' CIRs

1. Clients register CIRs with server





Information Flow

- Servers send all information matching a CIR to the subscriber
 - Information currently in server's cache
 - Later changes that match the CIR
- Servers maintain independent copies of information
 - Received from peer servers through CIR
 - Originated by local clients
- Client-side cache contains information created by client and received from server



Handling Loss of Comm

- Caching provides “best available” information to a client or server
- Loss of communication to a node, or loss of a node, does not prevent subscribers from working with cached values
- Changes made while out of communication are automatically synchronized when communication is restored
 - Servers arbitrate conflicting changes with relative timestamps



Shared Net Comm Layer

- Supports TCP, UDP and Multicast
 - Adds reliable communication to UDP and Multicast
- Channel interface conceals network details from callers
- Enforces delivery by CIR-defined priority
- Configurable time to live to survive network failure
- Adjustable output rates (bytes/sec)



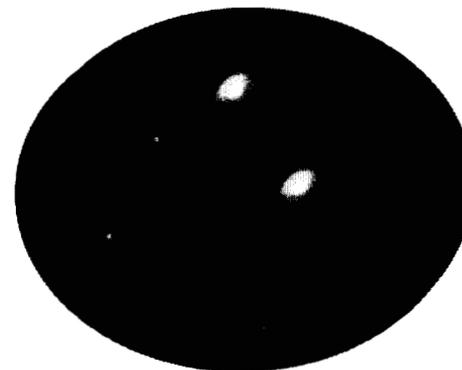
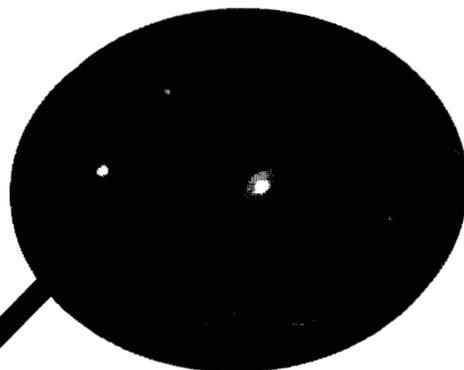
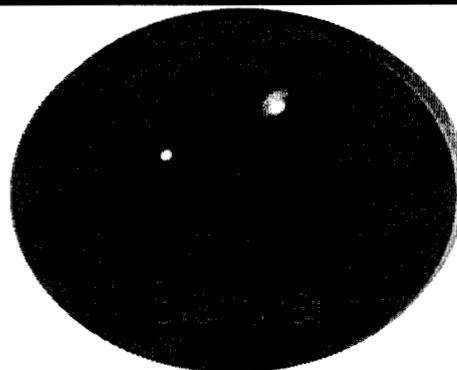
Additional Features

- Support for logical grouping of clients with similar interests or network connections
 - Efficient use of limited network resources
- Servers may act as gateways to other sources of information
- Server propagation of CIRs eliminates need for clients to contact each data source

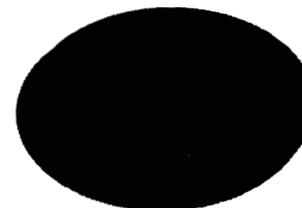
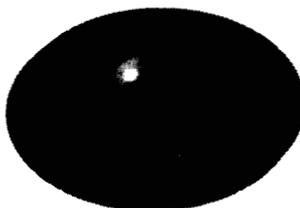
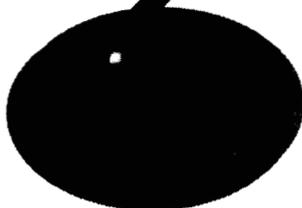


Example: Initial Location

**Server cache contains
objects created by local
clients and objects received
by CIRs**



**Client cache contains created
objects and those from CIR**

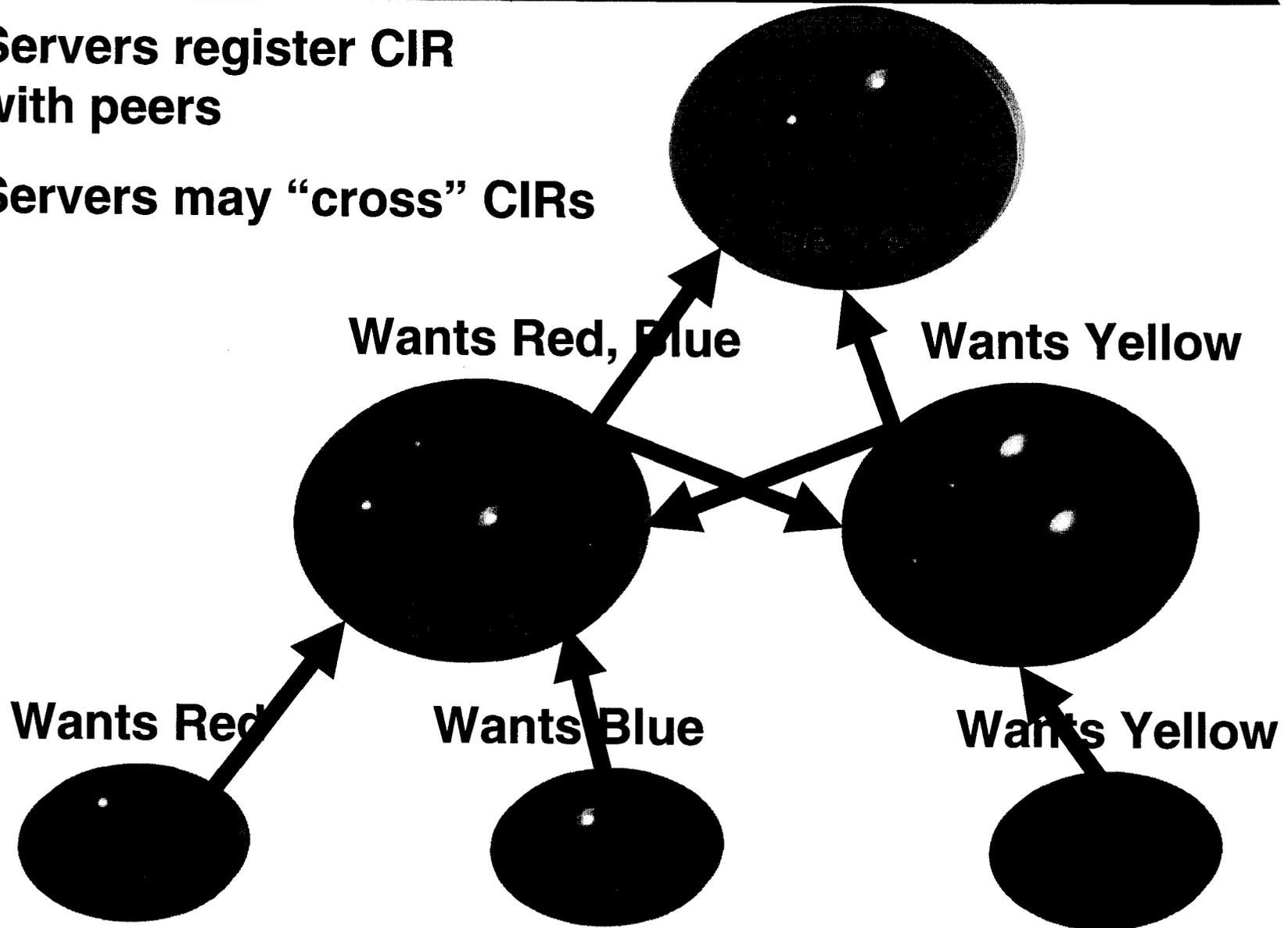




Example: CIRs Propagated

Servers register CIR
with peers

Servers may “cross” CIRs





Example: Final Distribution

Servers send objects matching CIR to Subscribing clients and servers

Servers continue to send updates matching a CIR

