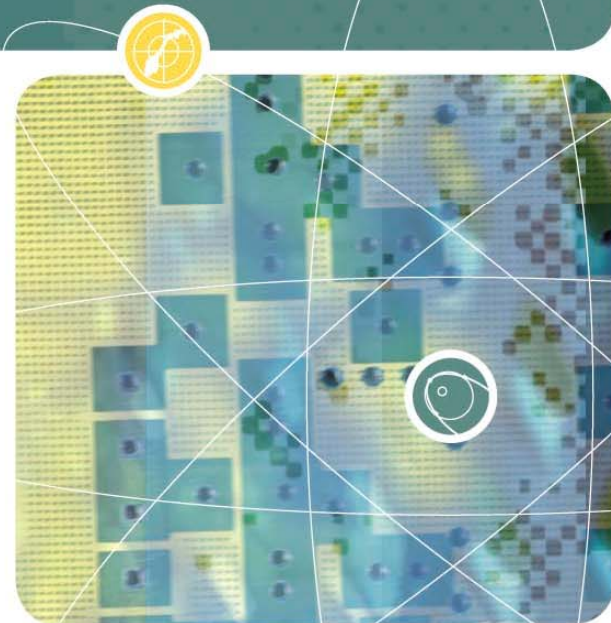**FFI** Forsvarets
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Adapting Web Services for Limited Bandwidth Tactical Networks

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Outline

- Web Services
  - Push vs pull communication
  - Standardization efforts
- Optimizations
  - data representation
  - data communication
- Summary

Web Services and Network Based Defence

- Web Services is in widespread use on the Internet today.

- COTS products are readily available.

- Web Services is being considered as an enabling technology for NEC, and seem well suited.

- Web Services provides both synchronous and asynchronous communication.

"Push" vs "Pull" communication

- Push:
  - Push information to recipient.
  - Asynchronous: No polling, which reduces communication overhead. Non-blocking.
  - Example: Event service
  - Good for wide-area distributed systems

- Pull:
  - Actively fetch information from server.
  - Synchronous: Polling; communication overhead and potential blocking of the application.
  - Example: Remote procedure call

An Event Service
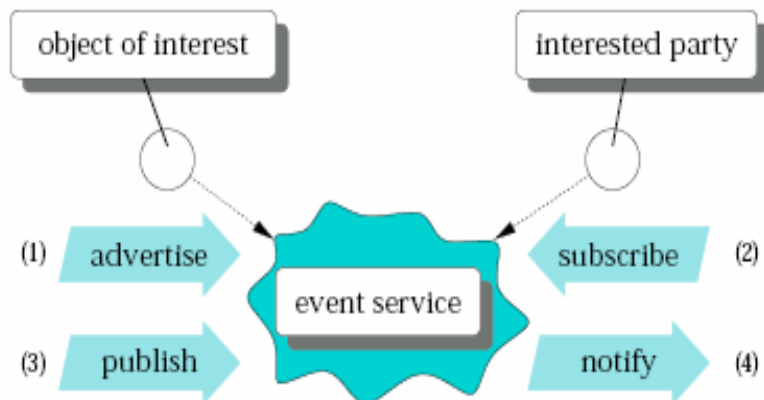
- Asynchronous dissemination of information.
- Participants:
  - *publishers*, that submit information to the system, and
  - *subscribers*, that express their interest in specific types of information.

Web Services pub/sub standardization efforts

- The asynchronous nature of the publish/subscribe paradigm makes it a very important mode of communications in NBD.

- Two standardization efforts regarding publish/subscribe:
  - OASIS finished its Web Services Notification (WSN) standard late in 2006.
  - W3C has a draft version of a similar framework called Web Services Eventing (WS-Eventing).
  - WSN has most features.

WS-Notification

- Three parts to the WSN specification:
  - **WS-BaseNotification**
    - The WS-Eventing specification provides similar functionality to that of WS-BaseNotification, but they are not compatible with each other.
  - **WS-BrokeredNotification** defines the interface for notification intermediaries, i.e. notification brokers.
  - **WS-Topics** enables users to specify the types of events in which they are interested.

Web Services and Network Based Defence

- Pub/sub is well suited for use in a military context:
  - track updates,
  - building COP, and
  - creating situational awareness.
- Challenges when using web services over tactical communications links

Tactical networks

- Volatile medium
  - low bandwidth
  - high delay
  - unstable connections
- Challenges when using Web Services
  - Compression
  - Information representation and encoding
  - Optimizing transport (e.g. caching, multicast)

Information representation

- Work by Gerz et al[1]
  - Message based communication
    - Referentially complete message, e.g., self-contained XML document.
  - Replication based communication ("push").
  - Query based communication ("pull").
- A combination may be most suited for Web Services
  - Adapting the message representation
  - Mainly status updates ("replication")
    - Retrieving missing data using queries.
 - Standardization required for interoperability.

[1]Gerz, M., Loaiza, F., and Chaum, E. "An Object-Oriented XML Schema for the MIP Joint Command, Control, and Consultation Information Exchange Data model", CCRTS 2006

Optimizing transport

- Pub/Sub optimization by proxy
  - content filtering
    - deliver only relevant and necessary information
  - unicast/multicast gateway
    - utilize the underlying transmission medium
  - subscriptions on behalf of clients
    - reduce network traffic
    - increase scalability
- Request/Response optimization by proxy
  - caching of responses
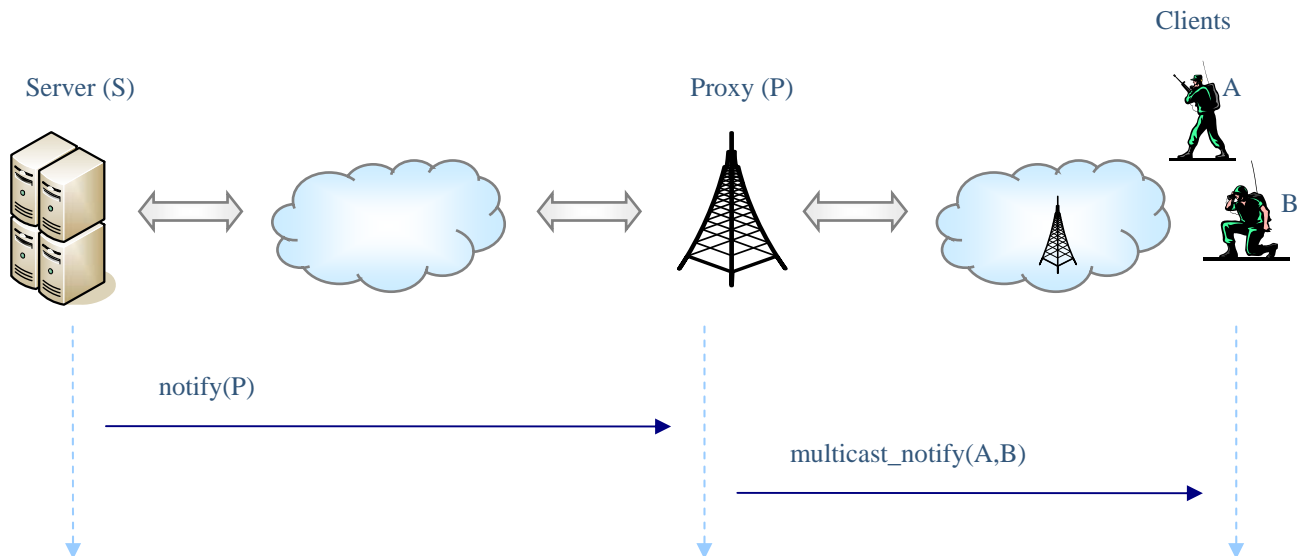   - reduce network traffic
    - increase scalability
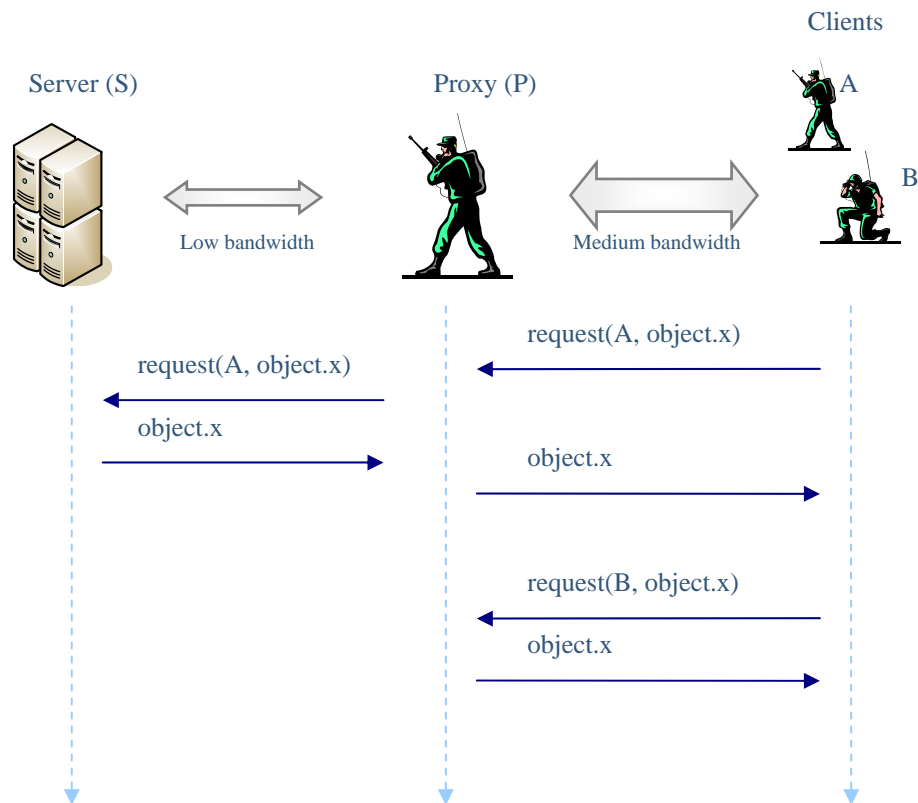
Subscription by proxy
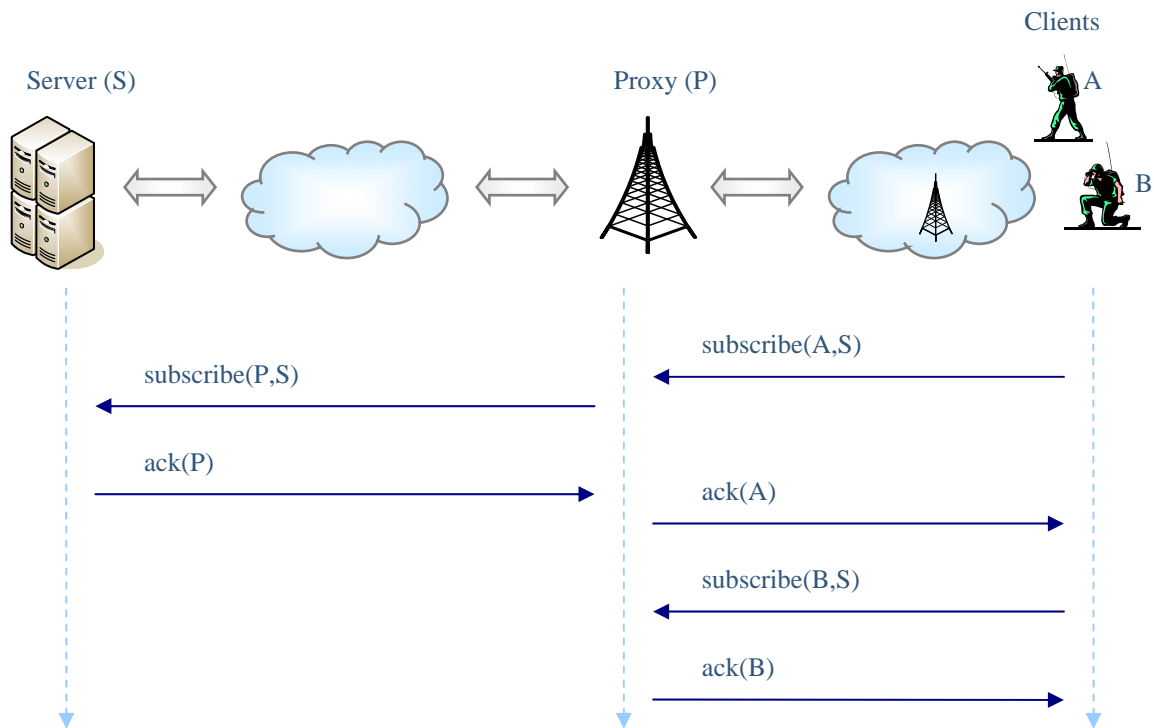
Notification via proxy, unicast
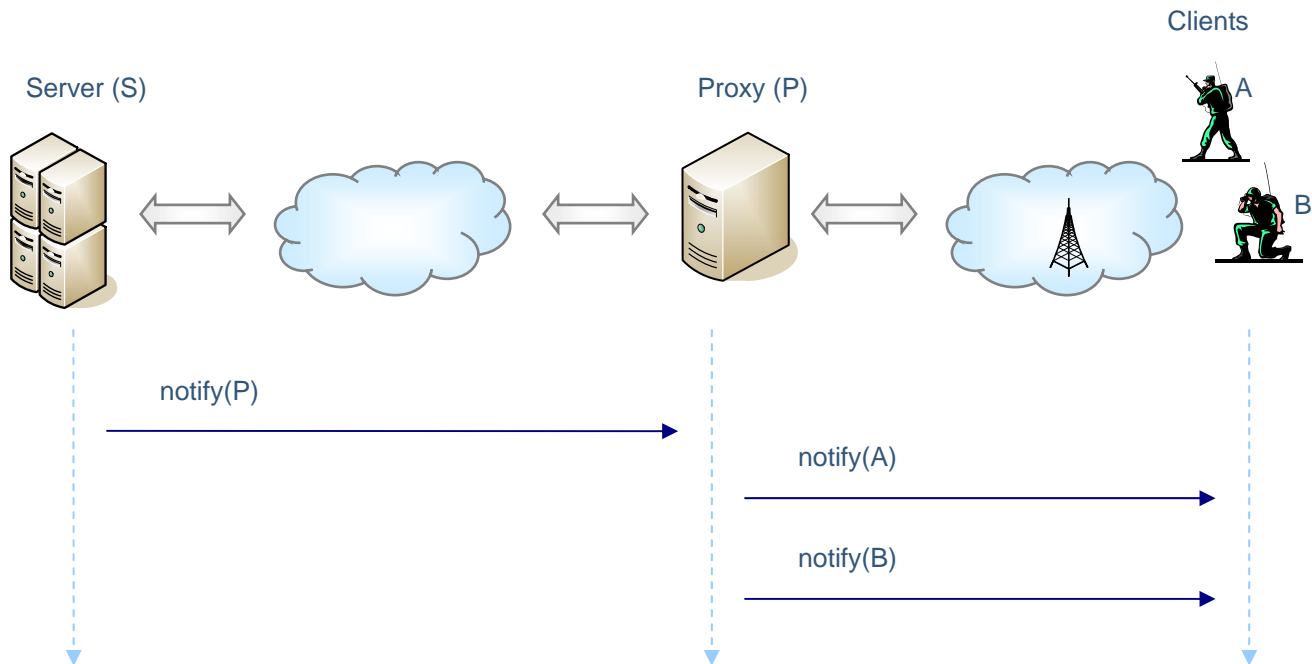
Notification via proxy, multicast

Server (S)

Proxy (P)

Clients

A

B

notify(P)

multicast_notify(A,B)

Caching

Other considerations

- COTS Web Services use HTTP over TCP as default
    - not suited to tactical networks
    - we are currently evaluating other means of transport
- What about security?
    - More information available to the proxy means more ways to optimize data flow. (Security on link layer.)
    - Little information available to the proxy, less ways to optimize data flow. (End-to-end application level security.)

Summary

- Web Services – well suited for implementing NEC, but
  - verbose - based on XML, so inefficient in tactical networks
- Means to adapt Web Services
  - compression
  - proxy servers
  - information representation optimization