Content-Based Networking: DTN, AMS, Sharednet

DARPA DTN
Phase 2 Kickoff

Arlington, VA

9 August 2006

Scott Burleigh

Systems Engineering Section

Jet Propulsion Laboratory, California Institute of Technology

818.393.3353

Scott.Burleigh@jpl.nasa.gov

DARPA Content-Based Networking Summary of Requirements

1. Want to push data, so that it's there as soon as it's needed.
   - Minimize latency.
2. But don't want to push everything to everybody; targets must pull what they need.
   - Minimize bandwidth consumption.
3. Must retain data until user is ready to use it, and not decrypt until then.
   - Minimize need for repeated transmission.
   - Minimize security exposure.

Concept

- For secure data retention within the network fabric:
  DTN Bundle Protocol (BP).
- To strike a balance between data “push” and “pull”:
  AMS publish/subscribe functionality.
- For secure data cache at the edge of the network:
  Sharednet relevant common operational picture.
- Sharednet client registers as an AMS node.
  - Uses AMS to subscribe on user’s behalf.
  - Receives remotely published data via Remote AMS (RAMS) gateway.
  - Caches data locally, securely, pending retrieval by the user.
- Messages are exchanged among RAMS gateways via Bundle Protocol, over whatever underlying transport is available.

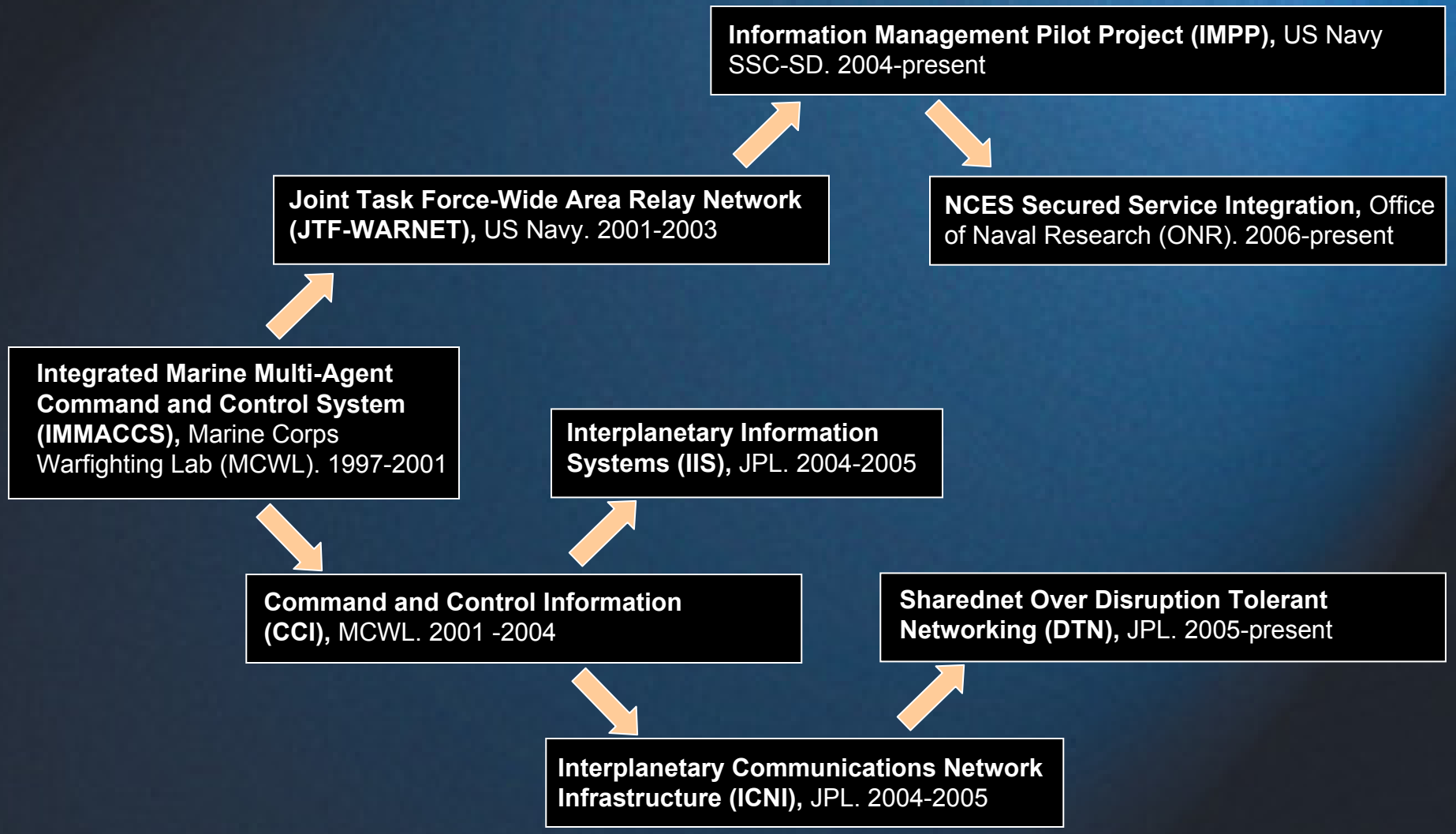
Key Features of AMS

- Core *message bus* model
  - Publish/subscribe by message *subject*.
  - Each application software node subscribes to (and consumes) the information it needs, and publishes the information it produces, without knowing which other modules are currently running.
- Other communication models supported as needed:
  - *Explicit awareness of other nodes*
  - *Private message transmission* to specific nodes
    - E.g., *replies* to published messages
  - *Synchronous (client/server)* communication
  - *"Announcement"* of data to multiple anonymous nodes
- Remote AMS (*RAMS*)
  - Aggregates message publication to minimize bandwidth consumption on constrained links
  - Designed to enable dynamic publish/subscribe over interplanetary distances
  - Generalizes to – in effect – scalable reliable multicast

Overview of Sharednet

- Middleware developed by JPL for the US Navy and Marine Corps
- Objective:
  - Distribute the C2 information needed to assemble a *relevant* common operational picture (COP).
  - Provide the distribution framework required to facilitate collaborative planning and increased situational awareness (i.e. storage, translators, and agents).
- Design Principles
  - Consumers, not producers, drive information flow.
    - User-defined operational picture
  - Cross platform interoperability must be supported.
    - Java & C++ clients
    - Linux, Mac OS, Solaris, Windows
  - Incorporate a common information ontology.
    - Bridge between Communities of Interest (COI).
    - Enable agent-based reasoning.
  - Operating environment failures are inevitable and must be gracefully handled.
    - Communication sessions must survive network outages and loss of nodes.

SharedNet Deployment History

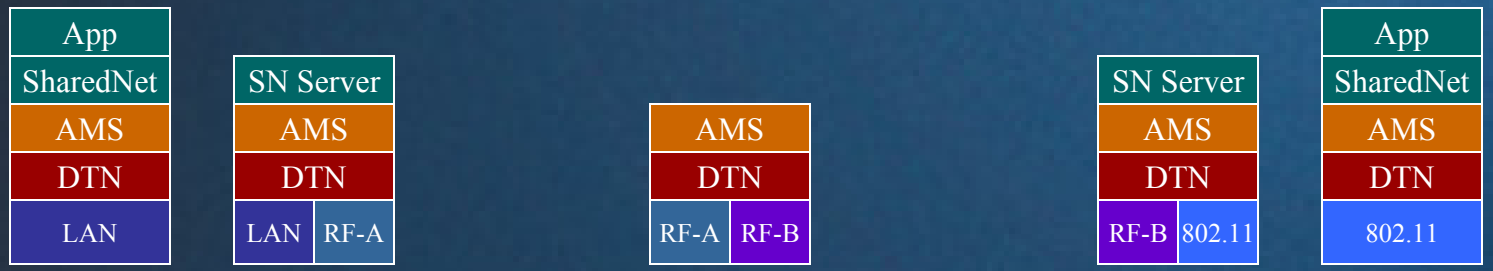


SharedNet – AMS – DTN

Mission Operations at Sea HQ

Airborne & Orbital Relays

UAVs, people & sensors

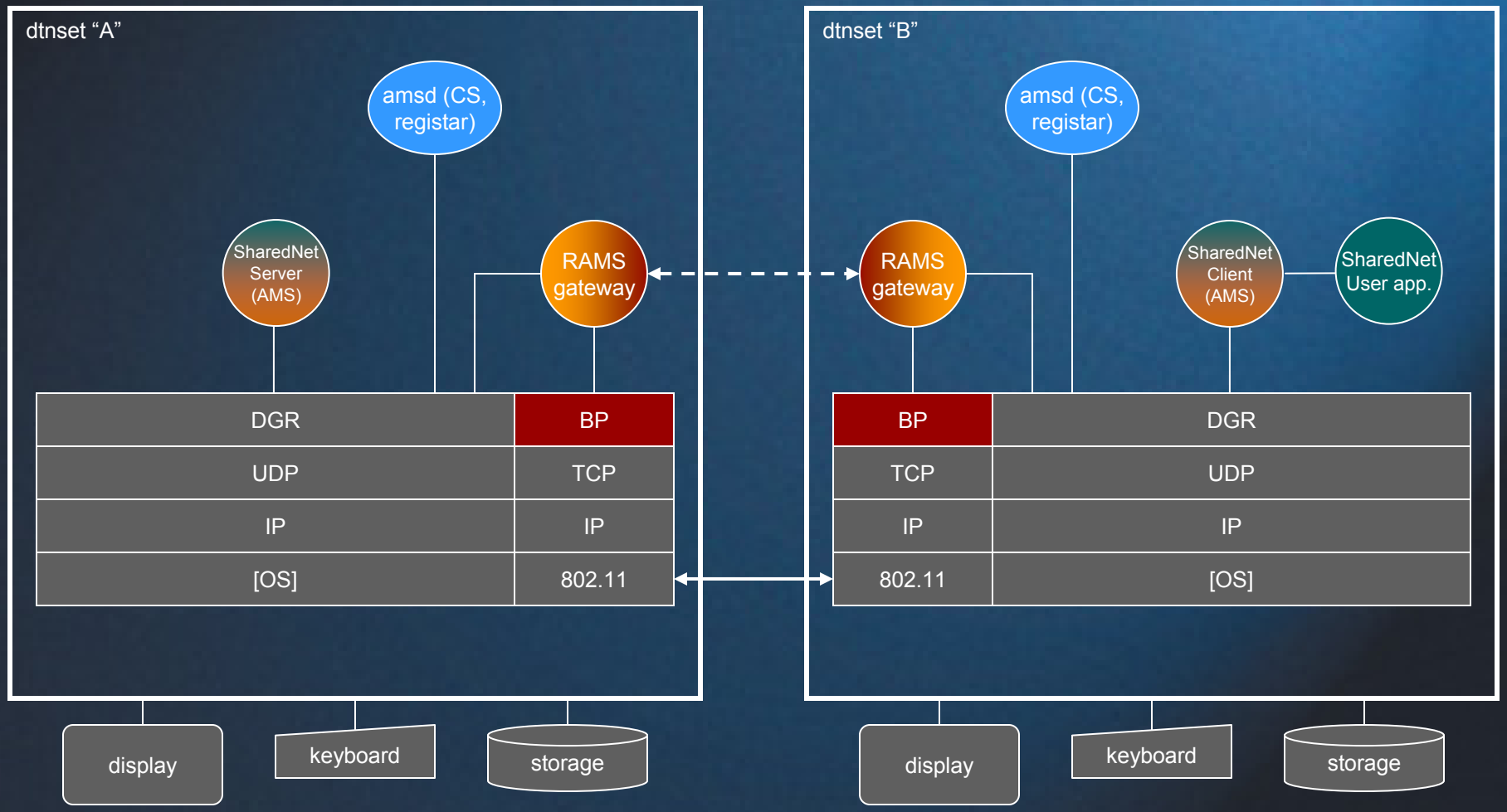


- Servers with well-connected clients
- Reachback to other information sources (e.g. through GIG)
- Interface with other systems via translators and web services

- DTN nodes enable reliable transmission and routing over transient and variable relay platforms.

- Local servers automatically synchronize with remote servers according to subscriptions on behalf of end users.
- End users can communicate within local groups even if link to HQ is down.
- All information produced/consumed by end users is stored on their devices and on local server.

Detailed Structure



Bottom Line

- Minimizes latency.
  - Messages are pushed (published) upon production.
  - Note: arrival of a new subscription can be processed as a query, triggering immediate initial publication.
- Minimizes bandwidth consumption.
  - RAMS tree minimizes parallel transmission; similar to multicast.
  - Fine-grained subscription eliminates unnecessary transmission.
    - Subscriptions can be added and removed at any time.
- Minimizes data loss.
  - DTN retains data at routers while waiting for links.
  - Sharednet retains data at edge nodes while waiting for queries.
- Secure at multiple layers of the stack.
  - Bundle encryption defends against AMS traffic analysis.
  - SharedNet encryption protects content confidentiality.