Postellation: an Enhanced Delay-Tolerant Network (DTN) Implementation with Video Streaming and Automated Network Attachment

Marc Blanchet, Simon Perreault, Jean-Philippe Dionne
Viagénie
Marc.Blanchet@viagenie.ca
http://viagenie.ca

Copyright Viagénie 2012
Plan

- Background
- Key Design Considerations
- Features
- HTTP over DTN
- DTN News Service
- Virtual DTN Cloud and demo
Delay-Tolerant Networks

- Requirements:
  - Delay-tolerant
  - Disruption-tolerant
  - Network
    - instead of point to point links
  - Reliability

- Basic atomic element is a bundle (RFC5050)

- Carried over a convergence layer:
  - Terrestrial: TCP, UDP
  - Space: Licklider Transport Protocol (RFC5326)
    - over CCSDS links

- Store and Forward
Example of DTN

METERON Reference Mission

From: Multipurpose End-To-End Robotic Operations Network (METERON), ESA/NASA

Copyright Viagénie 2012

- A Rover Control Center which manages the overall robotic operations
- A Mission Control Center which manages the space mission by transmitting Telemetry/Command messages via the Ground Stations
- A Manned Orbiter (or Surface Habitat) from which crew teleoperate the surface robotic elements
- A Relay Satellite which interconnects:
  - the Rovers with the Manned Orbiter/Surface Habitat, other surface Rovers, and; with the Ground
Current Issues with DTN Software

• Some implementations are big, heavy, complicated
  – Many not ready for flying

• Applications to use DTN need to be written from scratch
  – No standardized API. Even standardized, new network API.
  – New logic
  – Application need to be deeply aware of DTN network layer
  – Consequence: long long development time. No reuse.

• Complicated usage for end-users
  – No current usage in terrestrial world.
  – Codepaths are not exercised.
Postellation

- Name comes from:
  - `<post>ellation`:
    - Postal service is store and forward “network”
    - Has optional “custody”
  - `post<ellation>`:
    - Constellation => network

- Project:
  - Implementation of DTN
  - DTN simulation cloud

- [http://postellation.viagenie.ca](http://postellation.viagenie.ca)
Key Design Considerations

- **Lean** Bundle protocol implementation  
  → good for embedded systems

- **Smart** HTTP proxy  
  → enabling Web/SOA application developers to use DTN “transparently”  
  → optimized video streaming

- **Easy** deployment of DTN networks  
  → enabling a much larger number of end-users to use DTN, develop a community, applications, ...
Features

• written in lean and “vanilla” C → for embedded systems

• Portable code: compiles/runs/tested on:
  - Linux (kernel 2.6+)
  - *BSD, MacOSX (Leopard, Snow Leopard)
  - Windows (from XP to W7)
  - RTEMS (4.10+)

• Bundle Protocol (RFC5050)

• Convergence Layers:
  - UDP, TCP and TCP-TLS

• Transport: IPv4 and IPv6
Features (cont.)

- Included applications:
  - dtnping/dtnpong
  - dtnsend/dtnrecv
  - HTTP/HTTPS Proxy
  - RSS news service delivery, such as NASA news over DTN!

- Packagers for Windows, MacOSX and Linux

- Automated registration of nodes to our DTN node:
  - No configuration to do.
  - And you are connected to the DTN network
HTTP Proxy

• Support:
  - http
  - https
  - or any http tunnels

• Smarts to facilitate transparency of Web applications over DTN

• Implemented as a local proxy
  - For bundling HTTP requests into Bundles

• With a remote proxy
  - For unbundling HTTP requests and sending them over IP
Interoperability

- Tested with the various DTN implementation in the middle of the Postellation DTN Cloud:
  - DTN2
  - IBR
  - ION
- Interop test plan from RFC5050 was created and applied against the implementations.
Exemple Scenario

<table>
<thead>
<tr>
<th>SC App</th>
<th>HTTP/API</th>
<th>DTN</th>
</tr>
</thead>
</table>

Space DTN

Copyright Viagénie 2012
Meteron

From: Multipurpose End-To-End Robotic Operations Network (METERON), ESA/NASA

Copyright Viagénie 2012
Demonstration (1)

Client node

HTTP

HTTP to DTN Proxy
bpd

Internet

HTTP

reeves.viagenie.ca

DTN to HTTP Proxy
bpd

Copyright Viagénie 2012
Demonstration (2)

Browser

HTTP

HTTP to DTN Proxy

bpd

Internet

HTTP Server

HTTP

REEVES.VIAGENIE.CA

DTN to HTTP Proxy

bpd

moon.viagenie.ca

bpd

Bundles Over TCPcl

1.3 sec delay

Bundles/UDPcl

Copyright Viagénie 2012
Video Streaming

- If one uses Video streaming over http and carry it over a DTN, then the whole video will be buffered in the entry of the DTN network. Therefore, a latency as large as the length of the video will be seen by the end-user.

- Postellation optimize this by sending chunks of video stream real-time, therefore the end-user will see almost no difference than full real-time. The only latency would be the actual latency of the DTN network itself.
Available to Try and Use

• Implementation:
  – has been tested in production work
  – connected automatically to the DTN node and HTTP proxy

• If you would like to test it out, go to:
  – http://postellation.viagenie.ca (via IPv4, IPv6 or DTN)
  – After downloading, uncompress, then run the “start” program. This will start Bundle Protocol, HTTP proxy and registers the node to the DTN network.
  – After running it, you can also subscribe to our RSS News Service Delivery over DTN, to receive your NASA news over DTN!
Porting to Real-Time Operating System

- System requirements, memory footprint for an i386 target running bpd:
  - Binary image size: 508 kB (full RTEMS OS + Postellation software)
  - Heap size: 256 kB (bare minimum for enabling the RTEMS networking stack)
  - Stack size: 4 kB (bare minimum on the i386 architecture)

- This shows that Postellation makes it possible to deploy a full DTN stack in under one megabyte of memory.
Conclusion

- **Lean** BP implementation → good for embedded systems
- **Ported to most OS**
- **Smart** http/https proxy for easy application deployment
- **Easy** deployment by automating registration and configuration
- Available to use: [http://postellation.viagenie.ca](http://postellation.viagenie.ca)
Questions?

Marc.Blanchet@viagenie.ca

This presentation: http://www.viagenie.ca/publications/

References
- http://postellation.viagenie.ca