Interplanetary Internet interoperability and management considerations

A perspective from IPNSIG

Alberto Montilla
Board Member InterPlanetary Networking Special Interest Group – IPNSIG
Member of Pilot Projects Working Group
Board Member at Spatiam Corporation

Executive Summary

- The InterPlanetary Networking Special Interest Group (IPNSIG) mission is to realize a functional and scalable system of interplanetary data communications.
- The Pilot Projects Working Group (PWG) engages in research and prototyping opportunities to validate and extend the use of DTN.
  - Exercise scale, interoperability and management of DTN protocols.
  - Experiment with use cases and applications applicable to space and Earth.
- We are building a DTN testbed currently with active participation from Google, Spatiam Corporation, Digital Health Information Network, CONICET, University of Manitoba, APL, JPL/NASA, Glenn Research/NASA, John Hopkins University, Luleå University and more.
- We would like to share periodically our progress and learnings with the IETF DTN WG, this is our first update.

Active projects

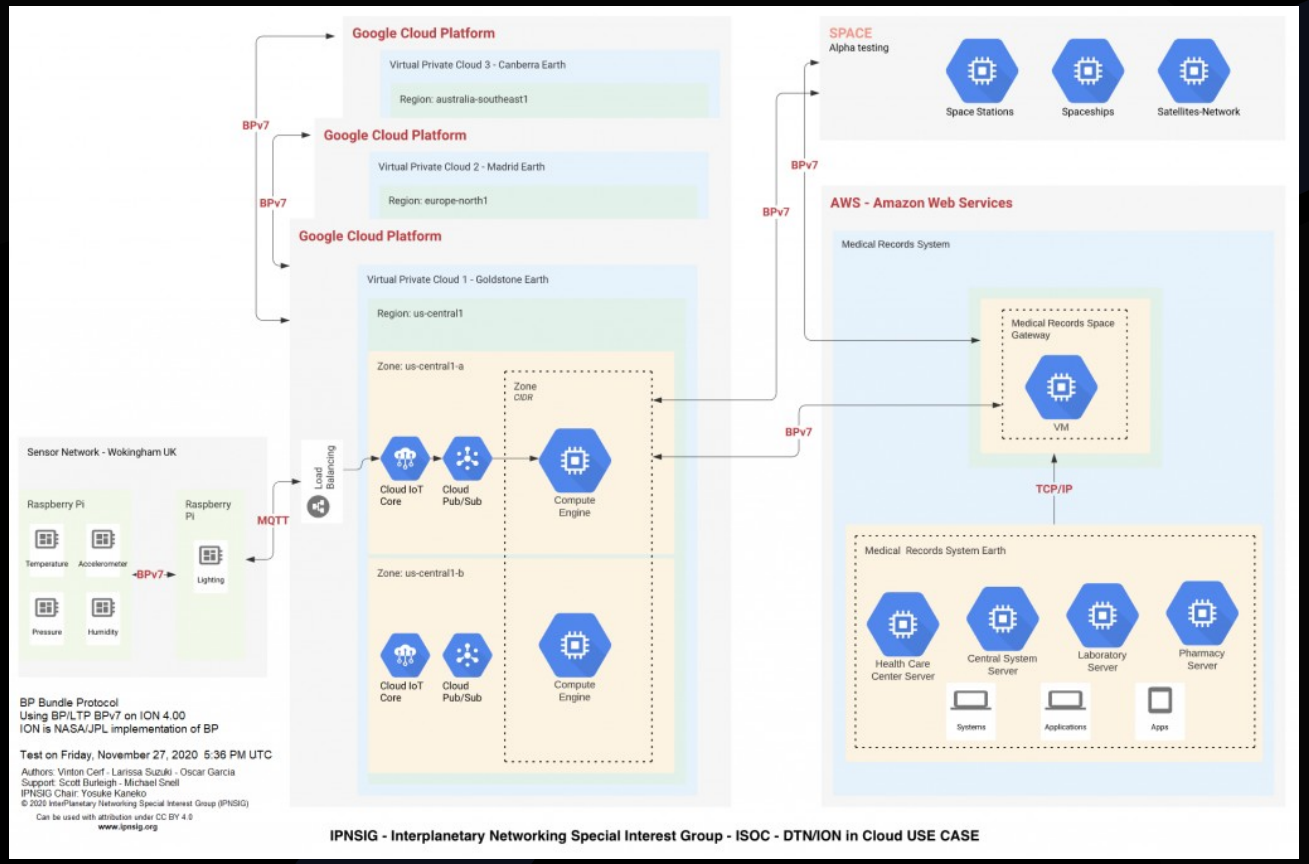
IPNSIG DTN test bed

- Create a network or networks for experimentation (for general public)
- Experiment with scale, interoperability and new features
- Experiment with use cases

Member projects

- Network Management – Space and Earth use cases
- Extending Crisis Information Management Systems (Earth)
- Reindeer husbandry (Earth) – Fully operational
- Unified Medical Records for Space Exploration
- AI-based image recognition on DTN

IPNSIG DTN Testbed



On November 27, 2020 at 17:36 UTC a message was sent from Dr. Larissa Suzuki (Google) to Oscar Garcia (Digital Health Information Network) via (ION) DTN nodes deployed in their networks (GCP and AWS), since then we have made great progress.

February Update

- 4 organizations on board, many more coming. ION based
- Exercising messaging, files, multicast
- Image recognition prototype over DTN.

Lessons learned

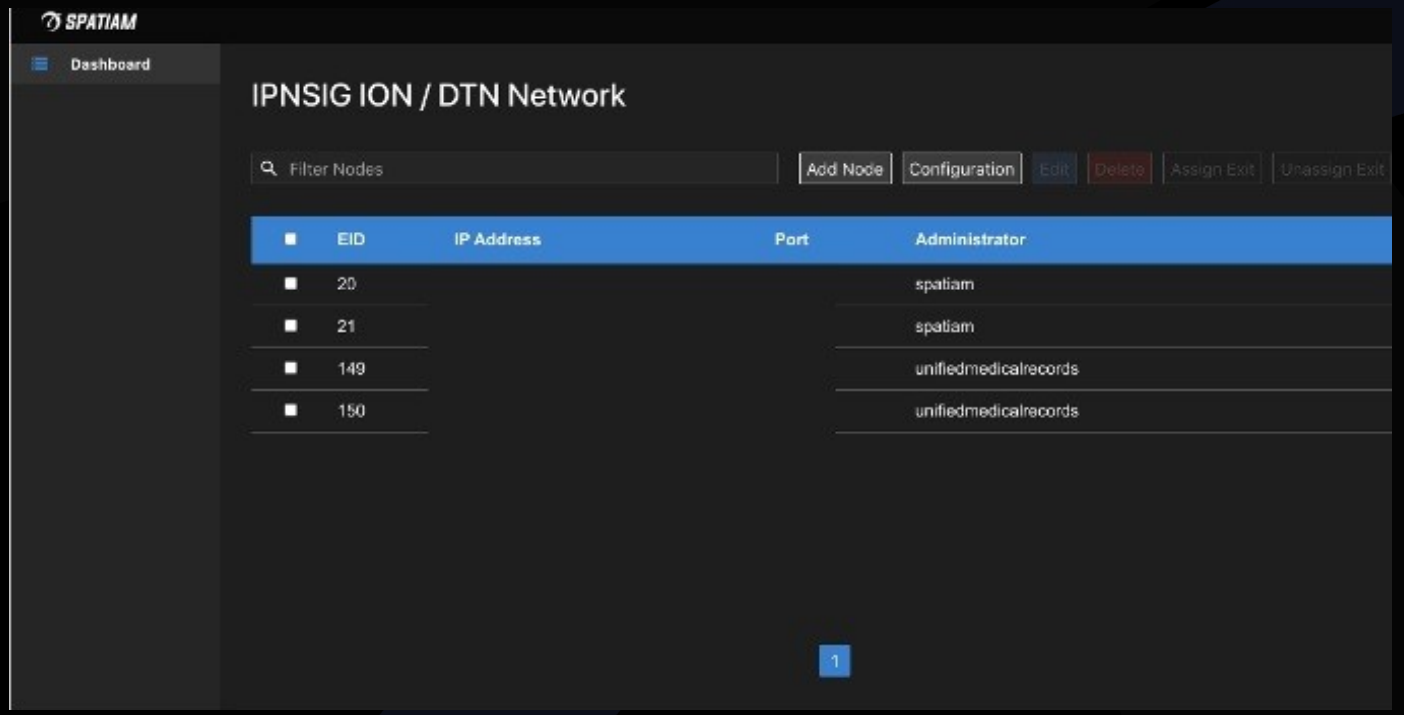
- **Management is critical**

  Contact Plans are hard to manage and prone to errors (it is like building your routing table manually)…cannot scale.

  Separate routing from management domains is an interesting challenge (topology hiding)

- Governance and automation are critical to test scale and standardize results

Network Management



In early February we released the first draft of the IPNSIG ION DTN Network Manager, built by Spatiam Corporation.

February Update

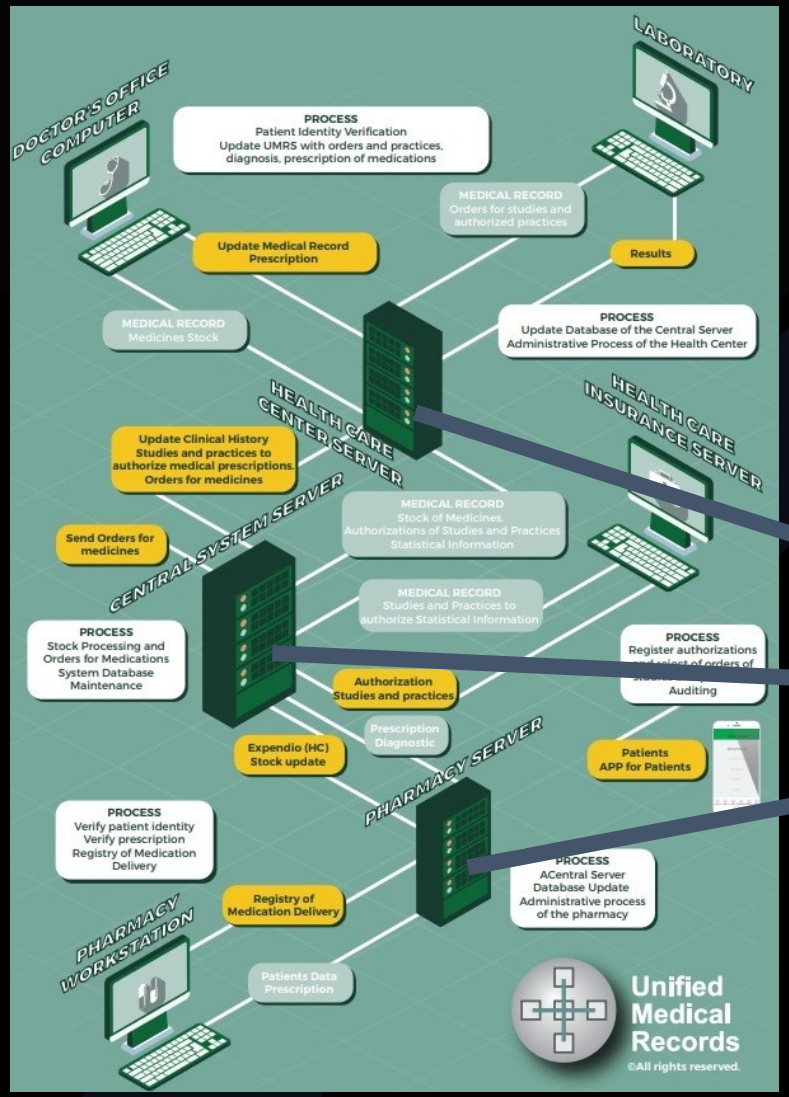
- High level requirements in place.
- Contact Plan generator with Implementation of two routing features: CGR and Exit (GW) node.

Lessons learned

Major interdependencies between DTN and management (AMP) itself. Similar to routing/forwarding, space has unique characteristics. At this point, you need to understand space networking to understand management for space networking.

State of implementation: AMP implementation on ION-DTN needs more maturity. We are helping.

Unified Medical Records for Space Exploration



Unified Medical Records
From the Earth to Space

Internet

TCP/IP

Interplanetary Network

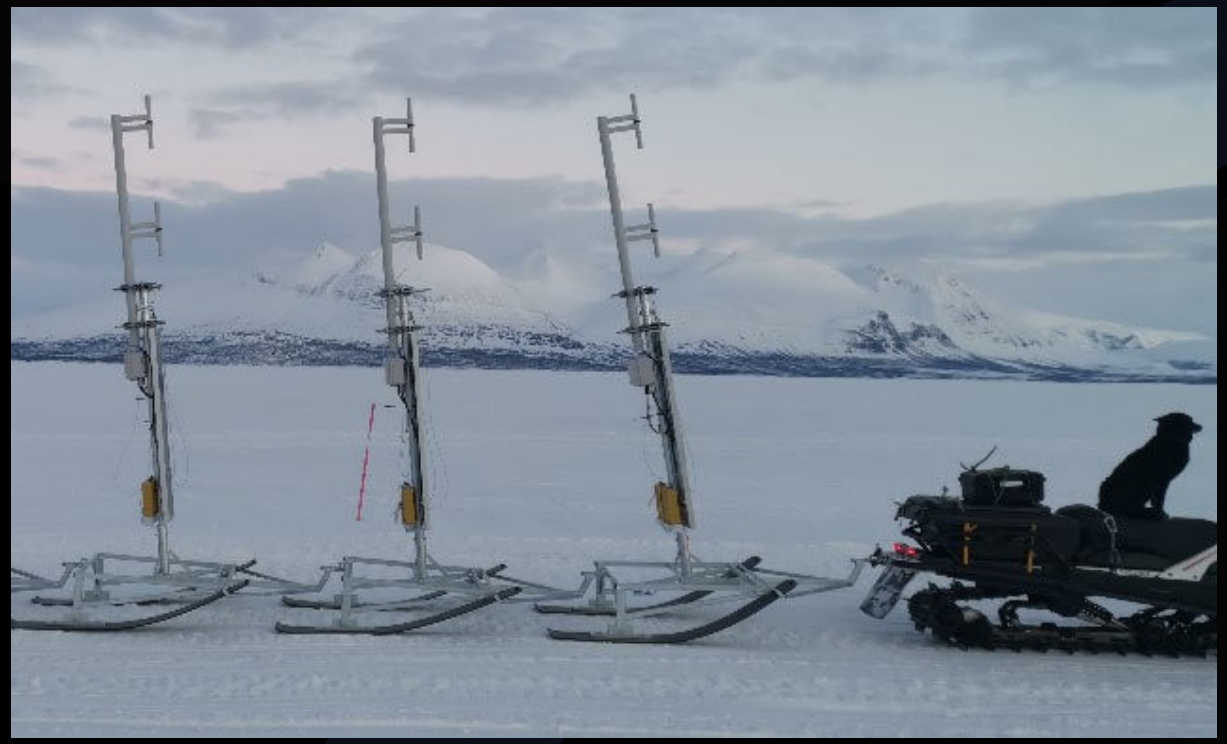
DTN / ION

Earth Unified Medical Records Gateway

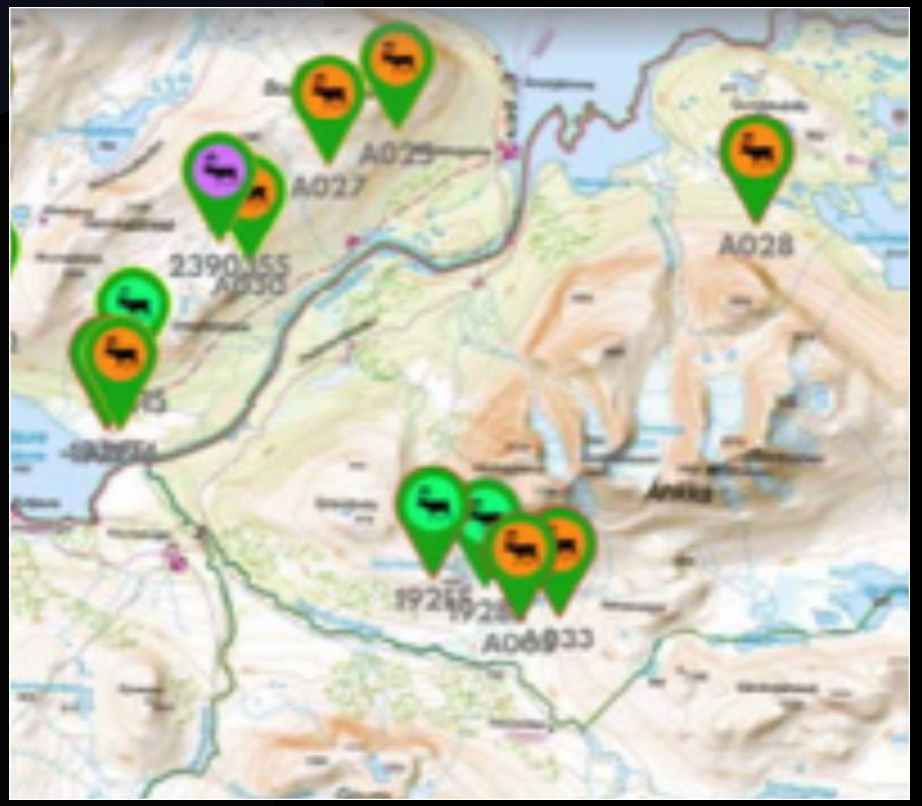
space

DTN for reindeer husbandry in the Artic

Dálvvadis Economic Association & Lulea University of Technology Sweden



NomaTrack sleigh design mobile base stations in transport to be positioned in field. Alongside new technology dogs remain notable help in herding



App/ user interface. Unique color on the position markers for each tracking service provider.

Our commitment to standards

Our goal is to promote use, exercise, experiment with, help validate and augment/scale DTN standards as means to achieve a public, interoperable network.

- Bundle protocol v7
- ADM/AMA/AMP

Several areas already identified to further explore/enhance:

- Multi-region and multi-agency routing and management
- Network management
- Better support for mobile user use case (discovery, autoconfiguration…)

Summary

- We are building the DTN testbed - a network of networks currently with active participation from many institutions and corporations.
- Current lessons learned include
  - Interdependency between DTN (ION) and Management (AMP) requires tight alignment to jointly evolve both protocols/frameworks.
  - Opportunity to continue enhancing the protocol stack with routing & management options to enhance multi-network and multi-agency connectivity, taking scale into consideration
- We are committed to promote use, experiment with and augment standards as needed.
- We would like to continue reporting updates to this WG as needed.

Thank you!

Thank You!

AI Image recognition on DTN - larissasuzuki@google.com

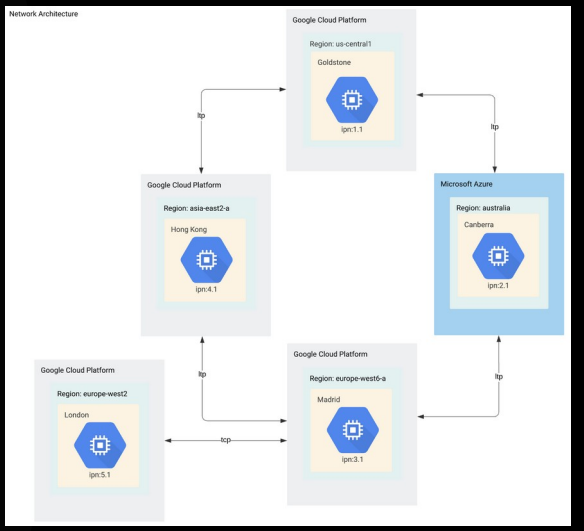
```
larissasuzuki@dtn-goldstone:~/ion-open-source-4.0.1/dtn$ python3 vision_dtn.py
Waiting for file via DTN
Stopping bprecvfile.
File Received via DTN
Executing Vision API
Labels:
: : : : : : : : : : : : : : : : : : : : Waiting for file via DTN
```

```
larissasuzuki@canberra-dtn:~/ion-open-source-4.0.1/dtn$ bpsendfile ipn:3.1 ipn:1.1 testfile1
Stopping bpsendfile.
larissasuzuki@canberra-dtn:~/ion-open-source-4.0.1/dtn$ bpsink ipn:3.1
ION event: Payload delivered.
        payload length is 3.
        'Dog'
ION event: Payload delivered.
        payload length is 3.
        'Sky'
ION event: Payload delivered.
        payload length is 9.
        'Dog breed'
ION event: Payload delivered.
        payload length is 9.
        'Carnivore'
ION event: Payload delivered.
        payload length is 16.
        'People in nature'
ION event: Payload delivered.
        payload length is 7.
        'Gesture'
ION event: Payload delivered.
        payload length is 5.
        'Happy'
ION event: Payload delivered.
        payload length is 4.
        'Fawn'
ION event: Payload delivered.
        payload length is 13.
        'Companion dog'
ION event: Payload delivered.
        payload length is 5.
        'Grass'
ION event: Reception interrupted.
```

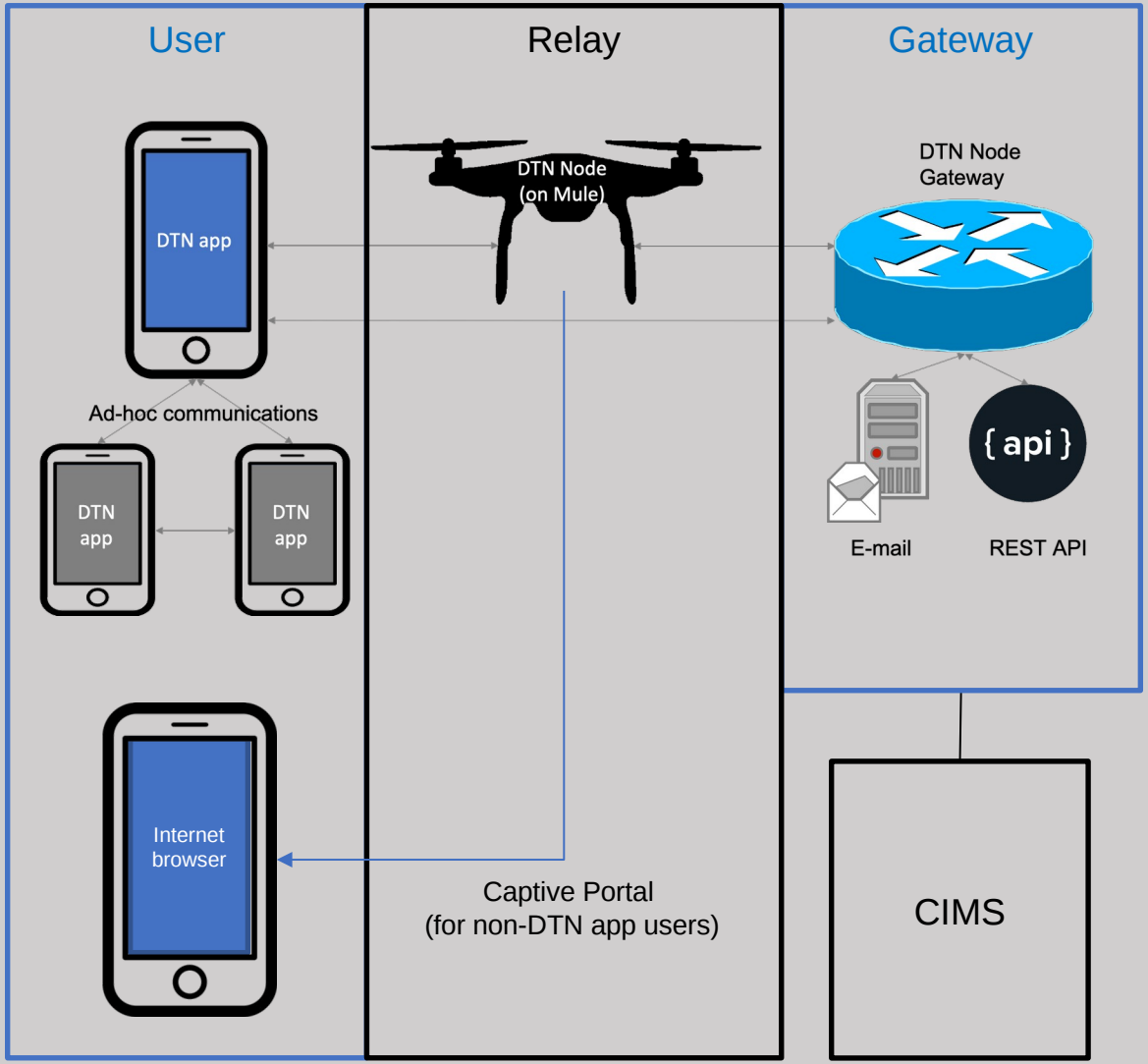
Multicasting on DTN

```
[2] 14587
larissasuzuki@dtn-goldstone:~/ion-open-source-4.0.1/dtn/dtn$ yzION event: Payload delivered.
        payload length is 17.
        'Hello from Madrid'
larissasuzuki@dtn-goldstone:~/ion-open-source-4.0.1/dtn/dtn$ yzION event: Payload delivered.
        payload length is 2.
        'hello'
^Clarissasuzuki@dtn-madrid:~/ion-open-source-4.0.1/dtn/dtn$ bpsource imc:19.0
: Hello from Madrid
ab: bccyzION event: Payload delivered.
        payload length is 17.
        'Hello from Madrid'
```

Routing in Clouds on DTN



ION-DTN Architecture for extending Crisis Information Management Systems



- ION-DTN nodes (ION 4.0.2/BPv7)
- Current Radio technologies
  - Bluetooth, WiFi, cellular (uplink)
  - Potential for LoRa and cellular