IPNSIG ACADEMY
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IETF Standardization Efforts

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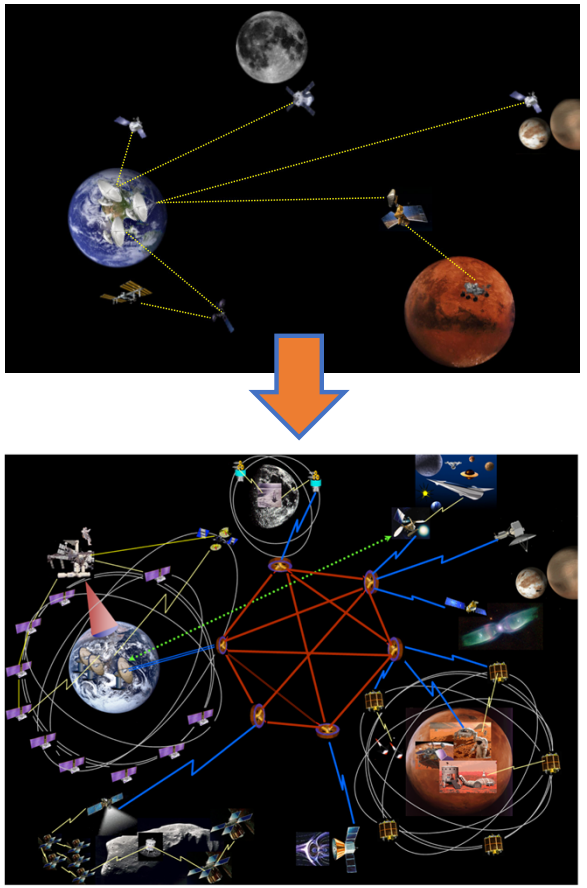
What does an Interplanetary Network Look Like?

Delay-Tolerant Networking (DTN) is a network architecture that describes what we need for interplanetary networks

- Store and Forward Data Exchange
  - **Do not** assume a path exists all at once.
  - **Do not** assume endpoints remember things for you.
  - **Do not** retransmit from the source. Inchworm through the network.
  - **Do** store data for milliseconds… or days.
  - **Do** carry all data and metadata in the same message.
- End-to-end Security
  - **Do not** rely solely on physical layer security.
  - **Do** secure different parts of a packet separately.
  - **Do** optimize for security at rest.
- Autonomy as Network Management
  - **Do not** assume an operator in the loop.
  - **Do** incorporate autonomy and automation. Operator “on” the loop.
  - **Do** push information proactively into the network.
  - **Do** be compatible with terrestrial management approaches.
- Routing
  - **Do** adjust to time-variant topologies.



https://www.nasa.gov/directorates/heo/scan/engineering/technology/disruption_tolerant_networking_history
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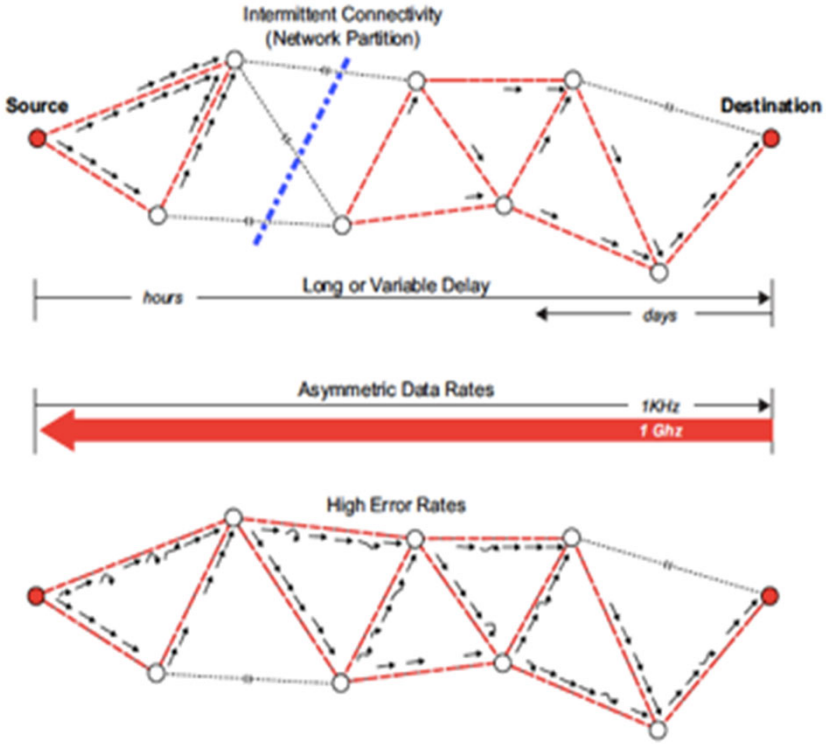
What kind of features do we want?

"Challenged" includes predictably disrupted, randomly degraded, and intentionally contested.

- You can send data without knowing if the destination is connected or on-line.
- Re-transmissions don't have to start over from the beginning.
- You can "bundle" payloads and annotative data together to avoid synchronization problems later.
- Endpoints do not need to remember sessions or special states. DTN bundles carry everything they need with them.
- Familiar features! Similar to text messaging and e-mail.
- But as a standard networking protocol – every application gets these benefits. No more point solutions.

Standards not Stovepipes!

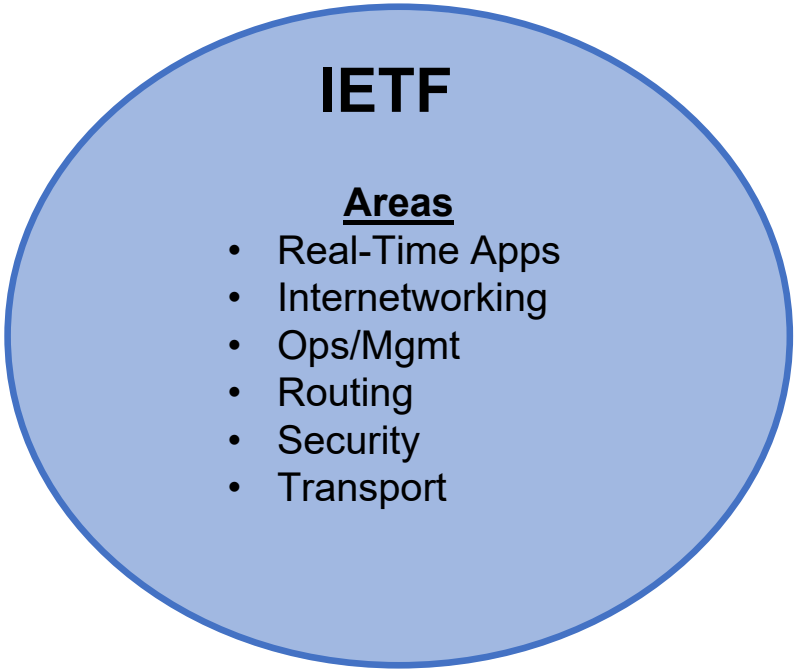


Warthman, Forrest. "Delay-and disruption-tolerant networks (DTNs)." *A Tutorial. V.. 0, Interplanetary Internet Special Interest Group* (2012): 5-9.

Where do we standardize things?

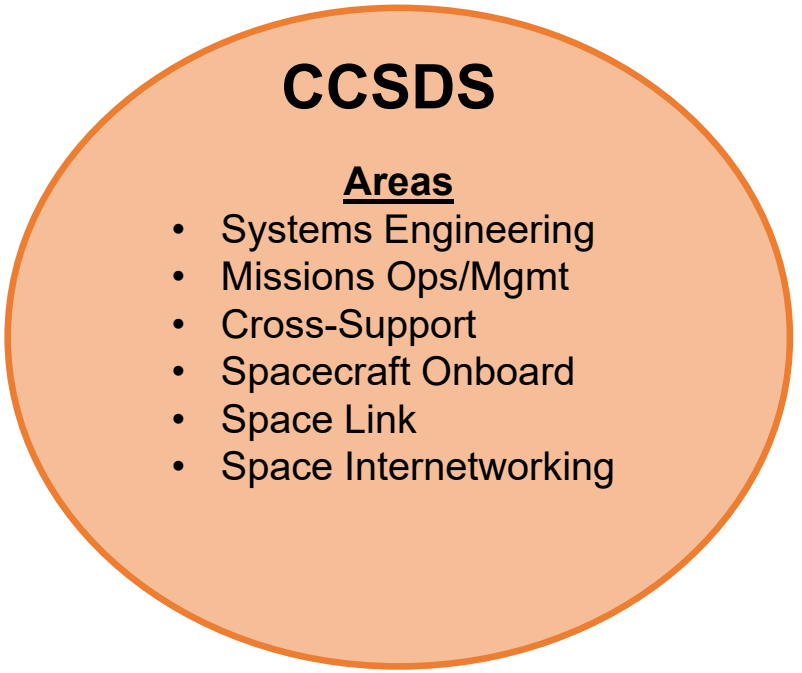
Two significant standards organizations

Internet Standards



- Expertise in Internet, ISPs, IoT, MANET.
- ~1500 attendees meet 3x year
- Open to anyone

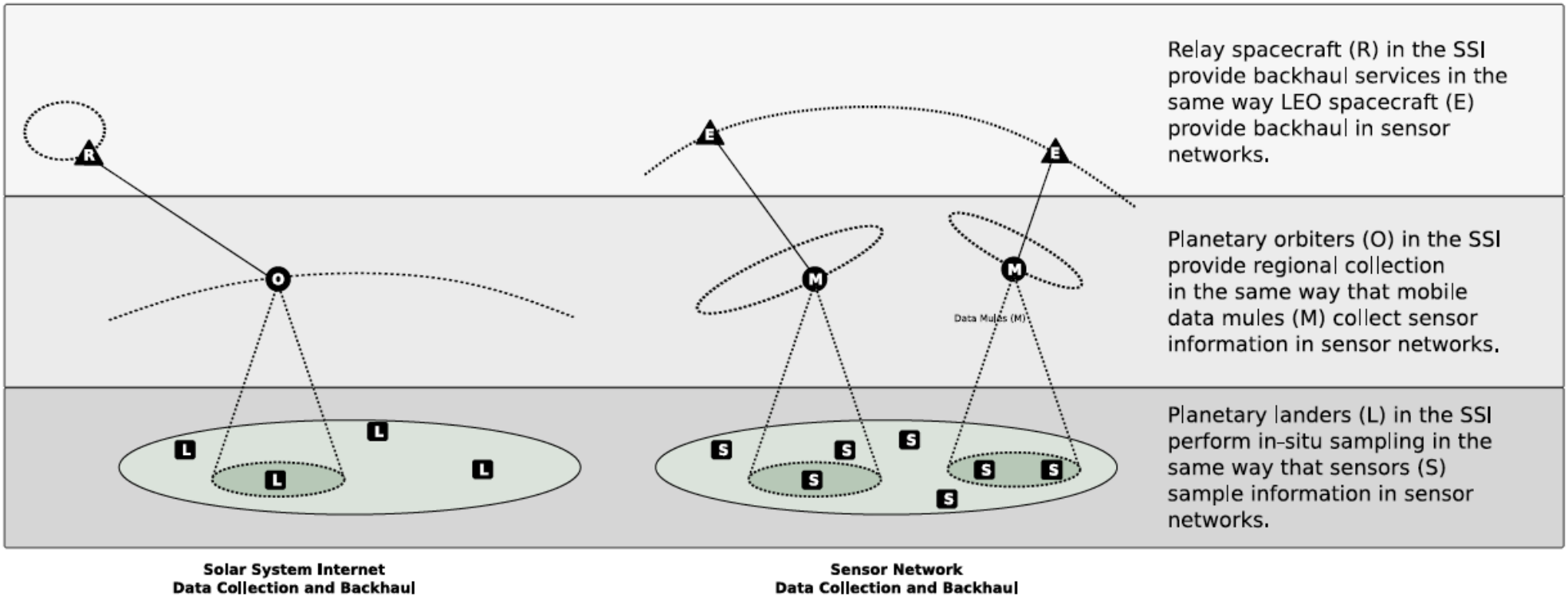
Space Standards



- Expertise in space mission development and operations.
- 100s of attendees meet 2x year
- Requires space agency Sponsorship

Some IPN feature sets are similar to nearer-Earth scenarios…

Is the IPN an extension of the internet, or a brand new internet?



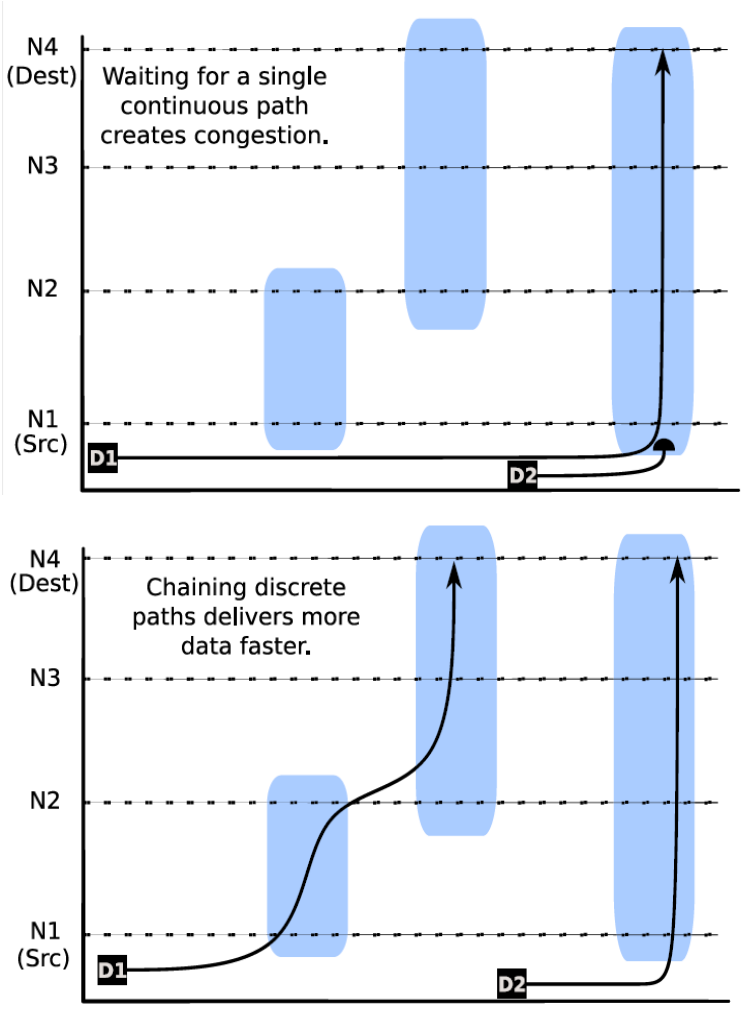
IPN features are useful in near Earth.

DTN features possibly useful even in resourced networks

Modern networks encounter problems similar to high delays and frequent disruptions.

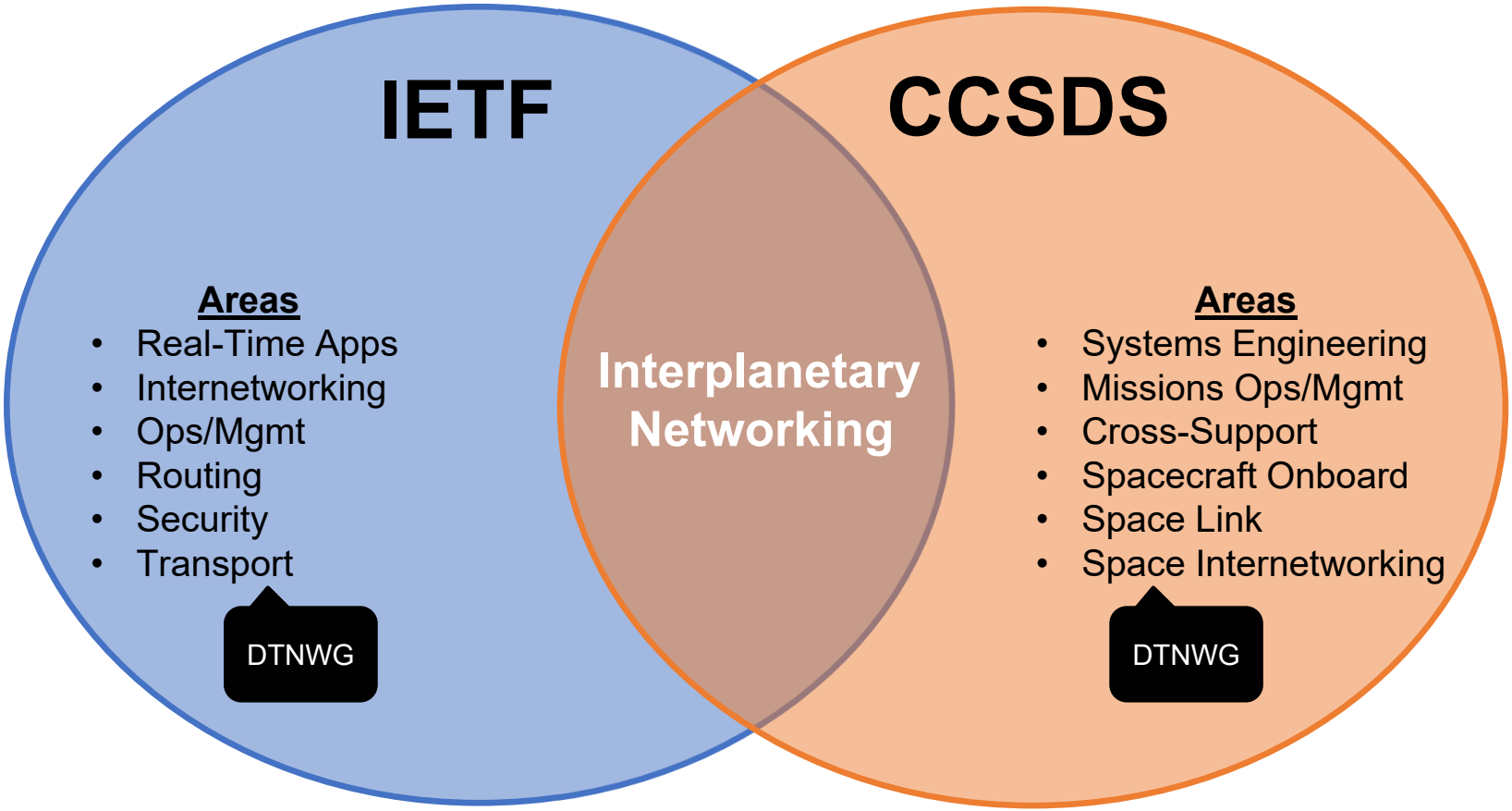
- What's useful on the Internet today?
  - Content delivery networks (**caching**)
  - Data subscriptions (**push mechanisms**)
  - Autonomic computing (**rules/automation**)
  - Stateless data (**RESTful interfaces**)
- Assuming infinite bandwidth leads to problems.
  - Waiting for an end-to-end path… causes congestion.
  - Sending traffic as soon as possible… causes congestion.
  - Handing congestion by dropping … causes congestion.
    - Re-transmitted again to be dropped again.
- Even small changes are meaningful.
  - Wait for the right time to put data in the network.
  - More on this later…

IPN features are useful on Earth.



We must mix cultures, experiences, and expertise.

A space internet is a combination of space expertise and internet expertise.



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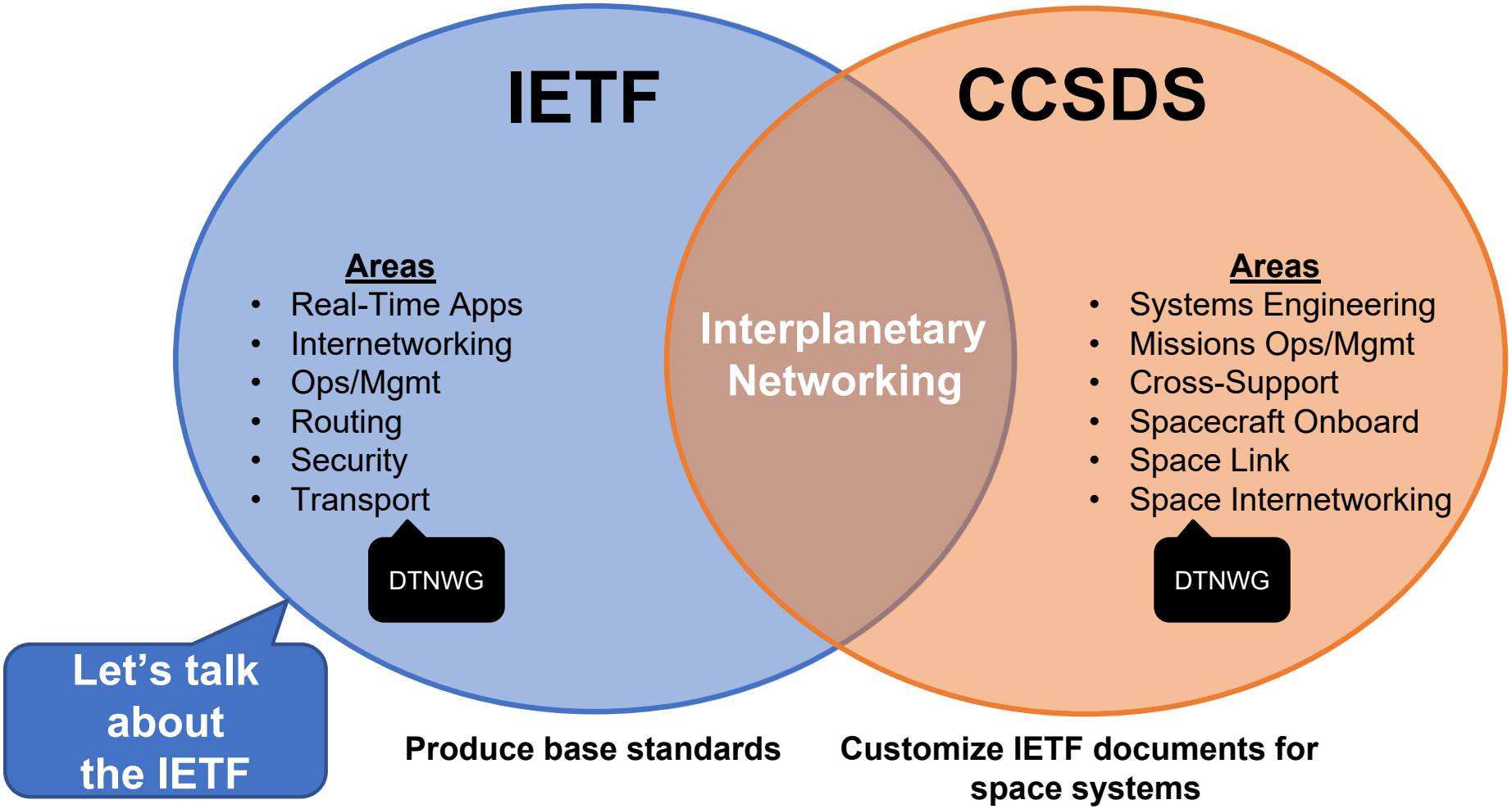

What is the IETF?

A Mission Statement for the IETF

"The overall goal of the IETF is to make the Internet work better.

Anywhere in the Universe!

The mission of the IETF is to produce high quality, relevant technical and engineering documents that influence the way people design, use, and manage the Internet in such a way as to make the Internet work better. These documents include protocol standards, best current practices, and informational documents of various kinds.

https://www.rfc-editor.org/rfc/rfc3935.html

https://twitter.com/ietf/status/1590740201218879488?s=20&t=QUqSR7pKXt8hsZjViOgRlA

How does the IETF operate?

Principles of the IETF.

- **Open process**
  - Any interested person can participate in the work, know what is being decided, and make his or her voice heard on the issue.
- **Technical competence.**
  - …the IETF is willing to listen to technically competent input from any source… we expect IETF output to be designed to sound network engineering principles.
- **Volunteer Core**
- **Rough consensus and running code**
- **Protocol ownership**
  - When the IETF takes ownership of a protocol or function, it accepts the responsibility for all aspects of the protocol, even though some aspects may rarely or never be seen on the Internet.

Summarized from: https://www.ietf.org/about/introduction/

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Focus is on technical solutions for all. Less on "here is my tool and you better make it a standard".

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Where does DTN Live in the IETF?

First the IRTF and then the IETF.

The **DTNRG** was formed in 2002.

"Observation that a noninteractive, asynchronous form of messaging service, able to operate over diverse types of networks, would be useful for several networks currently in use or being contemplated."

-https://irtf.org/concluded/dtnrg

Produced 14 RFCs, notably:

- *RFC4838* DTN Architecture
- *RFC5050* BPv6
- *RFC6257* Bundle Security Protocol
- *RFC7242* TCP Convergence Layer

The **DTNWG** was formed in 2014, IETF 91

Current Major Work Items

- Update RFC5050
- Update RFC6257
- Provide Convergence Layer RFCs

Produced 4 RFCs

- *RFC9171* BPv7
- *RFC9172* BPv7 Security (BPSec)
- RFC9173 Default Security Contexts
- *RFC9174 BPv7* TCP CLv4

Documents in AD Evaluation

- draft-ietf-dtn-bpsec-default-sc-02

DTNWG working on a milestone update, IETF 110

Current work of the DTNWG

Working groups work to an approved charter. The DTNWG charter includes the following.

Naming, Addressing and Forwarding

- The Working Group will define a common architecture for the delay/disruption tolerant assignment of names, and the late-binding of such names during bundle forwarding.
- This architecture will define a model for the forwarding process of a Bundle Protocol Agent, providing an informational reference point for further specifications.

Operations, Administration, and Management

- The Working Group will liaise with relevant experts in the OPS Area to discover if there are existing standards that meet, or may be extended to meet, the DTN use-cases before standardizing new protocols.

Extensions to, and best practices for, existing protocols

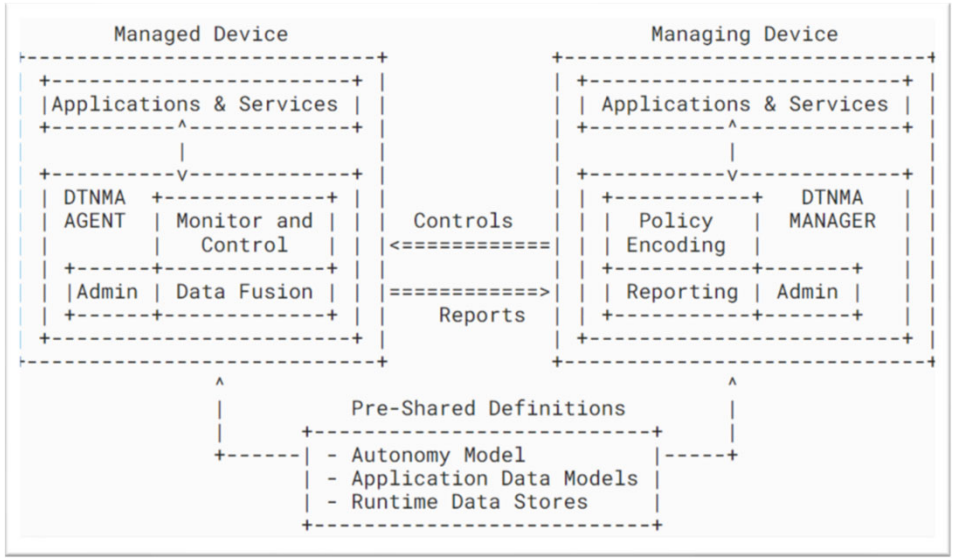
- Extensions to the Bundle Protocol to enable reliability signaling, tunneling and Quality of Service indication are needed for the operational deployment of DTNs.
- Extensions to the Bundle Protocol, additional Security Context definitions for BPSec, and new Convergence Layer adapters will be considered on a case-by-case basis.

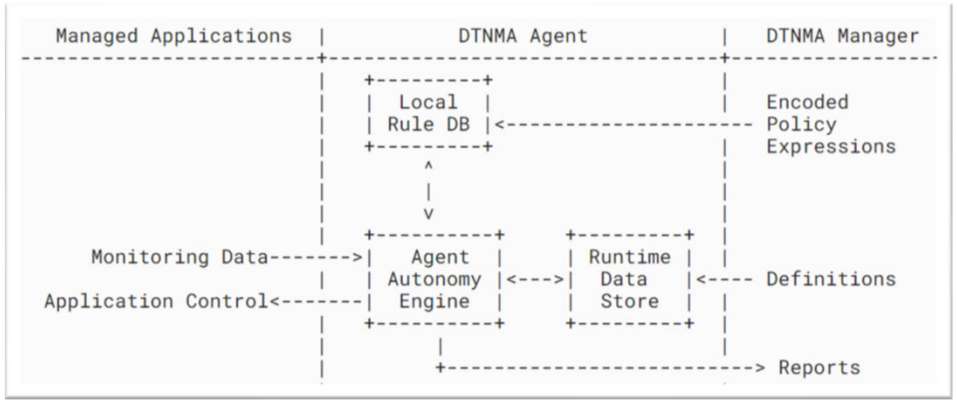
DTNWG Example

Delay-Tolerant Network Management Architecture

https://www.ietf.org/archive/id/draft-ietf-dtn-dtnma-03.html

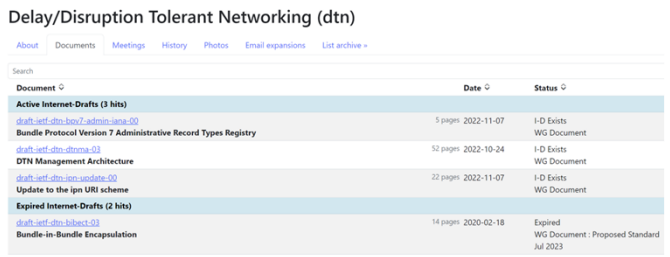
- How do you manage a DTN?
  - No closed-loop control.
  - Periods of disconnectivity.
  - Reliance on autonomy.
- What does autonomy look like?
  - Policy controls on a managed device.
  - Fewest dependencies possible.
  - Concise encodings.
- Are rule-based systems enough?
  - Policy intent as expert rules.
  - High-rate autonomy engines.
  - Closed loop control of local software.
  - Open loop control over a network.



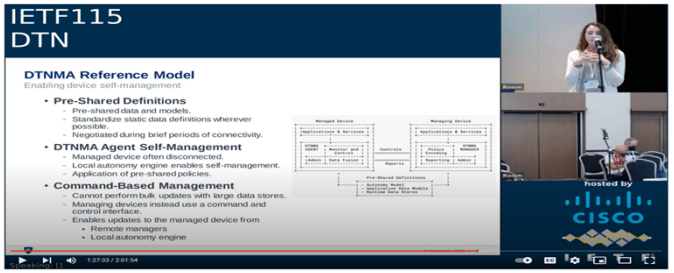


DTNWG – How to Participate

- Review online materials
  - DTNWG has a “homepage”.
  - https://datatracker.ietf.org/wg/dtn/documents/

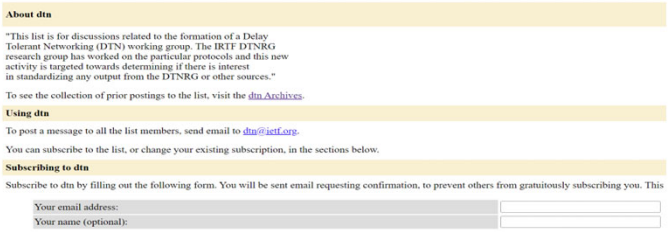


- Watch meetings on YouTube
  - Search for “IETF # DTN” on YouTube.
    - For example, “IETF 115 DTN”
    - https://www.youtube.com/watch?v=kqA-19a_XQY



IETF115-DTN-20221110-1300

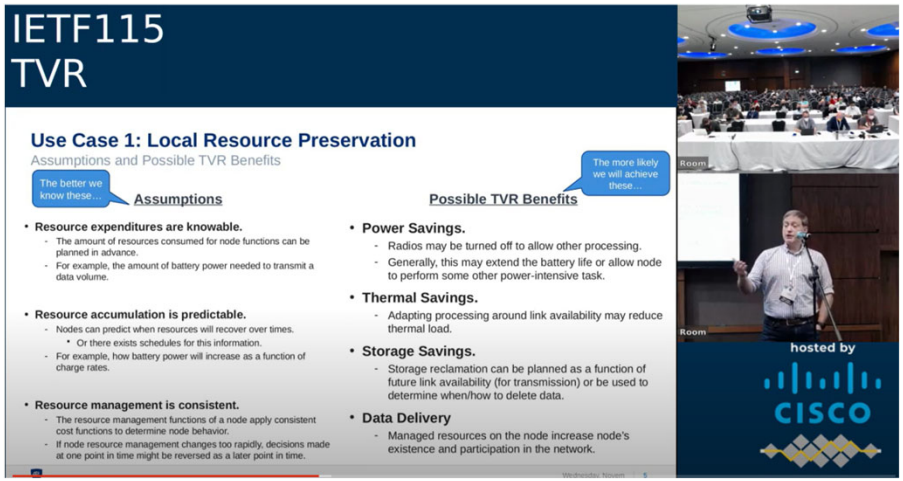
- Join the mailing list
  - Mailing list homepage.
    - https://www.ietf.org/mailman/listinfo/dtn
    - Subscribe or view archive



- Attend a meeting
  - https://ietf.org
  - Virtual attendance is supported!

Other IETF Work

Time-Variant Routing



- How to create new working groups
  - (Often) Birds of a Feather (BOF) Meetings
    - Document problems to be solved.
    - Gauge community expertise and interest.

- IETF 115 BOF
  - Time-Variant Routing (TVR)
    - 135 attendees. ~70 for (~5 against) creating a new working group.
  - Recording:
    - https://www.youtube.com/watch?v=uc4pwwj6bR0

- Standardize ways to account for known link changes in a network
  - When links come and go.
  - Important consideration for interplanetary spacecraft.
  - Also important for terrestrial use cases
    - Eco-computing. Extending sensor life. Lower utility costs.

Conclusion

- An Interplanetary Internet is a tremendous endeavor
  - “Space is hard”.
  - Networking is hard.
  - Blending technical knowledge communities is hard.

- We need standards not stovepipes
  - Networks are built from networking devices.
    - If you aren’t launching with a networking device, you aren’t building a network.
  - Standards make sure our systems interoperate.

- This future is that thing **you** create
  - There are many ways to contribute.
  - Joining the IPNSIG is an excellent start.
  - Joining the IETF is another excellent start.
  - Come find me if you want to contribute.

The whole standard.
Not just the parts you like.

Academy materials at:

➡ *https://ipnsig.org/ipnsig-academy-events/*

Any questions to:

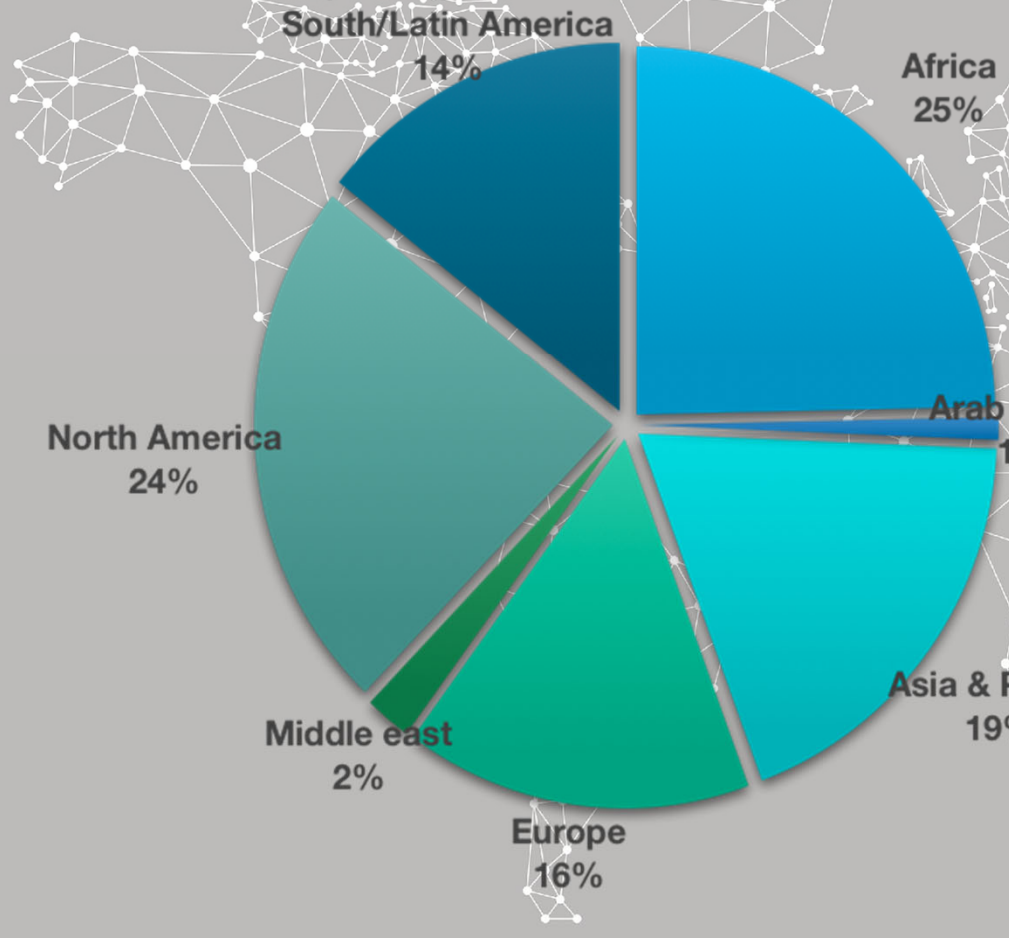
➡ *secretariat@ipnsig.org*

IPNSIG Academy – Program for 2022-2023

Links to recordings - https://ipnsig.org/ipnsig-academy-events/

1.	Yosuke Kaneko	**100+ Years Vision [May 18]**
2.	Vinton G. Cerf	**DTN Overview [June 1]**
3.	Oscar Garcia	**DTN Projects Work [July 13]**
4.	Scott Burleigh	**SSI Architecture Study [Aug 3]**
5.	Lara Suzuki	**DTN Live Demonstration [Sep 7]**
6.	Dave Israel	**NASA Luna Net Overview [Oct 12]**
7.	David Gomez Otero	**ESA Moonlight Overview [Nov 2]**
8.	Ed Birrane	**IETF Standardization Efforts [Dec 7]**
9.	Keith Scott	**CCSDS Standardization Efforts [Jan 4]**
10.	Laura DeNardis	**Interplanetary Internet Governance [Feb 1]**
11.	Scott Pace	**Space Policy, Perspective on IPN Governance [Mar 1]**
12.	“IPNSIG Workshop”	**Architecture and Governance of IPN [April 5]**

BECOME A MEMBER OF THE IPNSIG!



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Thank you.
You will be redirected to a short survey.

https://www.surveymonkey.com/r/8HDP8PT