



IETF Standardization Efforts



Moderator: Scott Burleigh
IPNSIG Board Member

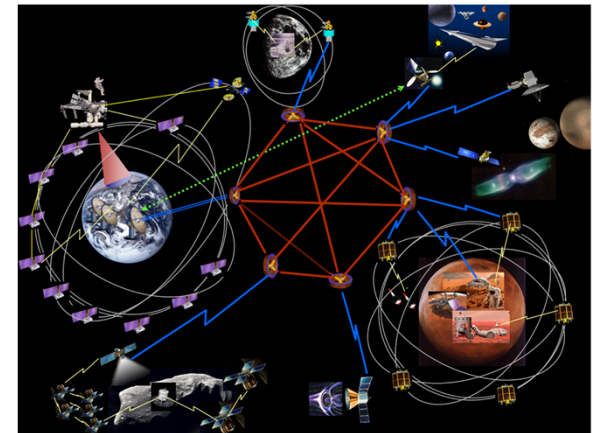
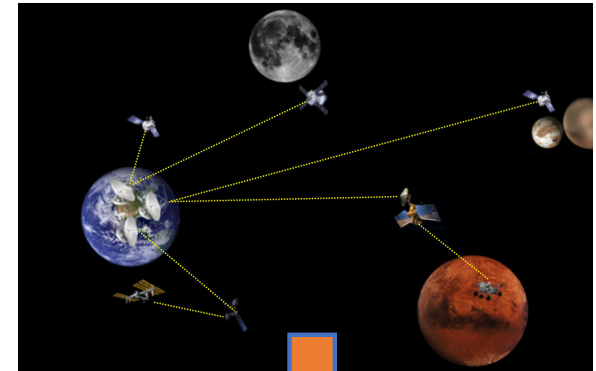


Presenter: Dr. Edward J. Birrane, III
Chief Engineer
Space Constellation Networking
Space Exploration Sector
Johns Hopkins Applied Physics Laboratory

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.



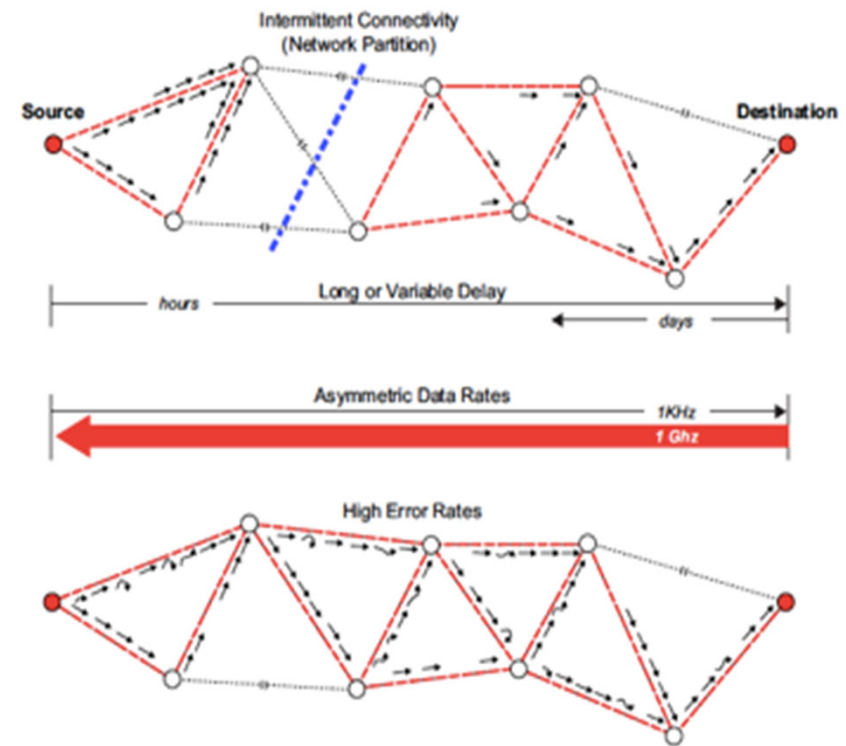
https://www.nasa.gov/directorates/heo/scan/engineering/technology/disruption_tolerant_networking_history
https://www.nasa.gov/directorates/heo/scan/engineering/technology/disruption_tolerant_networking

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

IETF

Areas

- Real-Time Apps
- Internetworking
- Ops/Mgmt
- Routing
- Security
- Transport

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

Space Standards

CCSDS

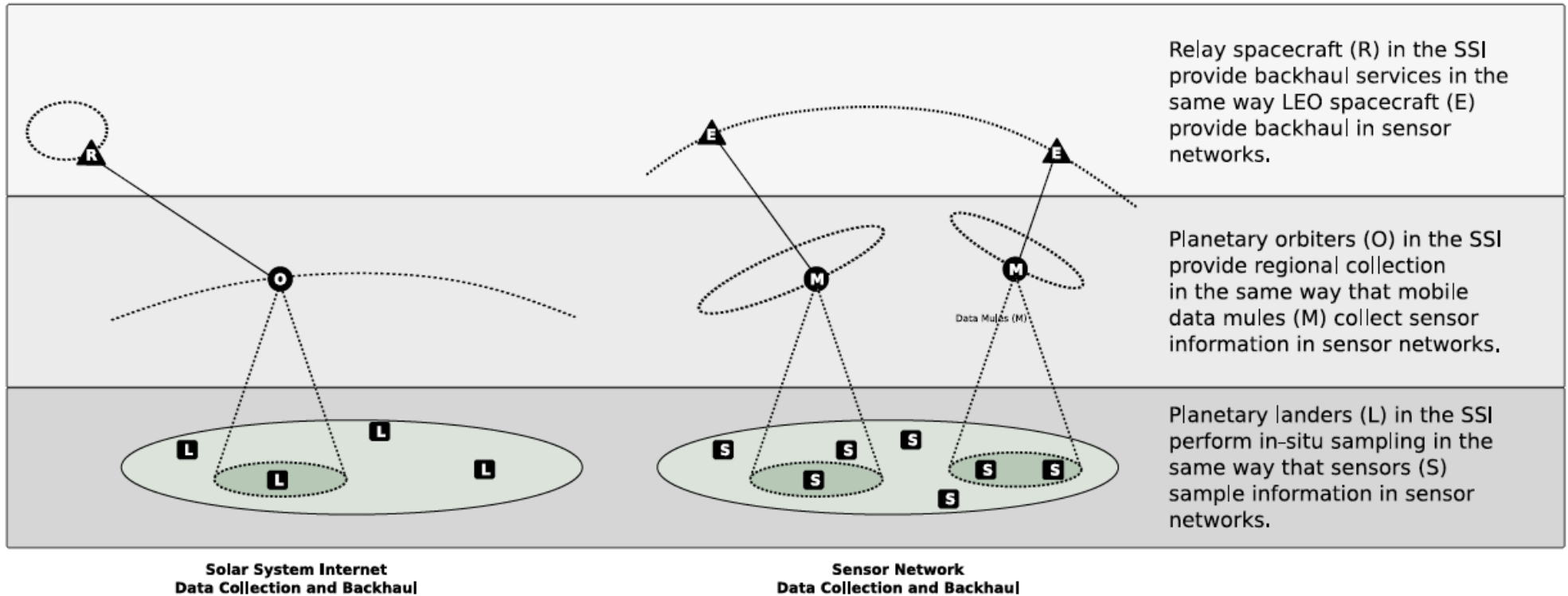
Areas

- Systems Engineering
- Missions Ops/Mgmt
- Cross-Support
- Spacecraft Onboard
- Space Link
- Space Internetworking

- 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?



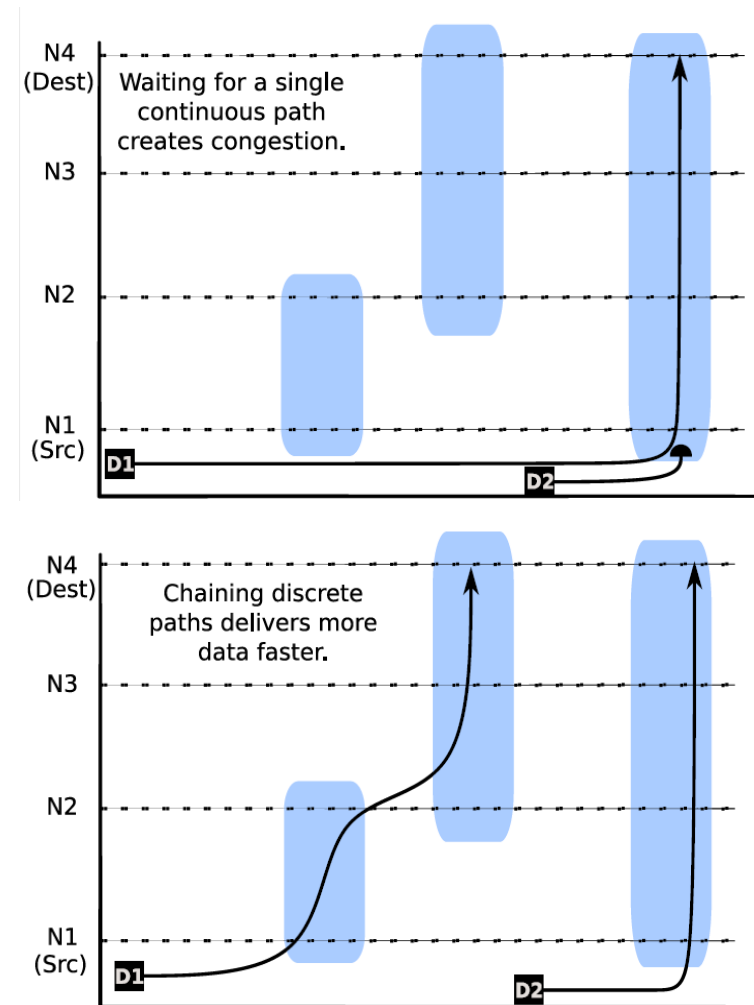
IPN features are useful in near Earth.

DTN features possibly useful even in resourced networks

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

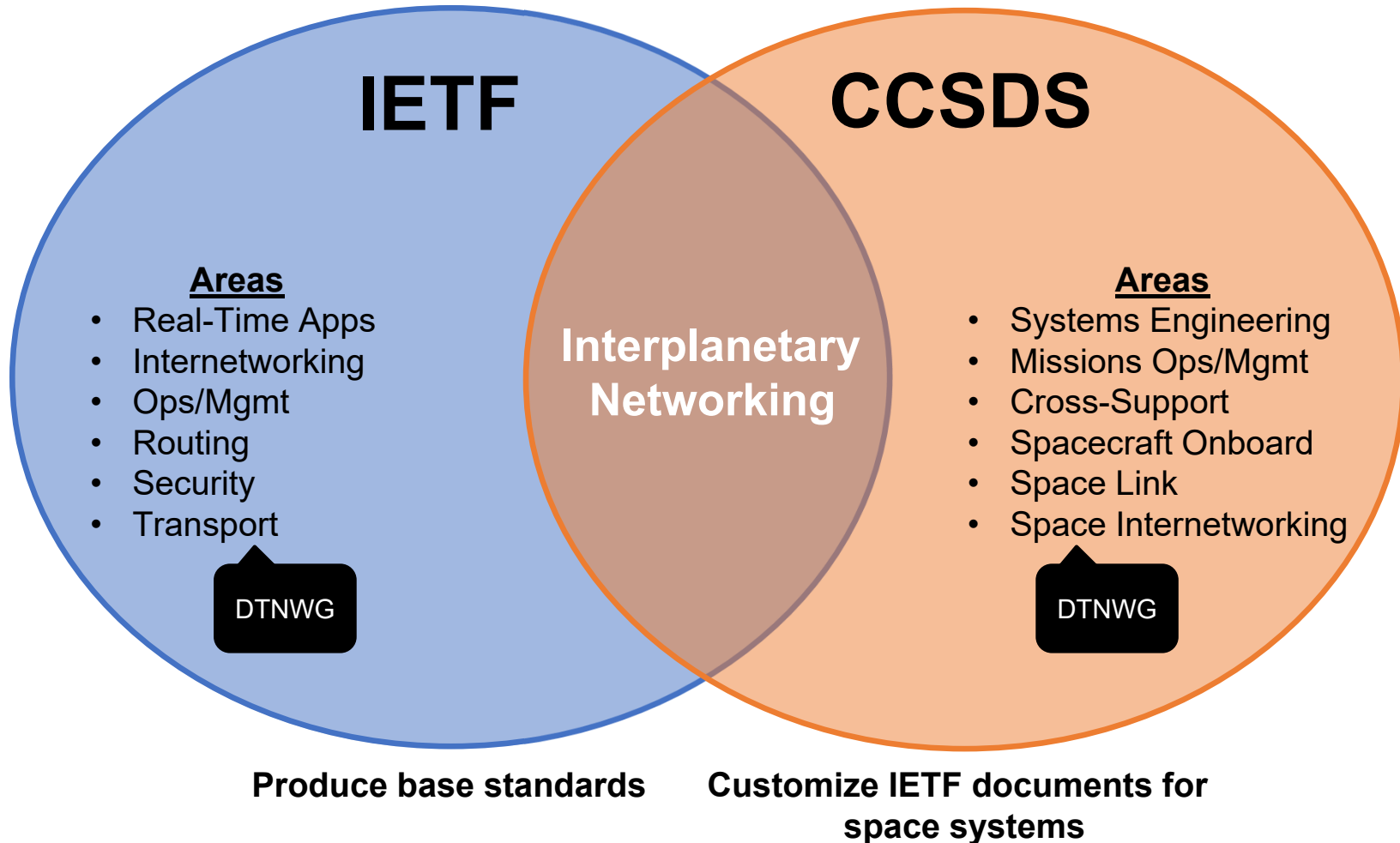
- What's useful on the Internet today?
 - Content delivery networks (**caching**)
 - Data subscriptions (**push mechanisms**)
 - Autonomic computing (**rules/automation**)
 - Stateless data (**RESTful interfaces**)
- Assuming infinite bandwidth leads to problems.
 - Waiting for an end-to-end path... 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.



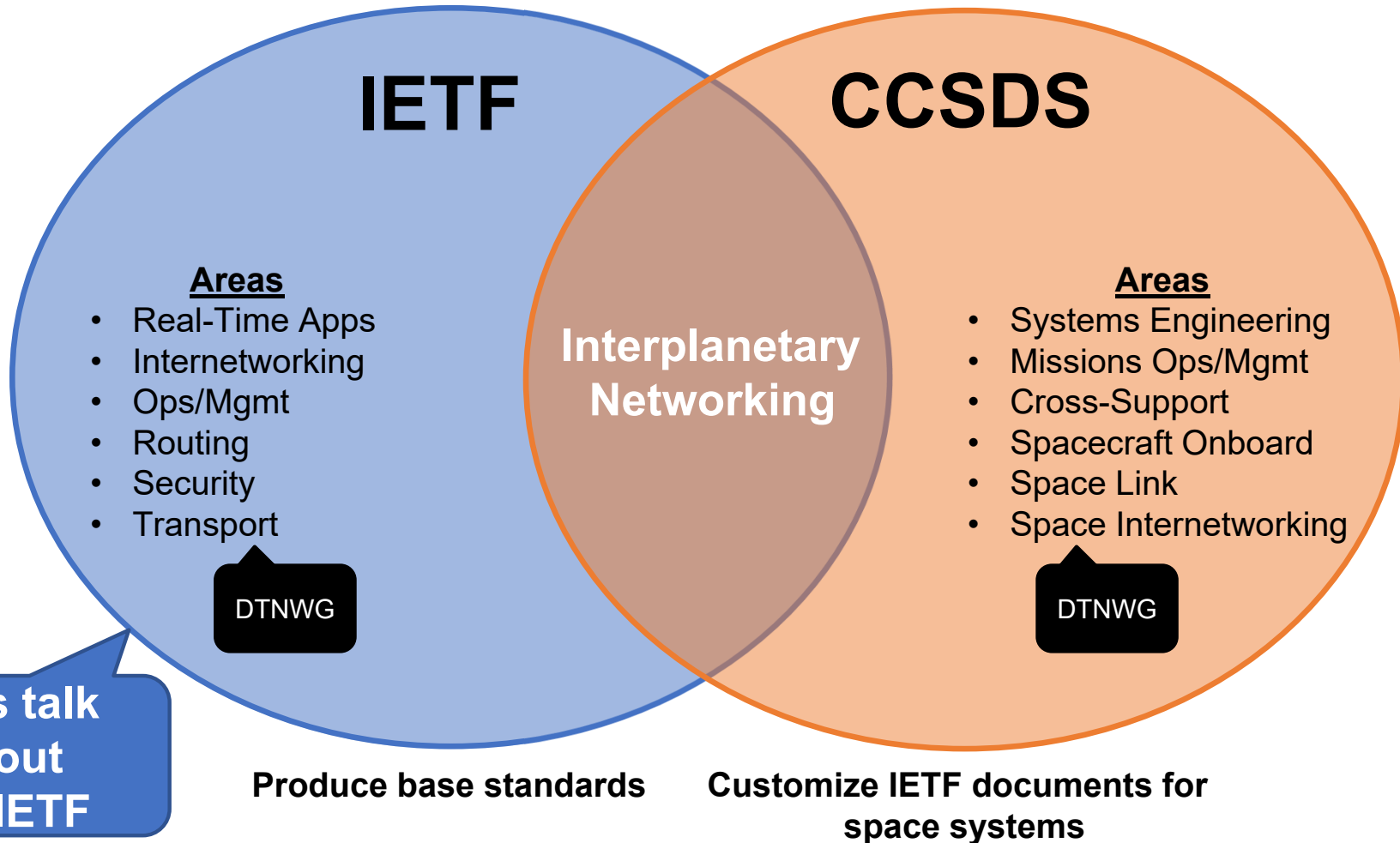
We must mix cultures, experiences, and expertise.

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>



@IETF · Nov 10

ICYMI: #IETF115 meeting hosted by @Cisco today featured a presentation by Kevin McMenamy and Fredrik Pihl, discussing Project Callisto and extra-terrestrial collaboration using #WebRTC and #AV1 technologies: ietf.org/live/ietf115-h...



<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/>

How does the IETF operate?

Principles of the IETF.

- **Open process**

- Any interested person can participate and make his or her voice heard.

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 **DTN WG** 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 (BPv7Sec)
- *RFC9173* Default Security Contexts
- *RFC9174* BPv7 TCP CLv4

Documents in AD Evaluation

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

DTN WG working on a milestone update, IETF 110

Current work of the DTN WG

Working groups work to an approved charter. The DTN WG 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

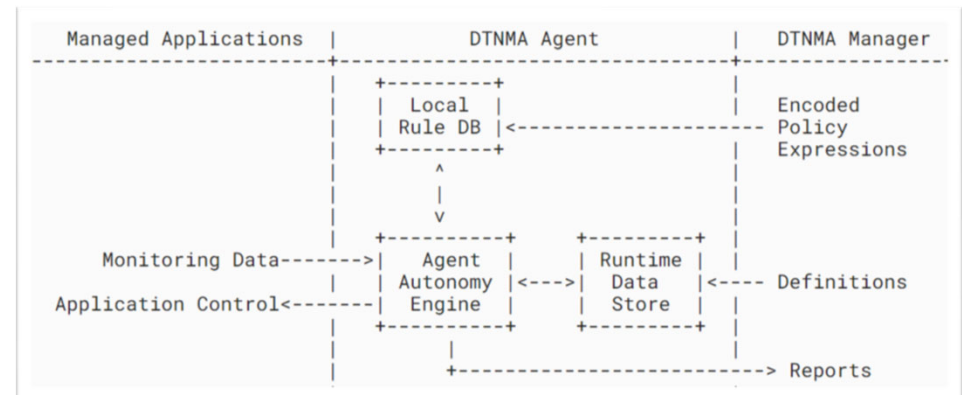
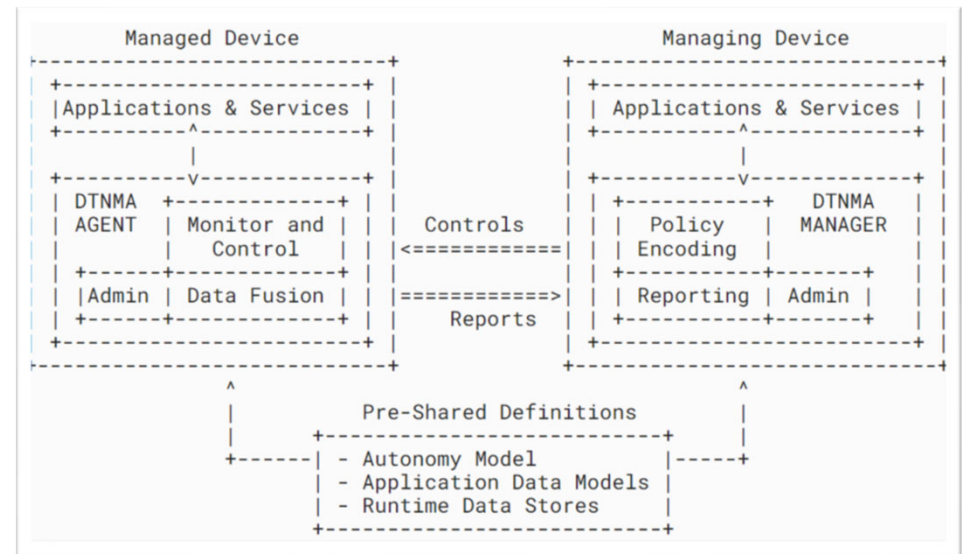
- Extensions to the Bundle Protocol to enable reliability signaling, tunneling and Quality of Service indication are needed for the operational deployment of DTNs.
- Extensions to the Bundle Protocol, additional Security Context definitions for BPsec, and new Convergence Layer adapters will be considered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

DTN WG Example

Delay-Tolerant Network Management Architecture

- **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.

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



DTN WG – How to Participate

- Review online materials
 - DTN WG 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
- 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!

Delay/Disruption Tolerant Networking (dtn)

About Documents Meetings History Photos Email expansions List archive

Search

Document	Date	Status
Active Internet-Drafts (3 hits)		
draft-ietf-dtn-ietf-admin-02	5 pages 2022-11-07	I-D Exists WG Document
Bundle Protocol Version 7 Administrative Record Types Registry		
draft-ietf-dtn-dtnma-03	52 pages 2022-10-24	I-D Exists WG Document
DTN Management Architecture		
draft-ietf-dtn-ipn-update-00	22 pages 2022-11-07	I-D Exists WG Document
Update to the ipn URI scheme		
Expired Internet-Drafts (2 hits)		
draft-ietf-dtn-bbaect-03	14 pages 2020-02-18	Expired WG Document : Proposed Standard Jul 2023
Bundle-in-Bundle Encapsulation		

IETF115 DTN

DTNMA Reference Model
Enabling device self-management

- **Pre-Shared Definitions**
 - Pre-shared data and models.
 - Standardize static data definitions wherever possible.
 - Negotiated during brief periods of connectivity.
- **DTNMA Agent Self-Management**
 - Managed device often disconnected.
 - Local autonomy engine enables self-management.
 - Application of pre-shared policies.
- **Command-Based Management**
 - Cannot perform bulk updates with large data stores.
 - Managing devices instead uses a command and control interface.
 - Enables updates to the managed device from
 - Remote managers
 - Local autonomy engine

About dtn

"This list is for discussions related to the formation of a Delay Tolerant Networking (DTN) working group. The IETF DTN WG research group has worked on the particular protocols and this new activity is targeted towards determining if there is interest in standardizing any output from the DTN WG or other sources."

To see the collection of prior postings to the list, visit the [dtn Archives](#).

Using dtn

To post a message to all the list members, send email to dtn@ietf.org.

You can subscribe to the list, or change your existing subscription, in the sections below.

Subscribing to dtn

Subscribe to dtn by filling out the following form. You will be sent email requesting confirmation, to prevent others from gratuitously subscribing you. This

Your email address:
Your name (optional):



[IETF 116 Yokohama >](#)

IETF 116 starts Saturday 25 March and runs through Friday afternoon, 31 March.

Yokohama, Japan

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.

The image is a composite. On the left is a presentation slide titled "IETF115 TVR" with the subtitle "Use Case 1: Local Resource Preservation". The slide is divided into two columns: "Assumptions" and "Possible TVR Benefits". The "Assumptions" column lists three points: "Resource expenditures are knowable", "Resource accumulation is predictable", and "Resource management is consistent". The "Possible TVR Benefits" column lists four points: "Power Savings", "Thermal Savings", "Storage Savings", and "Data Delivery". On the right is a photograph of a man in a light blue shirt speaking at a podium in a large conference room. The photo is overlaid with a "hosted by CISCO" logo at the bottom.

IETF115 TVR

Use Case 1: Local Resource Preservation
Assumptions and Possible TVR Benefits

Assumptions

- **Resource expenditures are knowable.**
 - The amount of resources consumed for node functions can be planned in advance.
 - For example, the amount of battery power needed to transmit a data volume.
- **Resource accumulation is predictable.**
 - Nodes can predict when resources will recover over times.
 - Or there exists schedules for this information.
 - For example, how battery power will increase as a function of charge rates.
- **Resource management is consistent.**
 - The resource management functions of a node apply consistent cost functions to determine node behavior.
 - If node resource management changes too rapidly, decisions made at one point in time might be reversed as a later point in time.

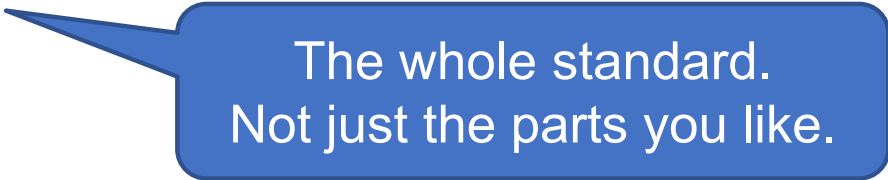
Possible TVR Benefits

- **Power Savings.**
 - Radios may be turned off to allow other processing.
 - Generally, this may extend the battery life or allow node to perform some other power-intensive task.
- **Thermal Savings.**
 - Adapting processing around link availability may reduce thermal load.
- **Storage Savings.**
 - Storage reclamation can be planned as a function of future link availability (for transmission) or be used to determine when/how to delete data.
- **Data Delivery**
 - Managed resources on the node increase node's existence and participation in the network.

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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/>



IPNSIG
ACADEMY



Any questions to:

➔ secretariat@ipnsig.org

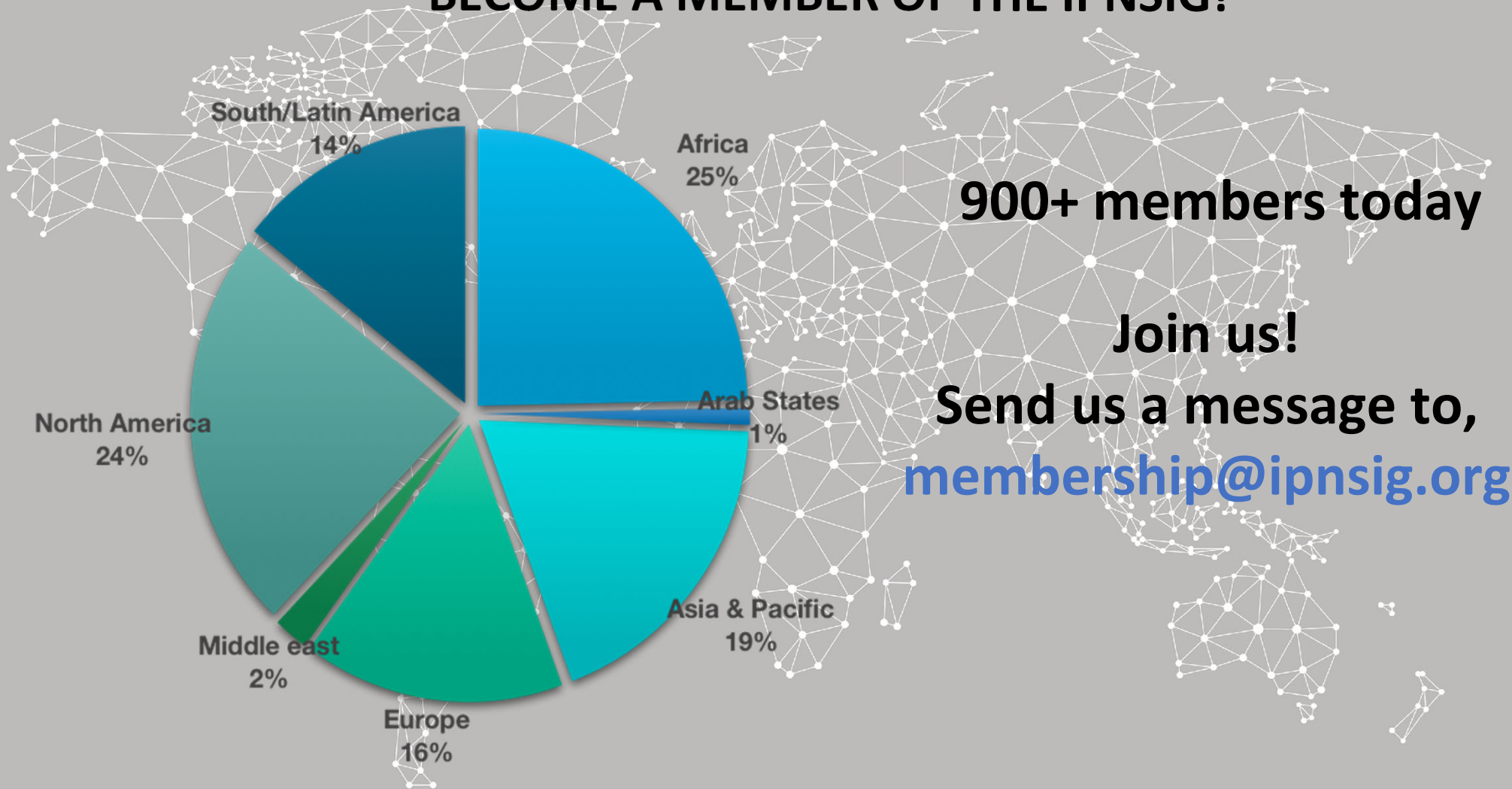


IPNSIG Academy – Program for 2022-2023

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 Burlleigh **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]**

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