Non-Custodial Multicast in Disruption-Tolerant Networks (DTNs)
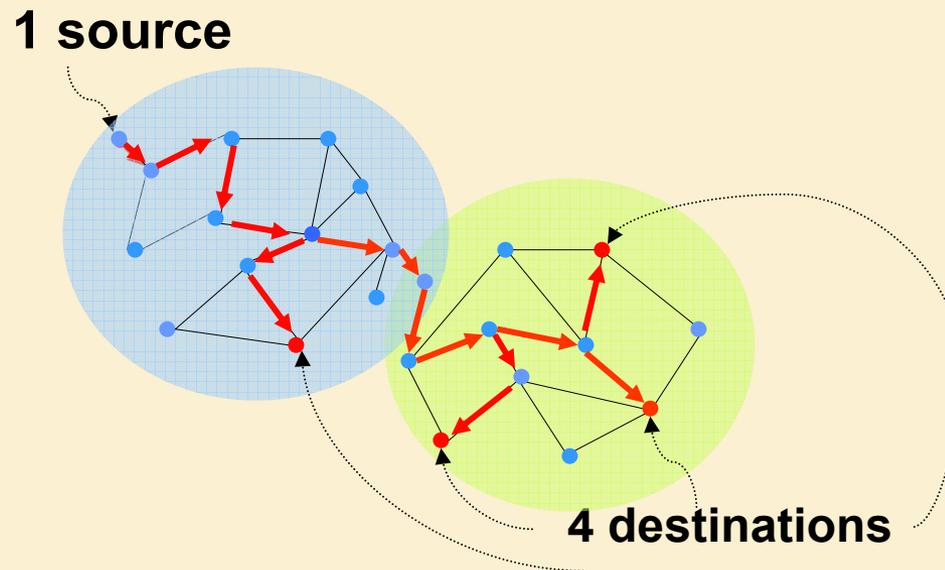
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Keith Scott

IETF Meeting

Dallas, TX

March 24, 2006

DTN Non-Custodial Multicast

- **Objective: define a non-custodial multicast capability for DTN to enable a source node to transmit a bundle to multiple destination nodes without having to originate a separate bundle for each destination node.**

- **Non-custodial=no support for custody transfer**

1 source

4 destinations

DTN Multicasting Internet Draft Status

- **Non-Custodial (Best-Effort) Multicasting Support in DTN** (Symington, Durst, Scott)
  - draft-symington-bundle-multicast-noncustodial-00.txt
  - Submitted February 25, 2006
- **Comments received on this draft indicate**
  - **It should be broken into four separate documents:**
    - **DTN Non-custodial Multicast Overview (informative)**
    - **DTN Previous Hop Extension Header (general capability)**
    - **DTN Bundle-in-Bundle Encapsulation (general capability)**
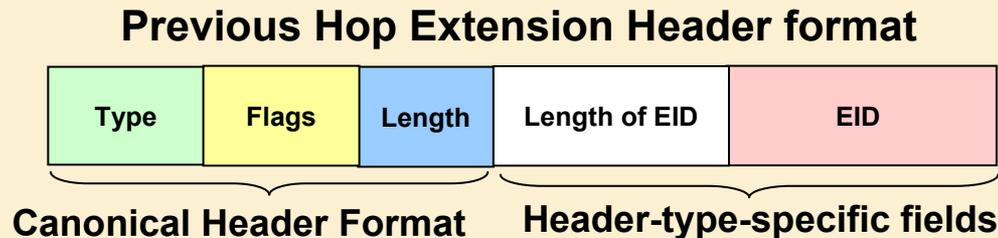   - **DTN Non-Custodial Multicast Extensions (normative)**

  This presentation will discuss the content of the four proposed documents

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Non-Custodial Multicast Overview (informative)
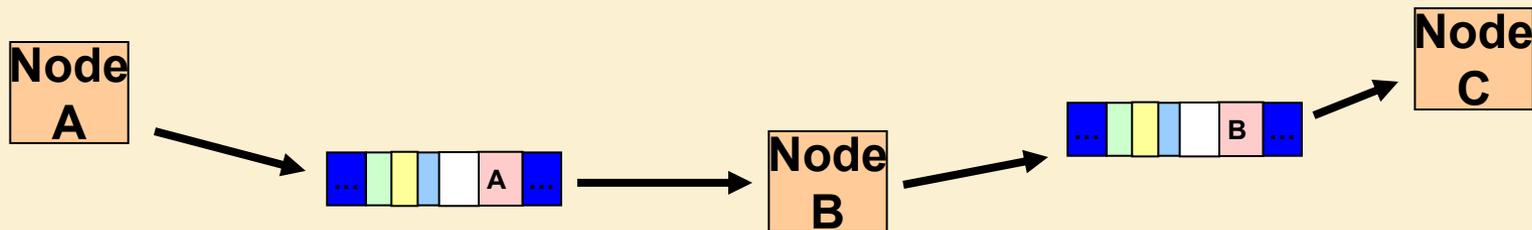
- **Overview and explanation of Bundle Protocol extensions for non-custodial multicast**

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Previous Hop Extension Header specification

- **Defines a Bundle Protocol extension header**
- **General capability (not specific to multicast)**
- **Header inserted into bundle by forwarding node**
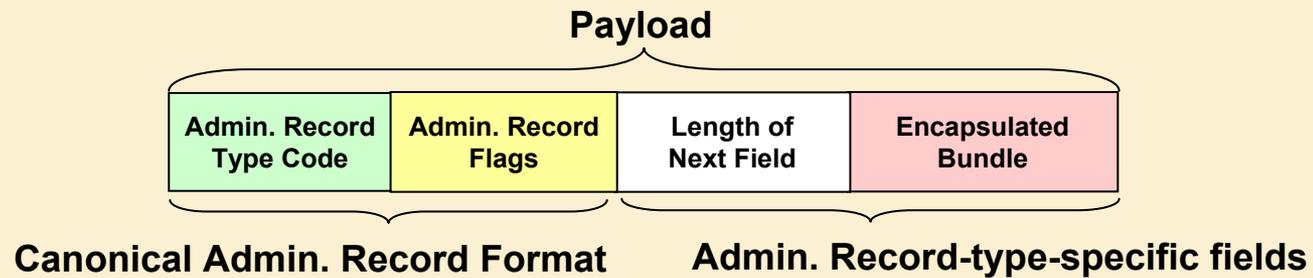- **Contains the Endpoint ID (EID) of the forwarding node**

Previous Hop Extension Header format

Type	Flags	Length	Length of EID	EID

Canonical Header Format   **Header-type-specific fields**

- **EID made available for use at the receiving node (e.g., as input to forwarding decisions)**

Node A → Node B → Node C

- **Header stripped out of bundle by receiving node**

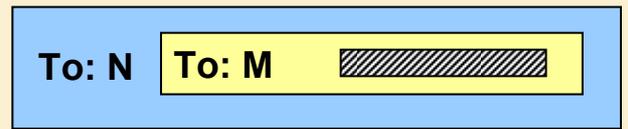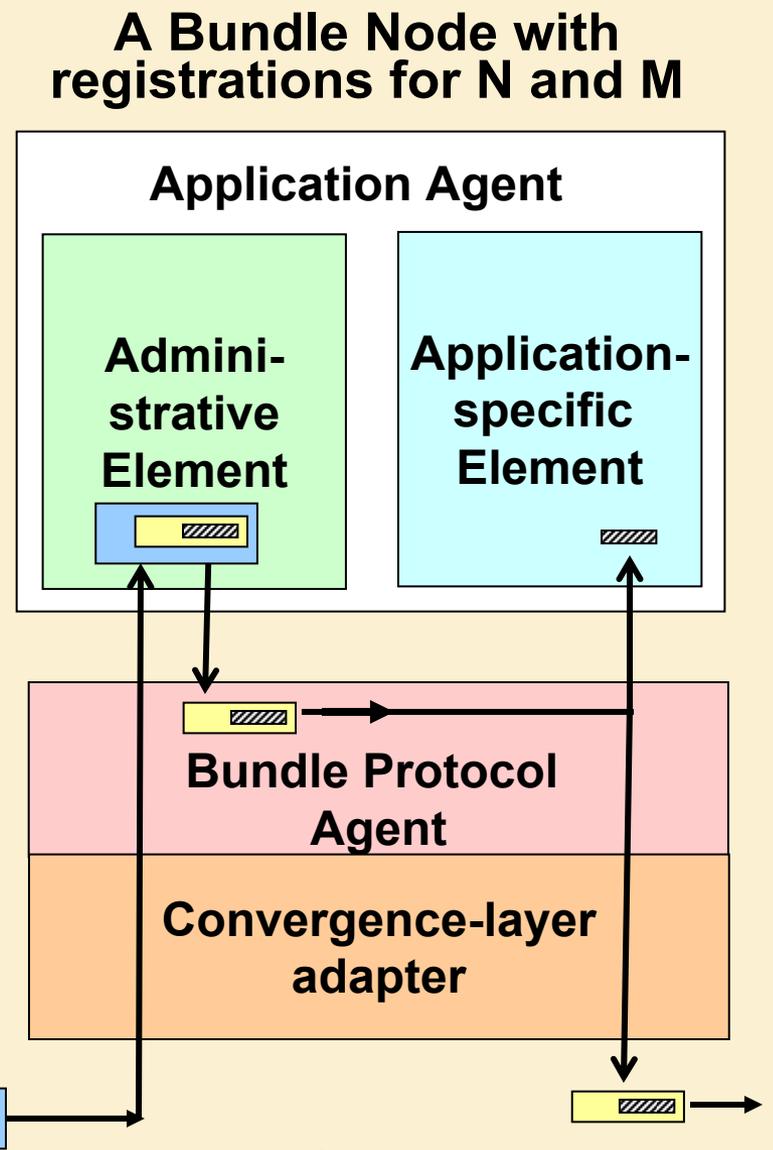**MITRE**

Bundle-in-Bundle Encapsulation

- **Defines a new administrative record type**

- **General capability (not specific to multicast)**

- **A mechanism for transmitting one bundle as part of the payload of another bundle**

Payload

Admin. Record Type Code	Admin. Record Flags	Length of Next Field	Encapsulated Bundle

Canonical Admin. Record Format   **Admin. Record-type-specific fields**

- **Bundle is delivered to Administrative Element of destination node's Application Agent (AA)**

- **Administrative Element extracts encapsulated bundle and passes it to Bundle Protocol Agent**

- **BPA processes encapsulated bundle as if it had just been received from another node**

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Receipt and Processing of an Encapsulated Bundle

- **Most bundles are delivered to the application-specific element of the Application Agent (AA); but bundles with application data units that are administrative records are delivered to the administrative element of the AA.**

- **Encapsulated bundles must be delivered to the administrative element of the AA because the administrative element implements the de-encapsulation procedures.**

A Bundle Node with registrations for N and M

Application Agent

Admini-strative Element

Application-specific Element

Bundle Protocol Agent

Convergence-layer adapter

To: N To: M

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Non-Custodial Multicast Extensions (normative)

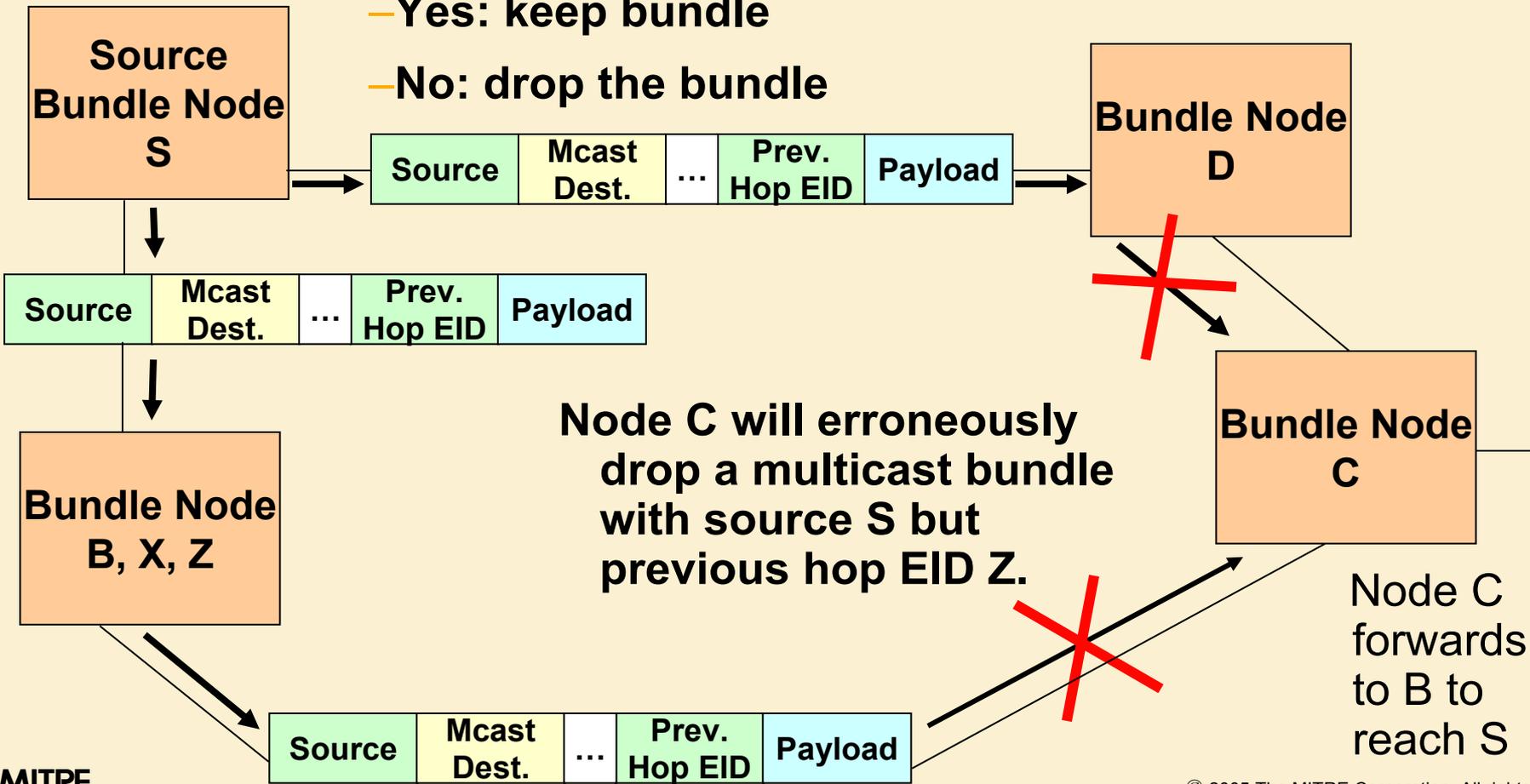- **Defines four extensions that may be required to support non-custodial multicast delivery; the exact profile of extensions required to support multicast in any situation depends on:**

  - **The multicast routing protocol being used, which**

    - **May require Previous Hop Identification**

    - **If so, will require unique identifiability of nodes**

  - **The capabilities of other nodes in the network, e.g., whether they implement the required extensions and whether they participate in the same multicast routing protocol as their adjacent nodes, will determine a need for**

    - **Bundle-in-Bundle Encapsulation**

- **Local Policy must be able to override bundle status reporting (no matter what)**

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Importance of
Unique Identifiabilty of the Previous Hop

Reverse Path Forwarding (RPF) check:

**Is the Previous Hop EID the EID that I would forward to to send to the source?**

- **Yes: keep bundle**
- **No: drop the bundle**

Source Bundle Node S

Source	Mcast Dest.	...	Prev. Hop EID	Payload

Bundle Node D

Source	Mcast Dest.	...	Prev. Hop EID	Payload

Bundle Node B, X, Z

Node C will erroneously drop a multicast bundle with source S but previous hop EID Z.

Bundle Node C

Source	Mcast Dest.	...	Prev. Hop EID	Payload

Node C forwards to B to reach S

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Use of Bundle-in-Bundle Encapsulation to Deliver a Multicast Bundle Through the Overlay
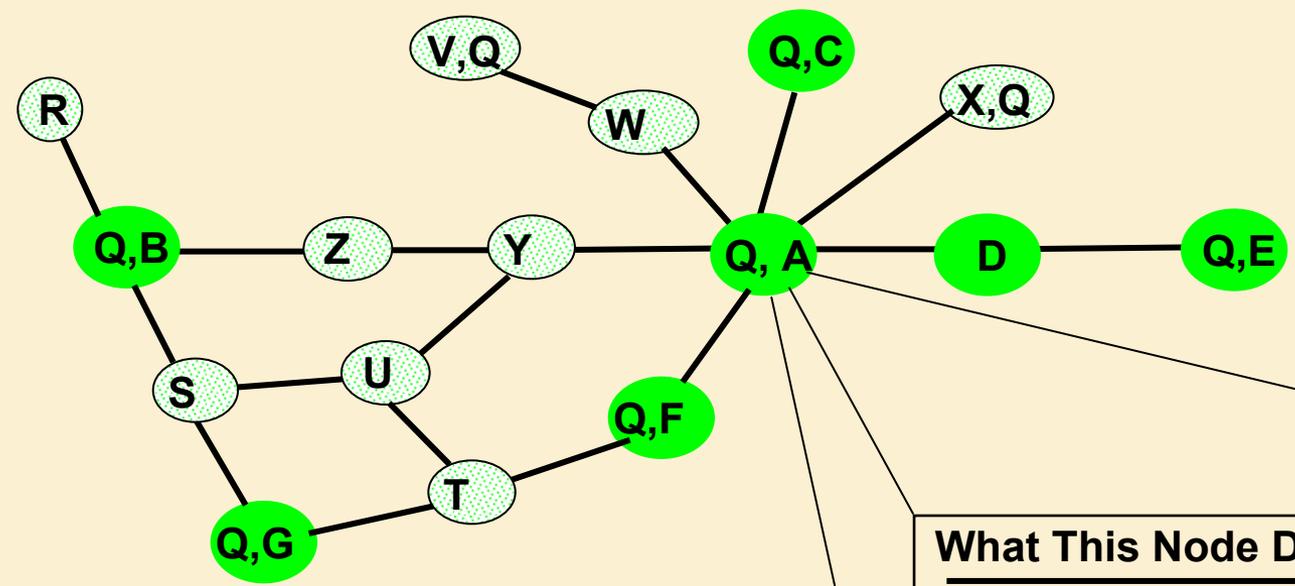
Q is a multicast EID

All other letters are singleton EIDs

What This Node Does With Bundles for Q

– Deliver

– Forward to nodes C, D, and F

– Encapsulate and tunnel to node B

– Static route to node X

Q, A = multicast-capable node participating in a multicast routing protocol with registrations for EIDs Q and A

V, Q = non-multicast-capable node (not participating in multicast routing protocol) with registrations for EIDs Q and V

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Why local policy must be able to override status reporting…
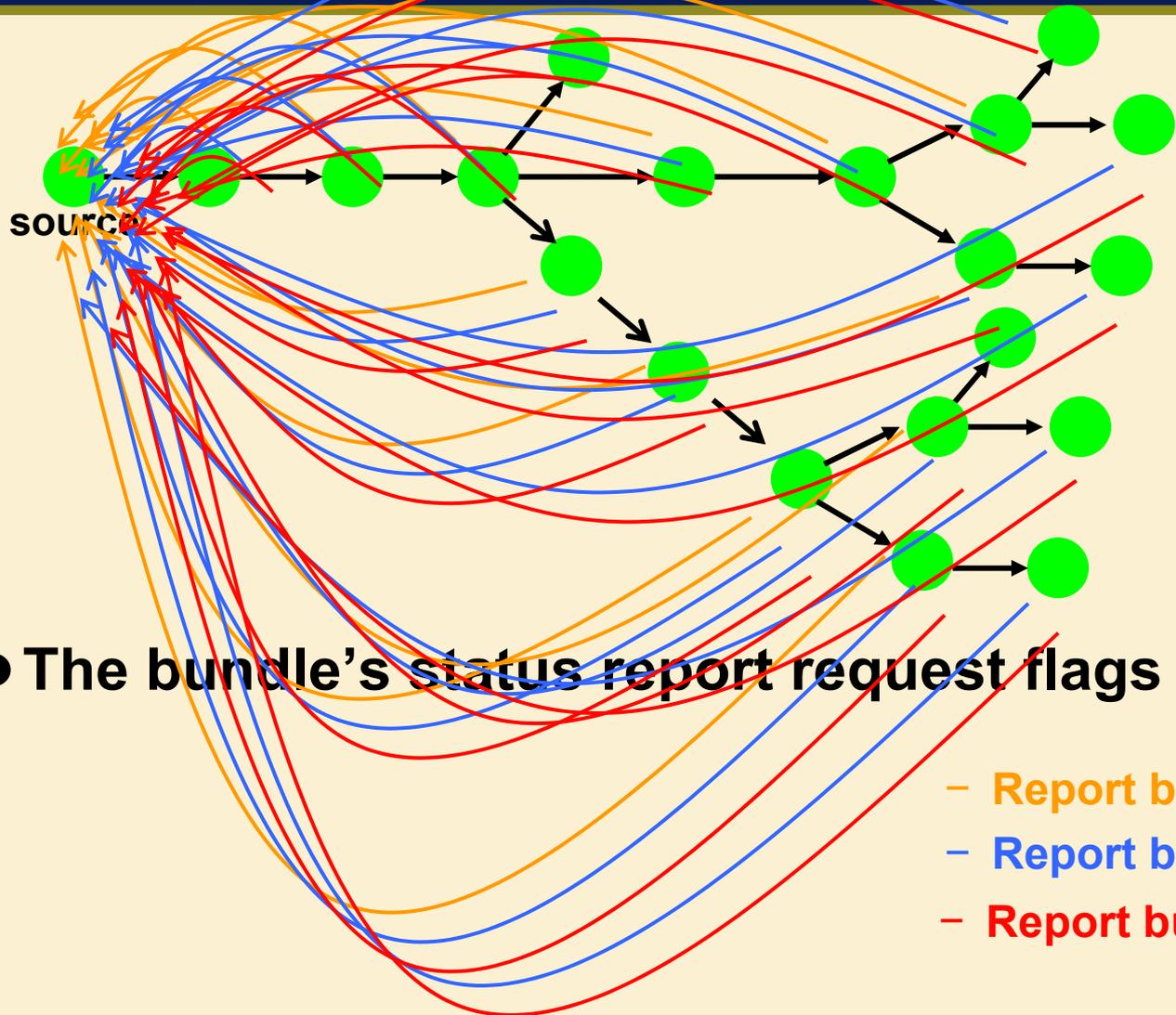
- **The bundle's status report request flags may request:**

  – **Report bundle forwarding**
  – **Report bundle reception**
  – **Report bundle delivery**

May want to define an approach to rate-limit or aggregate reports.

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Open Issues

- Supporting custody transfer of multicast bundles

- Group membership and Temporal Semantics (W. Zhao, M. Ammar, E. Zegura)

- Multicast routing protocols not yet defined for DTN

- Security protection for multicast bundles

- What is a "multicast-capable" node ?

  - Implements all four (or just required?) multicast extensions

  - Has the information needed to forward multicast bundles

    - Runs a multicast routing protocol w/ adjacent nodes, or

    - Has static/manual routing for all multicast addresses

  - If some nodes can't forward multicast bundles, encapsulation is a required capability

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Future Work

- **Publish the four internet drafts just described for supporting non-custodial multicast**

- **Create a separate specification that defines support for Custodial Multicast**

- **Custodial Multicast items to be addressed:**
  - Non-custodial branching points
  - Tracking the custody status of individual bundle copies
  - Aggregation of custody transfer signals along the reverse path to avoid implosion at the source
  - The capability to retransmit a multicast bundle over only part of the original distribution path
  - Distributed storage of multicast bundles for transmission to late-joining nodes

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