Forwarding Information Base for MANET Multicast

Lessons Learned from SMF

96th IETF MANET
Background - SMF

Simplified Multicast Forwarding (SMF)

• MANET Multicast (broadcast) protocol.

• Packets are disseminated to the entire MANET.
  – Duplicates are eliminated (no loops).
  – Optimized through use of Connected Dominating Set (CDS).

• Very efficient in small, highly dynamic mobile networks.

• Not intended to scale to large networks.
Background – SMF Shortcomings

• Design results in implementations in user space = poor performance
• Packets are disseminated to the entire MANET
• No knowledge of group membership
• CDS algorithms do not support multiple interfaces well
  – Appendix algorithms are all/none forwarding on all interfaces
• Forwarding rules are not well defined for multiple interfaces
  – DPD per interface? Incoming/outgoing?
  – DPD method managed manually
    • Hash based vs ID based
nrlsmf Functions

• MANET interface support
  – Duplicate packet detection
  – Supports S-MPR/ECDS/Classical forwarding
  – Multi-interface support (limited algorithmic control)
• Gateway support
  – Forced relaying of multicast packets across and among multiple interfaces.
  – Resequencing or packet marking for external flows injected into MANET/SMF areas
• “Remote control” interface allows external processes to control nrlsmf forwarding.
• Packet marking and resequencing for source hosts.
The Current nrlsmf Architecture

Note: A "Smf::Interface" may "associate" with itself for MANET interface forwarding
Separation of Forwarding/Control Plan in the Design

- Control Plane (e.g., user space)
  - Routing Control (e.g., arouted, nhdp, etc)
  - Control Interface API (e.g., netlink, etc)
- Forwarding Plane (e.g., kernel)
  - Forwarding Engine (e.g., SMF)
  - Forwarding Information Base

Forwarding Engine (e.g., SMF)
Current SMF Design

- NHDP
- MIB API
- SMF Management
- Undefined Algorithm Control API
- Undefined Forwarding State
- SMF
- Duplicate packet detection
- Interface Algorithm State
- Interface 1
- Interface 2
- Interface n
Next Generation MANET Multicast FIB Based Design: a cleaner approach

Algorithmic Control Process
- NHDP (SMF enabled)
- Static Management
- Dynamic Routing

Standard FIB API Control Channel
- Forwarding Information Base
- Duplicate Packet Detection
- Source-Destination-Flow-Interface Forwarding State

Filter
- Interface 1
- Interface 2
- Interface n

SMF Management

MIB API
Future - Elastic Multicast
FIB Design should support

• Dynamic pruning of SMF relays for specific group memberships
• Converges to single path multicast trees in stable networks
• Expands to full network flood in highly dynamic networks
  – Dynamic expansion/reduction in forwarding
• Maintains no topology or global membership information
• Relay set reduction applied to higher bandwidth traffic
  – Flow based reductions
• Lower bandwidth traffic still flooded to the entire MANET
Elastic Multicast
Control/Forwarding Interaction

flow_forwarding_status
(based on configured policies, membership, and ACKs)

flow_activity_status
(active, idle)
Flow vs. Generalized Forwarding

• What do I mean by Flow?
  – Packets identified by
    • Destination
    • Source
    • Port
    • Protocol
    • Incoming interface
  – Forwarding rules based on largest match
    • Supports pruning
    • Supports group based joins
    • Supports general dissemination rules
    • Can reduce redundant rebroadcasts

• Current SMF algorithms only specify On/Off forwarding on all interfaces for ALL multicast
Just Forwarding?

• Current *nrlsmf* implementation doesn’t just do forwarding on matching packets....
  – Forward
  – Limited (rate limited)
  – Hybrid (fixed forward then drop)
  – Drop
  – Queue
  – Error
FIB API should NOT be unidirectional

• Algorithmic controllers should be able to be notified of new flows
  – Perform algorithmic duties (i.e. send control messages etc.)
  – Update the FIB
MANET FIB for just Multicast?

• A “MANET Multicast FIB” useful for supporting multiple multicast approaches
  – Elastic Multicast
  – On Demand MANET Routing Protocol

• A “MANET FIB” could be part of a more generalized MANET approach in support other protocols
  – On-demand protocols
  – Network Coding

• A “MANET Multicast solution” would need to consider additional things including group management and gateway to existing infrastructure network multicast protocols
struct mfc_cache {
    struct mfc_cache *next;  /* Next entry on cache line */
    #ifdef CONFIG_NET_NS
    struct net *mfc_net;
    #endif
    __be32 mfc_mcastgrp;  /* Group the entry belongs to */
    __be32 mfc_origin;  /* Source of packet */
    vifi_t mfc_parent;  /* Source interface */
    int mfc_flags;  /* Flags on line */

    union {
        struct {
            unsigned long expires;
            struct sk_buff_head unresolved; /* Unresolved buffers */
        } unres;
        struct {
            unsigned long last_assert;
            int minvif;
            int maxvif;
            unsigned long bytes;
            unsigned long pkt;
            unsigned long wrong_if;
            unsigned char ttls[MAXVIFS]; /* TTL thresholds */
        } res;
    } mfc_un;
};