Requirements for Network Collaboration Signaling

draft-kwbdgrr-tsvwg-net-collab-rqmts-01

Authors: John Kaippallimalil, Dan Wing, Sri Gundavelli, Sridharan Rajagopalan
Spencer Dawkins, Mohamed Boucadair

IETF 120 Vancouver, July 2024

Why This Document?

- Several proposal were made to the WG about collaborative host/network signaling for the last two years, e.g.,
  - draft-kaippallimalil-tsvwg-media-hdr-wireless
  - draft-rwbr-tsvwg-signaling-use-cases
  - draft-herbert-host2netsig

- As an ***outcome of IETF#119***, the authors of various I-Ds were invited to collaborate and propose ***a single base document to help the WG understand the need and identify a set of requirements***

Collaborative Signaling: Rationale

- In order to ***enhance the perceived quality of experience*** of services delivered via a network, each entity is making enhancements within their administration scope

- That approach may ***reach its limits***
  - Heuristics may be suboptimal
  - There is no direct/explicit view on the implications of local decisions on others (e.g., aggressively solicit network resources, negative impact on application performance)

- A more ***collaborative approach is worth investigating***
  - Optimal and coordinated use of domain/layer-specific optimization
  - Supply information to ease enforcing optimization tasks
  - Clients can express their preferences, not only servers
  - Clients control which data to share/expose

Overview of draft

Media streaming, interactive media, user preferences, mixed traffic

Network, application considerations common to both H2N and S2N

Network, application considerations for H2N

Network, application considerations for S2N

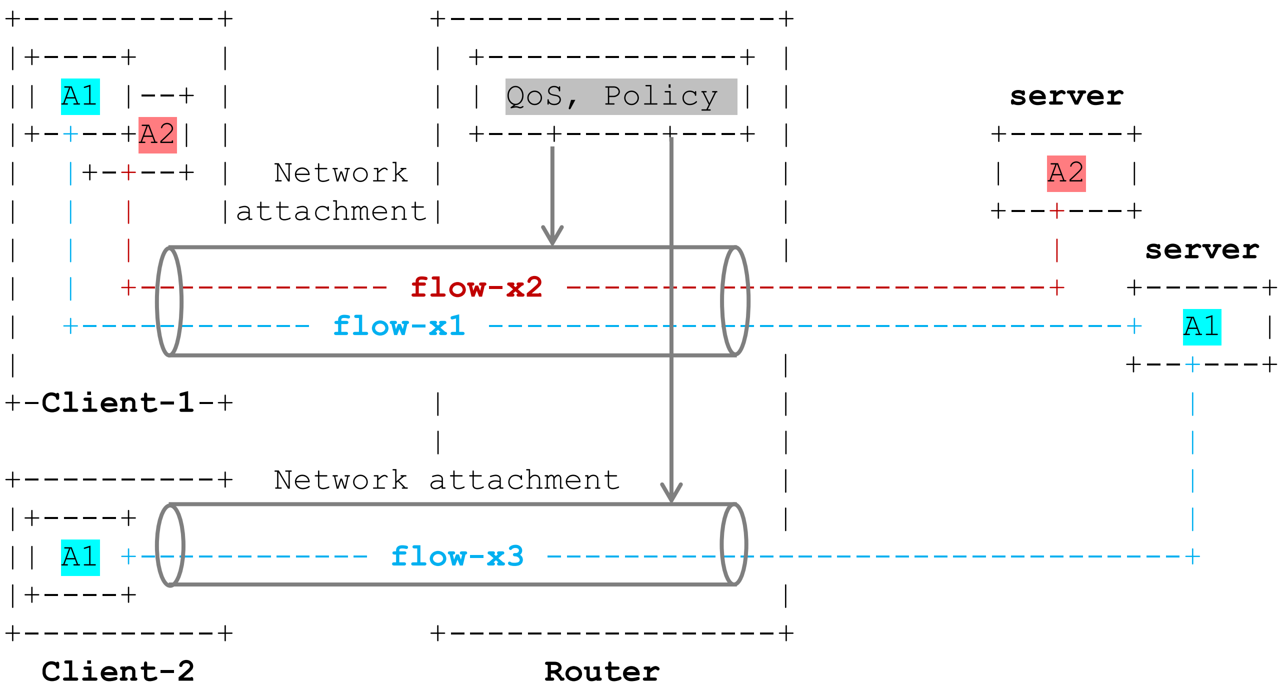
E2E System and Access network Bottlenecks

```
           3GPP/mobile network
+--------------------|----------------------+
|+-- ---+            |   +------+   +------+ |
||client+-----------(B)--+radio+----+ UPF  | |
|+-------+           |   +------+   +--+---+ |
+--------------------|-----------------|----+
                     |                 |
          Wireless home/ISP network    |
+--------------------|-----------+     |    |          |
|+--- --+    +-----+ |  +-------+ | +---+---+ | +-------+ | +-------+
||client+-(B)+WLAN+-(B)-+router+---+router+---+router+---+server|
|+-------+    +-----+ |  +-------+ | +-------+ | +-------+ | +-------+
+--------------------|-----------+           |           |
                     |                       |           |
                     |                       | Transit   |  Content
 User device/Network |    MNO/ISP Network    | Network   |  Network
```

- *Variations* in wireless *link quality* (channel conditions, user movement, etc.) in short intervals of ~1 ms or less
- Bandwidth constraints due to the number of concurrent users or *exceptional overload* events
- Interactive media can require *both high throughput and low latency*
- Traffic *patterns* in some emerging applications can vary significantly during the session (live media, AI-generated content)
- Network has limited means to enforce reactive policies and accommodate the need of a packet (implicit signals were used previously)

An explicit signal from the application can provide additional information to handle packet(s)
Such signals DO NOT need to reveal application or server identities

Network Attachments and Transport Flows



- Figure shows network QoS, Policy applied to a "network attachment"
  (note: control signaling/negotiation of capabilities and policy for that "network attachment" is not shown here.)
- One or more flows *coexist* in a "network attachment" (e.g., flow-x1, flow-x2)
- Flows that belong to a "network attachment" have the same subscription policies
- Networks may also shape distinct flows within the "network attachment" differently based on additional criteria
  (e.g., a high bandwidth flow may be shaped to provide better overall QoS for a set of flows within the policies)

Use Cases

3.1 Media Streaming

I-frame containing a full video frame should have higher priority.
Audio frames and video frames may be encoded separately
Client should be able to decide if audio (or video) is more critical

3.2 Interactive Media

Media that a user can engage with (i.e., input/response etc. can be highly delay sensitive).
Client indicates that a flow is interactive and request the network to honor incoming flow's per-packet signals.
(e.g., eXtended Reality (XR), VoIP (P2P, group conferencing)

3.3 User Preferences

A game or VoIP application may want to signal different metadata for the same type of packet in each direction (e.g., keystrokes to server)

3.4 Mixed Traffic

Multiple types of data (streams) flowing through the same 5-tuple connection (e.g., digital model of real world, desktop/apps, multimedia, interactive engagement). All packets of a stream should be treated in the same manner.

3.5 Honoring Metadata for Servers behind a Gateway

Servers in enterprise networks (and remote desktop use case) are exposed to the internet via a gateway-proxy and QoS signaling (DSCP) is often ignored. Client may use explicit signaling to server in this case.

Operational Considerations

4.1 Policy Enforcement (i.e., metadata hints from network to client to adjust behavior)

4.2 Redundant Functions and Classification Complications (i.e., preference for signaling over side channel of flow)

4.3 Metadata scope (i.e., network does not generally allocate a quota per application/stream/flow.)

4.4 Multiple Bottlenecks (i.e., more than one /changing bottlenecks over a path)

4.5 Application Interference (e.g., apps behind home GW, one of which has resource-quota may not be fair to the other)

4.6 Privacy (Metadata contains no additional info on content, user, application id. No inspection of encrypted payload)

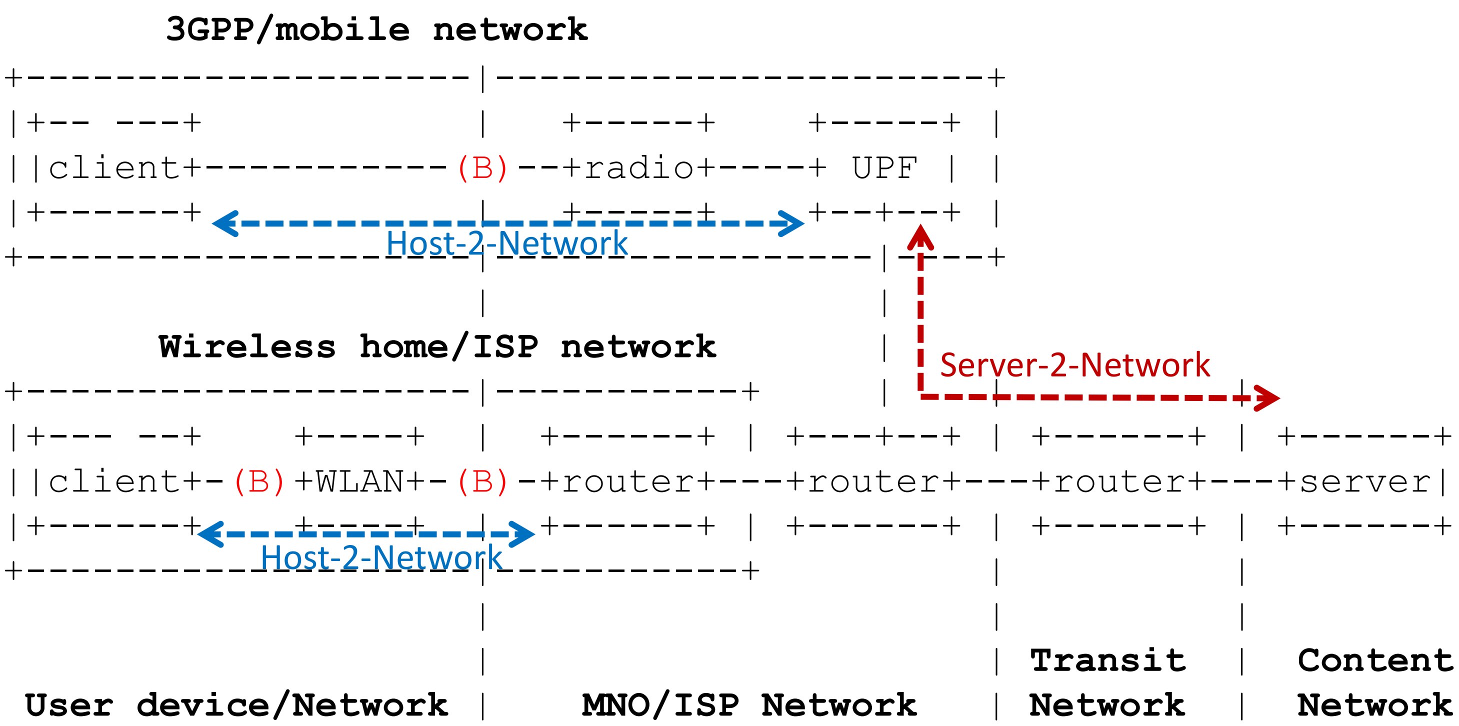
4.7 Scalability (metadata processing in networks should not require per-flow information)

4.8 Session Continuity (metadata should provide same service level following handover)

4.9 Abuse and Constraints (not every flow can be prioritized; needs client and network validation)

The efficiency and benefits that can get out of explicit signals depend whether operational considerations are taken into account in the design

Host-Network and Server-Network Metadata



- Host -> network, network -> host and server -> network requirements.
- Not necessary that all the requirements are addressed in one solution.

Host <-> Network Requirements

5.1 Host - Network Metadata

5.1.1 Priority between flows (Inter-flow)

Some flows are less important than other flows of ***the same host***.
Without explicit signaling from h2n, servers/remote peers may mark its packets as most important.
Solving inter-flow (de)prioritization is out of scope of this document due to complex challenges.

5.1.2 Priority within a flow (intra-flow)

Some streams (video, audio) in a transport flow are more/less important than others depending on the application.

5.2 Network - Host Metadata

5.2.1 Assisted Offload

Network seeks to change resource during "crisis" or other conditions when normal resources cannot be used to max.
N2H signals are useful to place adequate traffic distribution policies on the host (e.g., prefer alternate path, offload)

5.2.2 Network Bandwidth & Network Rate Limiting Policies

Bandwidth constraints because of rate limiting.
N2H mechanism to signal available network throughput to hosts.

Server-Network Requirements

5.3.1 Identification of Media Frames and Streams
Indicate start/end of frame, or a group of packets to be treated in the same manner.

5.3.2 Identification of Traffic Type without disclosure of the application
Indicate nature of packet as reliable/loss-tolerant, bulk/interactive.

5.3.3 Relative priority
Relative importance of a media frame or group of packets over another within the transport flow.

5.3.4 Tolerance to Delay
Indicate if the media frame, or group of packets can tolerate additional delay

5.3.5 Burst Indication
Size of a burst of packets arriving at the radio/access network to allow the network to reserve sufficient resources, or for the radio to sleep (e.g., C-DRX).

Next Steps

We request adoption by the WG as a basis for work on solutions:

- Problem has been presented at IETF 116, 117, 118 and 119
  (IETF 116: adapting for rapid resource change in wireless; IETF 117: metadata, transport details, ..
  IETF 119: combine H2N and S2N requirements)
- Considerable discussion of solution at TSVWG mailing list
  (UDP transport/network options, IPv6 HBH, efficiency, fragmentation)
- There is interest in the group for solutions in this space.
  (26 participants in IETF#119 indicated that this problem was worth addressing)