3GPP TSG RAN Rel-18 Workshop RWS-210040
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Agenda Item: 4.3

SDAP Enhancement for Low Latency High Throughput Communication

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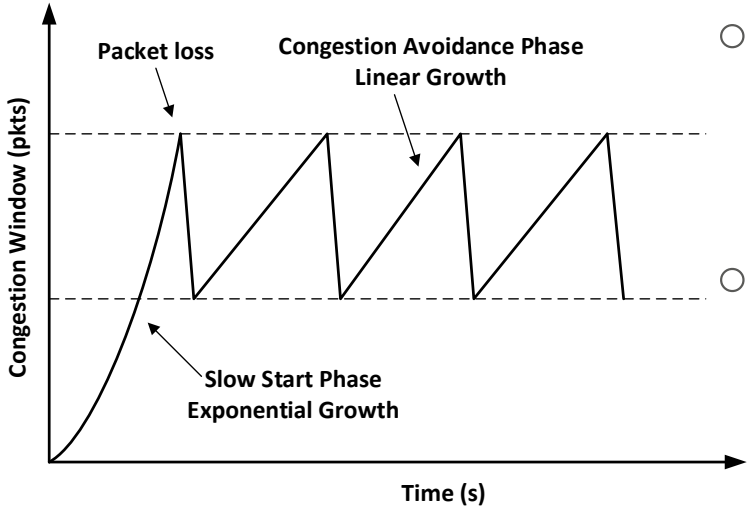
Increasing Need of Application Oriented QoS Control

- QoS parameters are QoS flow based
  - Resource type (Non-GBR/GBR/Delay-critical GBR), data rate (GFBR/MFBR), packet delay budget, averaging window, Maximum Data Burst Volume (MDBV), survival time, etc;
- QoS control needs to adapt to traffic burst and fast changing channel conditions
  - MDBV for delay-critical service, and survival time for Time Sensitive Communication (TSC);
- Applications act differently to data rate and RTT as transmission time/volume evolves;



  - TCP slow start and congestion avoidance, TCP ACK prioritization (head-of-line-blocking) and suppression;
  - AR/VR/XR, interactive gaming, and remote control require low latency and high throughput at the same time

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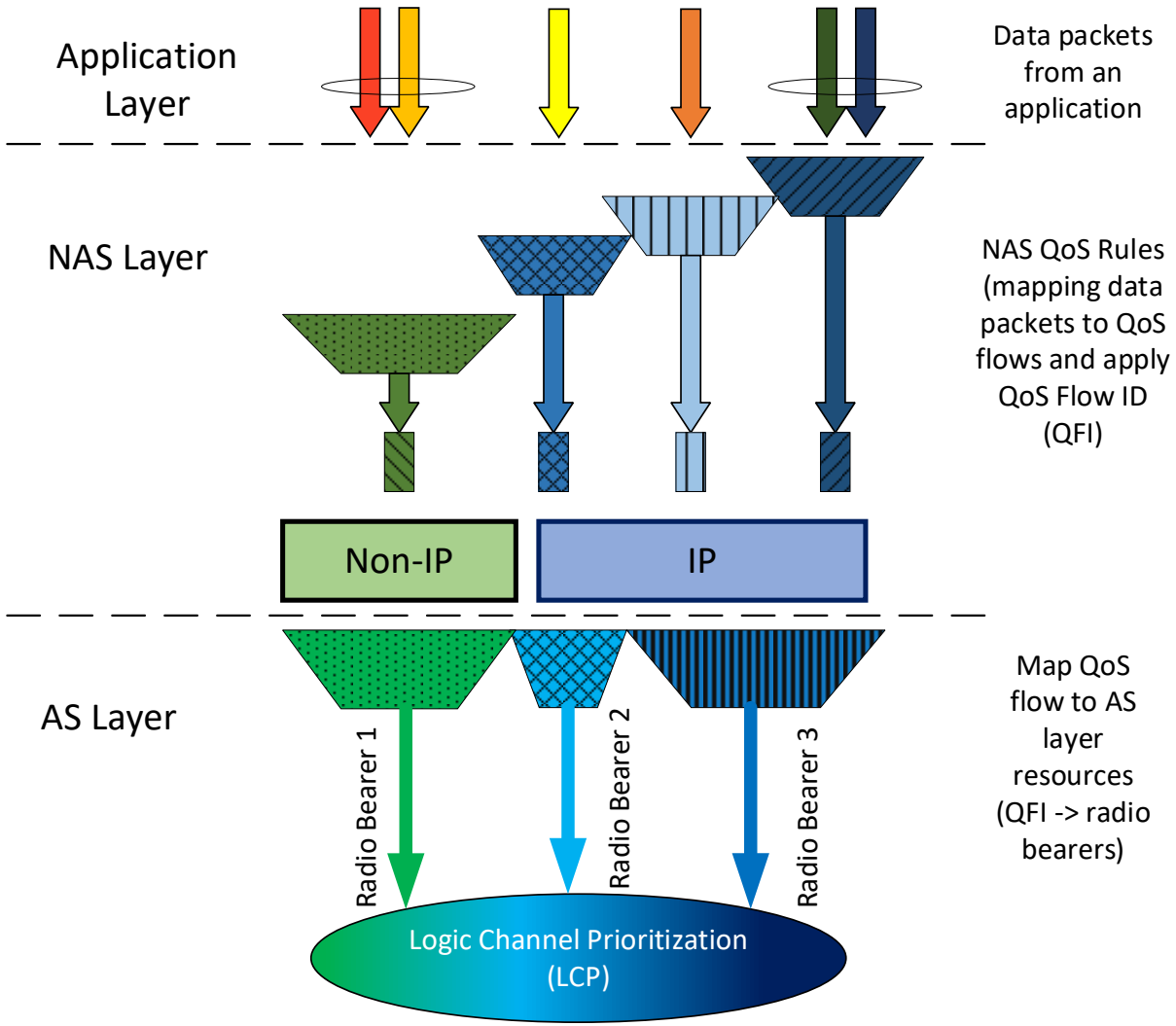
Current (R15/R16/R17) QoS Control Framework

- NG-RAN and 5GC perform QoS control by mapping packets to appropriate QoS flows and DRBs
  - NAS level packet filters in the UE associate UL packets with QoS flows;
  - AS level mapping rules in the UE associate UL QoS flows with DRBs.
- DRB defines the packet treatment on the radio interface
  - A DRB serves packets with the same packet forwarding treatment;
  - Multiple QoS flows may be mapped to 1 DRB.
- Logical Channel Prioritization (LCP) at MAC sublayer controls the radio resource allocation among DRBs in an uplink grant.
- RRC signaling configures QoS flow to DRB mapping and LCP operation semi-statically.



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Issues of Current QoS Control Framework

- RAN can't directly enforce flow based QoS control
  - unless configuring DRB per QoS flow, MAC doesn't have visibility of a QoS flow and its traffic burst;
  - unless configuring DRB per QoS flow and DRBs on separate cells, MAC doesn't have means to enforce data rate and latency per QoS flow.
- RAN can't adapt UL resource allocation to traffic burst of a QoS flow
  - Adjusting LCP operating parameters dynamically at MAC is challenging under tight processing timeline.
- Large layer-2 (RLC/PDCP) buffer in NR for high data rate introduces queuing delay
  - UL grant and LCP operations only prioritize the resource allocation among DRBs;
  - No queue management mechanism to achieve bounded latency for a DRB.
- Lack of interaction with application layer for rate adaptation
  - Many multimedia applications are designed to adapt to scalable throughput.

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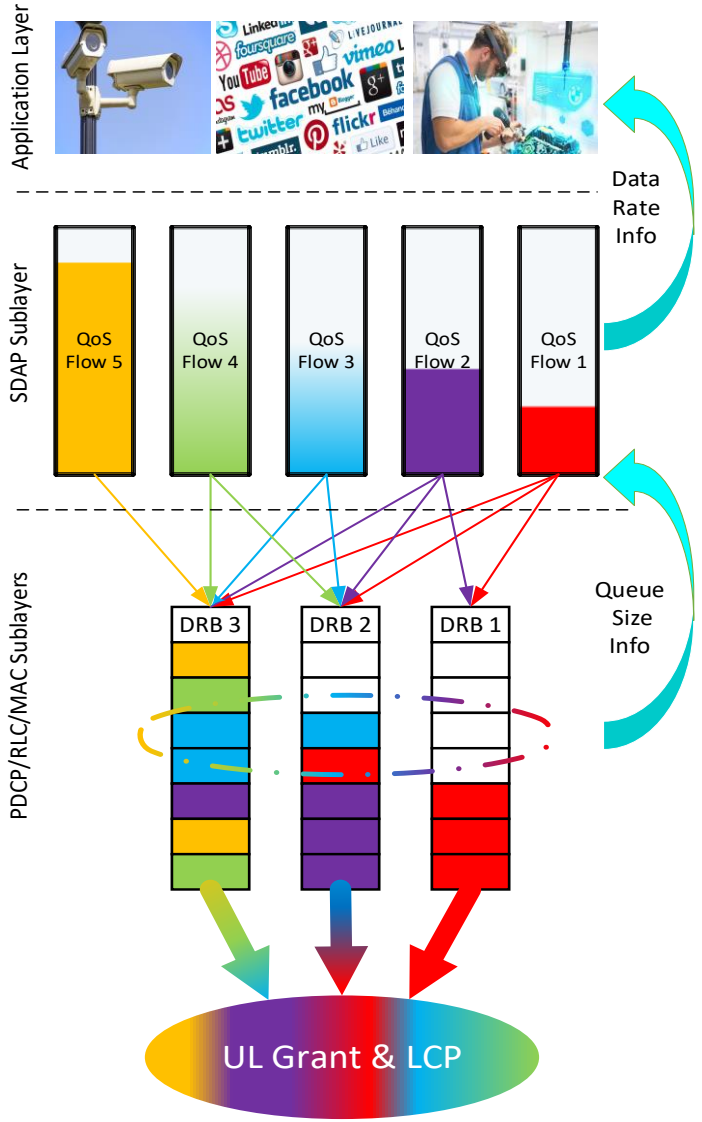
SDAP Enhancements



- Flow based QoS metrics measurement
  - Data volume, average window for GFBR/MFBR, MDBV, Slice-MBR, etc.
- Active queue management of DRBs
  - To control queue size on DRB reserved for latency critical traffic.
- 1:M flexible and dynamic mapping from QoS flow to DRBs
  - Steering traffic burst based on DRBs' queue status for bounded latency and guaranteed data rate;
  - Opportunistically increasing date rate of a QoS flow, e.g., over MCG bearer and SCG bearer.
- Congestion condition exposure to rate-adaptive multimedia applications
  - Scalable throughput without packet dropping.

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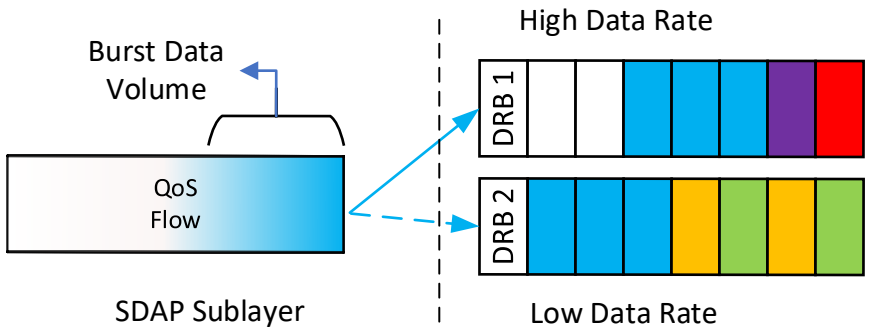
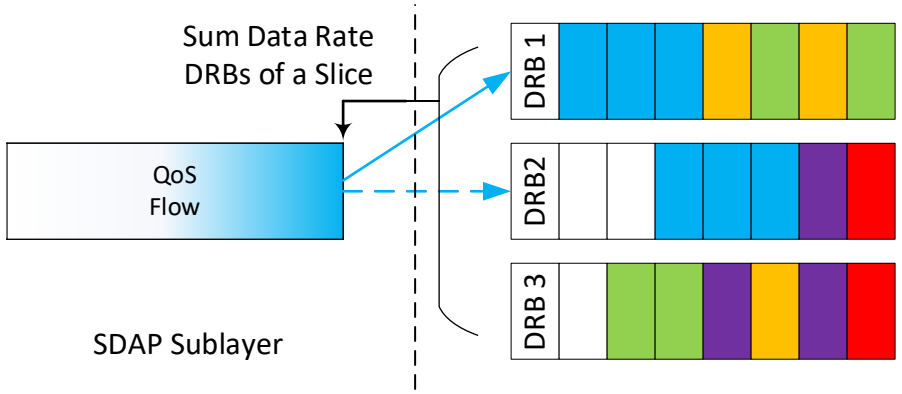
Use Case 1: Support of MDBV and SMBR

- Mapping of a QoS flow to DRB is adjusted dynamically based on the amount of data delivered in certain period of time.
- MDBV is enforced by switching the QoS flow from a DRB of high data rate, which meets MDBV requirement, to a DRB of low data rate for transmission of data exceeding the configured MDBV threshold.
- Slice MBR is enforced by holding packets of a QoS flow from being delivered to DRBs, if the sum of data rates of DRBs of the involved slice exceeds the S-MBR threshold.

Enforcement of MDBV



Enforcement of Slice MBR



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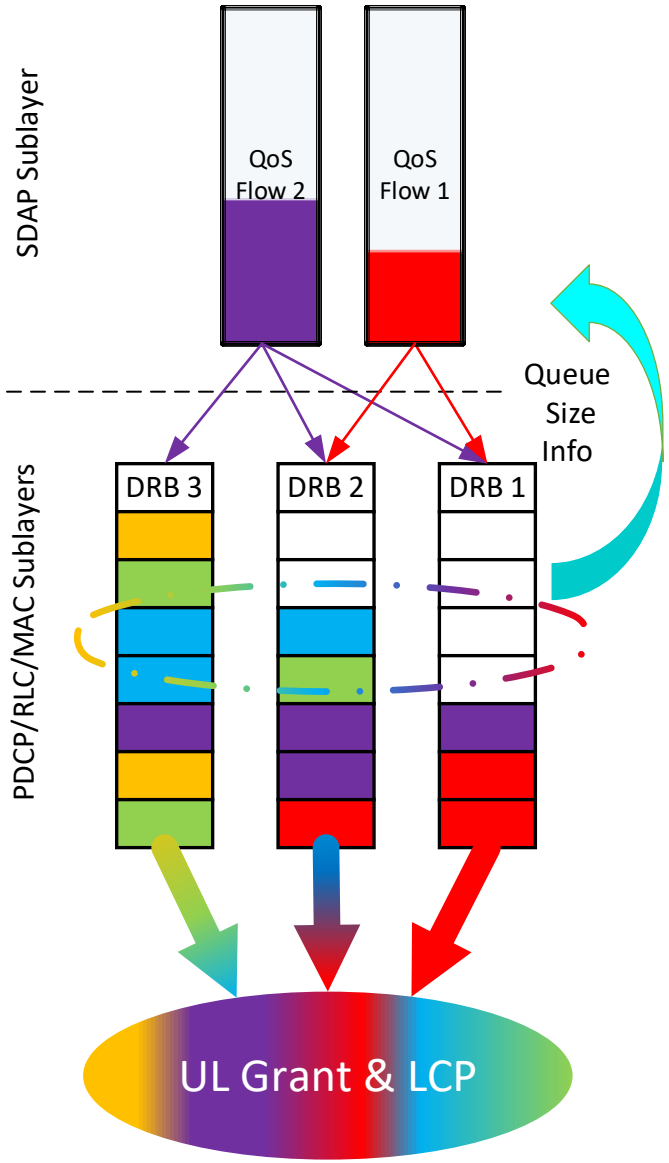
Use Case 2: Bounded Latency, High Data Rate



- Active queue management is performed by SDAP entity on DRBs
  - If a maximum queue size is configured for a DRB, packets of QoS flows are not to be delivered to the DRB when its queue is full;
  - Maximum queue size is configured by RAN to make sure that the last packet in the queue can still meet the latency requirement, under its scheduling and LCP operation;
  - Queue size is measured as the data volume in MAC/RLC/PDCP entities of a DRB, and it is equivalent to the sum of buffer status of the corresponding logical channels.
- A QoS flow of high data rate is mapped to multiple DRBs
  - Packets of the QoS flow are delivered to DRBs, whose queue has room (or if the DRB is not configured with maximum queue size);
  - QoS flows are configured with priorities, which determine their order to deliver packets to a queue.

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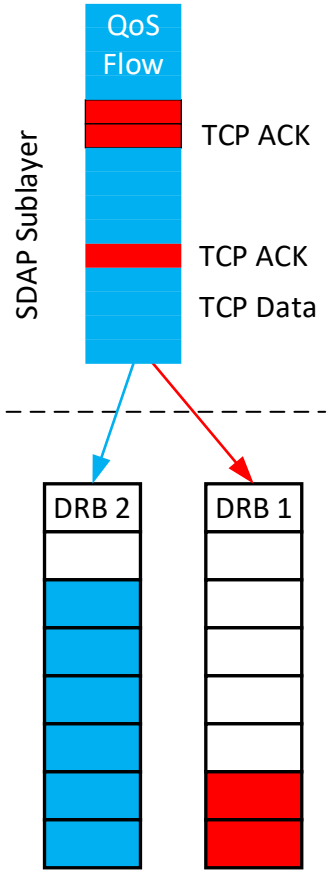
Use Case 3: TCP Performance Enhancement

- DL TCP throughput is maximized by prioritizing UL TCP ACK over normal data
  - TCP ACK is mapped to DRB of low latency, high reliability, and abundant data rate;
  - Head-of-line blocking is avoided by mapping normal data to a different DRB;
  - Packet size may be used to determine the DRB to be mapped to;
  - Consecutive TCP ACKs may be delivered only selectively, e.g., the last ones, or last-in-first-out to reduce UL overhead.
- Similar handling may be applied to other transport layer internet protocol
  - Rules may be configured by RAN to map packets of a QoS flow to multiple DRBs.



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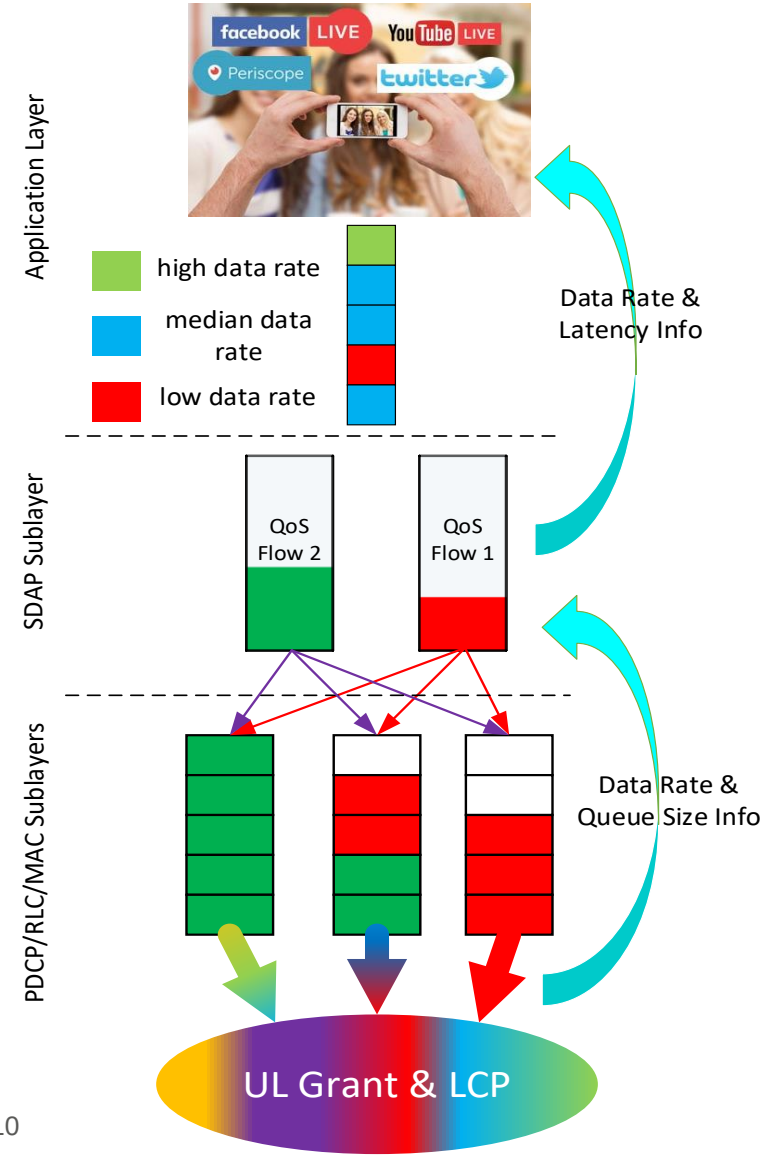
Use Case 4: UL Adaptive Streaming



- Congestion condition exposure to rate-adaptive multimedia applications
  - SDAP collects data rate and queue size information of related DRBs;
  - SDAP reports data rate and latency information of corresponding QoS flows to application layer.
- Scalable throughput without packet dropping
  - Timely update of link condition without incurring RTT in system;
  - More prompt response of applications to UL grant and LCP operation in traffic shaping;
    - ✓ Adjusting data volume of payload according to the allocated radio resource.
  - Less demand of buffering application data on UE.

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Work Item Scope

- Flow based QoS metrics measurement and enforcement
  - data volume in a configured time window;
  - transmission queue size and delivery latency;
  - experienced data rate and reliability.
- Active queue management of DRBs
  - Configurable maximum queue size per DRB;
  - Queue size is measured as the data volume in MAC/RLC/PDCP entities of a DRB, and it is equivalent to the sum of buffer status of the corresponding logical channels;
  - Latency of a DRB is bounded by not exceeding maximum queue size when QoS flow to DRB mapping is performed;
  - Mapping priority per QoS flow to control the order to deliver packets to a DRB's queue.
- N:M mapping from QoS flow to DRBs
  - A QoS flow may be mapped to multiple DRBs;
  - Dynamic switch of a QoS flow to different DRBs to reserve premium DRB for prioritized traffic, while using regular DRB for normal traffic;
  - Steering data burst dynamically based on DRBs' queue status to control latency;
  - Increasing date rate of a QoS flow by opportunistically spreading traffic over multiple DRBs, e.g., over MCG bearer and SCG bearer.

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