3GPP TSG SA4 Video SWG post 111-e
December 2020

S4aV200607
Agenda Item 4.13

Cloud Gaming & XR Traffic Model

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Introduction

- **Goal:** To identify realistic traffic models for CG & XR Applications

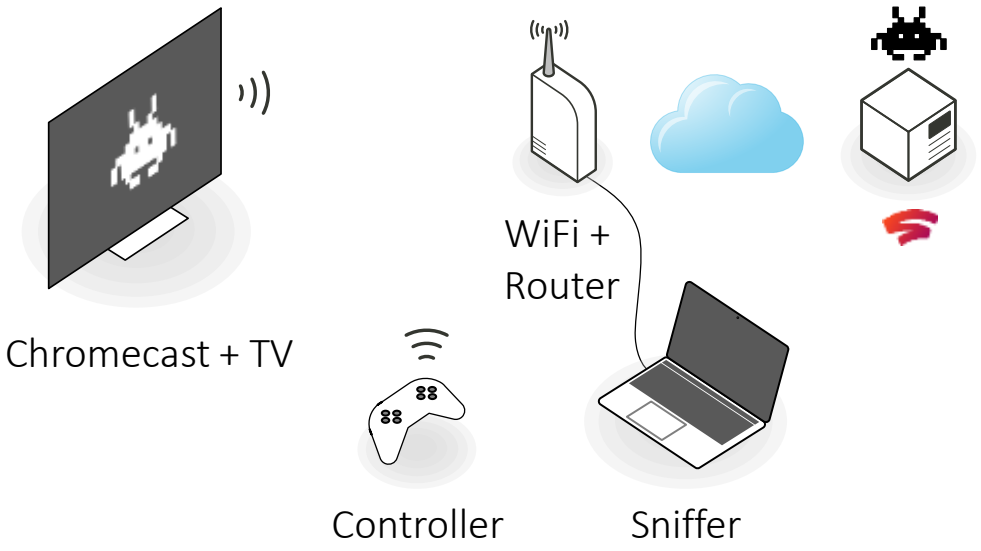
- **Methodology:** measurements derived traffic models
  - Overall measurement framework
  - Different gaming platforms: Stadia, GEFORCE Now, PS Now
  - Different game types: RPG, Racing

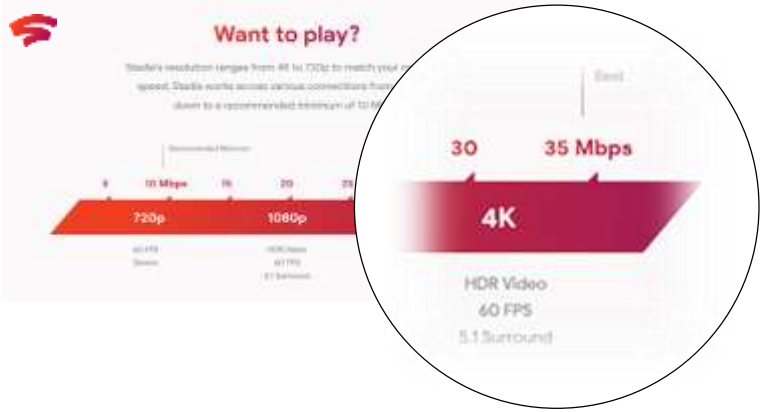
- **Proposed traffic models**
  - Edge-based baseline & Cloud-based baseline

Measurement framework and Measurements

Measurements settings and methodology
e.g. Google Stadia

- Platform: Google Stadia
- Game: misc. e.g. Grid (Racing)
- Frame rate: 60fps
- Screen resolution: 4K
- Capturing packets from Router
- WiFi AP: .11ac, 5GHz, 80MHz, 867Mbps
- Wireline
  - Data rate: 70Mbps DL / 20Mbps UL
  - Ping: 20ms



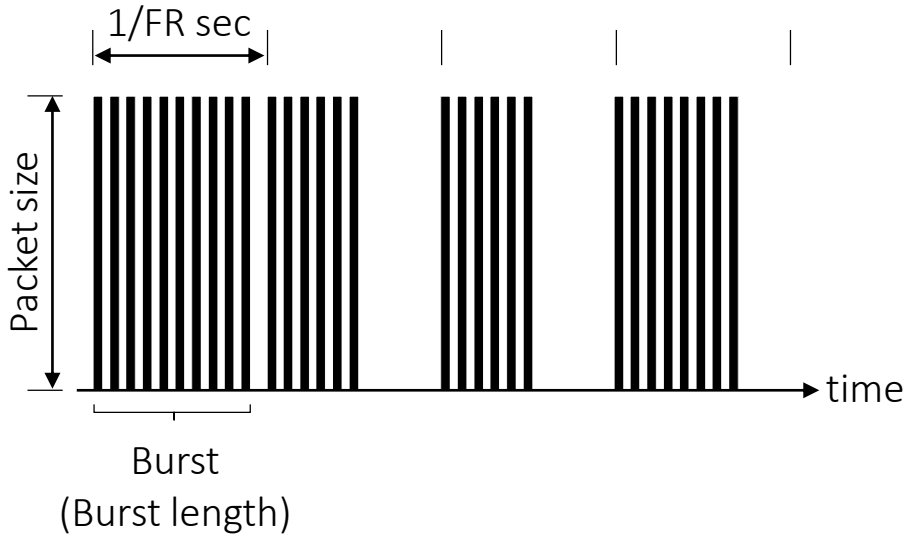


Data rate reference

Source: Google Stadia

Traffic Shape
Google Stadia

- Bursty Traffic Model
- Periodic bursts with a period of 1/FR sec
- Fixed Packet size
- Almost fixed inter-packets arrival time
- Burst Length follows truncated Gaussian distribution



Measurements on different gaming platforms
Packet Size

	NVidia	Google Stadia				PlayStation Now	
	Real-time RPG (Witcher)	Racing game (Grid) -bad link-	Racing game (Grid) -good link-	Real-time RPG (Gylt)	Real-time RPG (Steamworld)	Real-time RPG (Shadow of the tomb raider)	Racing game (Nascar Heat 3)
SA4 categories	Cat-B	Cat-C	Cat-C	Cat-B	Cat-B	Cat-B	Cat-C
Real throughput (Mbps)	16.5	19.4	29.4	19.6	13.8	5.5	12.38
DL packet size (bytes)	1466	1236	1236	1236	1236	1054-1264	1026-1450
Avg Burst length (packets)	20	21	23	19	18	7	8

- Packet Size: fixed (Google Stadia, Nvidia) vs. variable (PS Now)
- Packet Size limited by max. UDP/Ethernet: ~1500 bytes

Measurements on different gaming platforms
Arrival Time

	NVidia	Google Stadia				PlayStation Now	
	Real-time RPG (Witcher)	Racing game (Grid) -bad link-	Racing game (Grid) -good link-	Real-time RPG (Gylt)	Real-time RPG (Steamworld)	Real-time RPG (Shadow of the tomb raider)	Racing game (Nascar Heat 3)
SA4 categories	Cat-B	Cat-C	Cat-C	Cat-B	Cat-B	Cat-B	Cat-C
Avg. Packets IAT (ms)	0.1	0.8	0.2	0.2	0.6	0.2	0.17
Observed Jitter (ms)	5	32	8	8	24	10	8
Bursts IAT (ms)	16	16	16	17	17	17	16

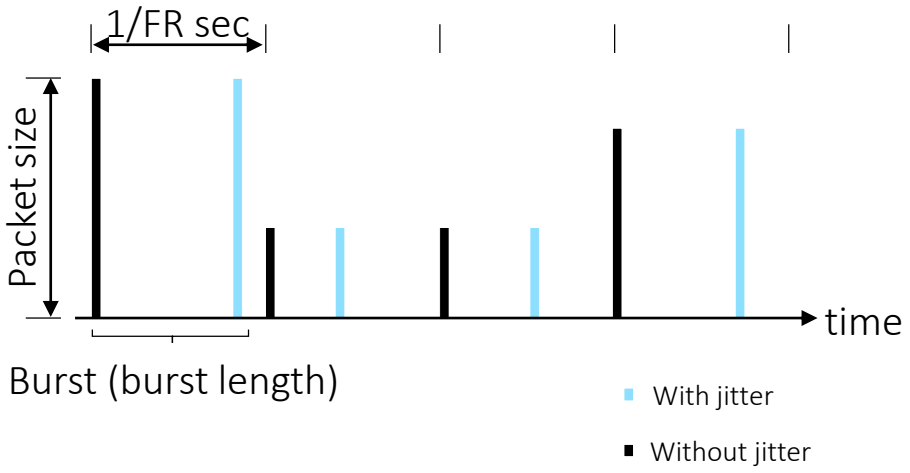
- Packets inter-arrival time and jitter varying depending on
  - Game characteristics (dynamicity, complexity …); and
  - Link Quality

IAT: Inter-Arrival Time

Proposed Traffic Models

Proposed CG/XR Traffic Models
a) Edge Server

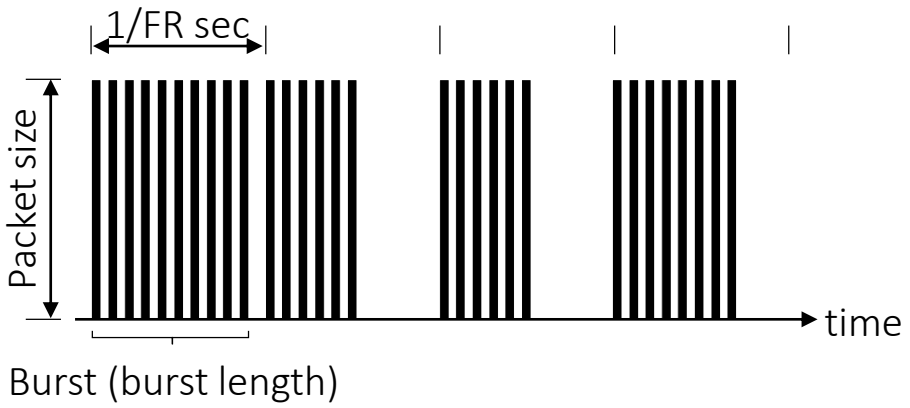
Proposal 1: Consider Edge-based traffic model for 3GPP RAN1 Evaluation. CG baseline (with necessary extension for XR)



- Packet Size & Traffic Shape
  - Packet size follows truncated Gaussian distribution (no MTU restriction)
  - No Segmentation
- Arrival time
  - Periodic Traffic with period 1/FR sec.
  - Jitter follows truncated Gaussian Distribution

Proposed CG/XR Traffic Models
b) Cloud server

Proposal 2: Consider Cloud-based traffic model for 3GPP RAN1 Evaluation. CG baseline (with necessary extension for XR)



- Packet Size & Traffic Shape
  - Fixed packet size. E.g. 1500 bytes
  - Bursty (Segmentation based on Ethernet MTU size limit)
- Arrival time
  - Inter-burst period of 1/FR sec
  - Burst length follows truncated Gaussian distribution and depends on channel conditions and games/XR req.
  - Jitter

Proposed Parameters for CG Traffic

		Category B High dynamicity & low/med complexity games	Category C High dynamicity & high complexity games
DL Traffic	Data Rate	5-20 Mbps	10-30 Mbps
	Packet size distribution	Truncated Gaussian	
	Avg Data packet size (Kbytes)	20	25
	Data packet size STD (Kbytes)	4	5
	Max packet size (Kbytes)	50	70
	Packet format	UDP	
	Packet Arrival rate (sec)	Periodic (1/FR)	
	Jitter distribution	Truncated Gaussian	
	Jitter STD (ms) *	3	4
	Max Jitter (ms)*	15	32

*Note: Jitter figures measured on wireline connection and may not be equally applicable to NR.

Proposal 3: Adopt Category B and Category C for CG parameter settings. Adopt above parameters.

Jitter Modelling

- Reason of jitter
  - XR Server at the Cloud (outside 3GPP network):
    - Variation in frame encoding time, Network routing and congestion, gNB buffering latency
  - XR server at the Edge (within 3GPP network):
    - Network routing and gNB buffering latency
- Jitter affects QoE
  - Results indicate that, even for slight variations of the underlying jitter distribution, the **QoE distribution shows significant variations**.
- Jitter can lead to high power consumption
  - **Uncertainty in the arrival time** of the periodic traffic could impact the DRX operation affecting power consumption.
- Edge compute can reduce baseline latency, but congestion in access still causes some jitter
- **Proposal 4:** Jitter modelling is required and shall be taken into account in simulations

Traffic differentiation

- CG and XR display different traffic types within the same application
  - E.g. in UL: game control commands, haptic sensors data, in-game voice traffic, video feed etc.
  - Traffic models differ depending on the type of traffic
  - Requirements differ depending on the type of traffic (e.g. control commands require high reliability)
  - **Observation 1:** CG and XR display different traffic types within the same application, in both UL and DL directions
- Some traffic also display differentiated frames with different associated requirements (e.g. I- and P-frames)
  - **Observation 2:** 5GS system awareness of differentiated frames may be beneficial
- As of Rel-15 flow-based QoS allows fine-grained traffic differentiation through the system incl. RAN
- **Proposal 5:** traffic model shall take into account different traffic types and possibly differentiated frames within the same application, in both UL and DL directions

Conclusions

Conclusions

- **Proposal 1:** Consider Edge-based traffic model for 3GPP RAN1 Evaluation. CG baseline (with necessary extension for XR) (1st priority)
- **Proposal 2:** Consider Cloud-based traffic model for 3GPP RAN1 Evaluation. CG baseline (with necessary extension for XR)
- **Proposal 3:** Adopt Category B and Category C for CG parameter settings (with parameters)
- **Proposal 4:** Jitter modelling is required and shall be taken into account in simulations
- **Observation 1:** CG and XR display different traffic types within the same application, in both UL and DL directions
- **Observation 2:** 5GS System awareness of differentiated frames may be beneficial
- **Proposal 5:** traffic model shall take into account different traffic types and possibly differentiated frames within the same application, in both UL and DL directions
- **Proposal 6:** Prioritize the traffic model design for CG then AR then VR

Thank You!