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ENABLING NGMN MIXED TRAFFIC MODELS FOR NS-3

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OUTLINE

- Introduction and contribution
- NGMN and 3GPP traffic models
- Implementation in ns-3
- Results
  - Traffic generation profiles
  - Validation
- Conclusions

INTRODUCTION AND CONTRIBUTION

- The recent advances in cellular network technologies allow serving mixed traffic applications with QoS guarantees. Thanks to it, new applications are gaining a lot of momentum, like gaming, video streaming, and web browsing.
- These new applications in the cellular domain, require a step forward in the models to simulate and analyze such traffic sources and their support by the various wireless technologies.
- In this work, we present an extension to the ns-3 applications module to simulate mixed traffic types, according to standardized NGMN models. The NGMN traffic models include FTP, video streaming, web browsing through HTTP, downlink and uplink gaming, and VoIP.
- We have created a generalized API and implemented the specific models for each of the traffic types except for HTTP which was already present in ns-3. Implemented NGMN FTP traffic model can be used to further implement different variants of 3GPP FTP models.
- Along with the implemented traffic generator framework and the specific models, we also present a simulation example and testing cases for the developed models.

NGMN AND 3GPP TRAFFIC MODELS

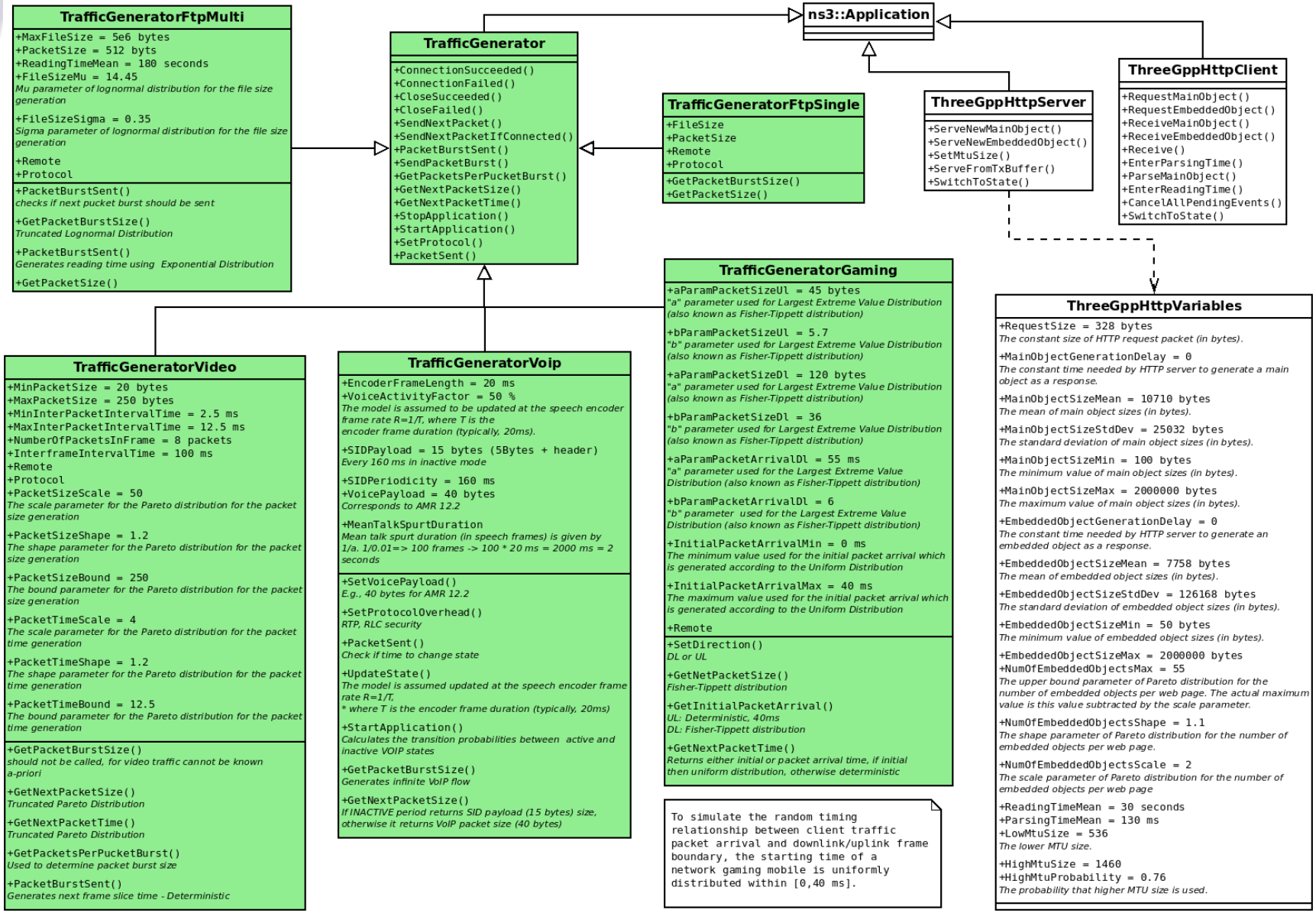
- 3GPP has defined traffic models for FTP and HTTP:
  - 3GPP FTP Model 1 and Model 2
  - 3GPP HTTP [already available in ns-3-dev]

- NGMN has defined various traffic models to simulate mixed traffic scenarios, in which a percentage of users is associated to a different traffic type each.
  - NGMN FTP [different from 3GPP FTP models]
  - NGMN HTTP [same as 3GPP HTPP]
  - NGMN video streaming
  - NGMN gaming (downlink and uplink models)
  - NGMN VoIP

NGMN AND 3GPP TRAFFIC MODELS

Traffic type	Parameter	PDF	Statistics
NGMN FTP	file size	truncated log-normal dist.	mean = 2 MB, max = 5 MB std deviation = 0.722 MB
	reading time	exponential dist.	mean = 180 s
NGMN HTTP 3GPP HTTP	main object size	truncated log-normal dist.	mean = 10710 B, min = 100 B, max = 2 MB std deviation = 25032 B
	embedded object size	truncated log-normal dist.	mean = 7758 B, min = 50 B, max = 2 MB std deviation = 126168 B
	number of embedded objects per packet	truncated Pareto dist.	mean = 5.64, max = 53
	reading time	exponential dist.	mean = 30 s
	parsing time	exponential dist.	mean = 0.13 s
NGMN video streaming	frame inter-arrival time	deterministic	100 ms
	number of packets per frame	deterministic	8 packets/frame
	packet size	truncated Pareto dist.	mean = 100 B, max = 250 B
	packet inter-arrival time	truncated Pareto dist.	mean = 6 ms, max = 12.5 ms
NGMN uplink gaming	initial packet arrival	uniform dist.	0 to 40 ms
	packet arrival	deterministic	40 ms
	packet size	Fisher-Tippet dist.	mean = 48.3 B
	UDP header	deterministic	2 B
NGMN downlink gaming	initial packet arrival	uniform dist.	0 to 40 ms
	packet arrival	Fisher-Tippet dist.	mean = 58.5 ms
	packet size	Fisher-Tippet dist.	mean = 140.8 B
	UDP header	deterministic	2 B
3GPP FTP Model 1	file size	deterministic	2 MB
	file arrival rate	Poisson dist.	0.12, 0.25, 0.37, 0.5, 0.625 files/s
3GPP FTP Model 2	file size	deterministic	0.5 MB
	reading time	exponential dist.	mean = 5 s

IMPLEMENTATION IN NS-3

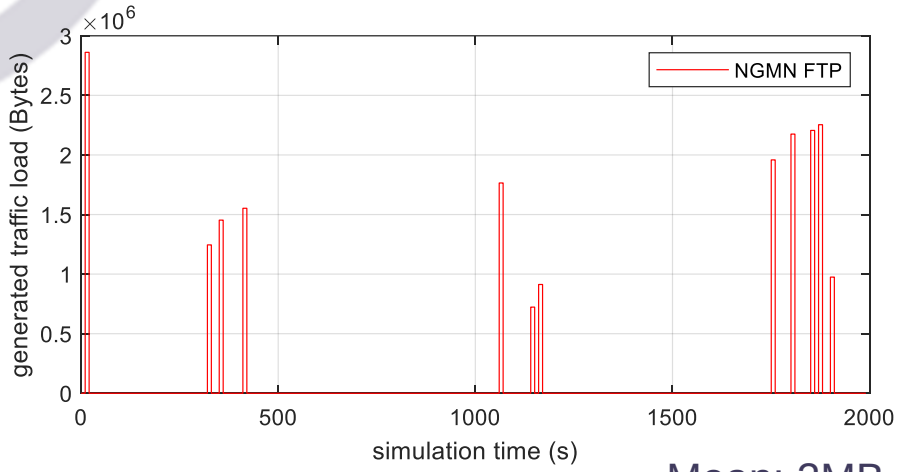


IMPLEMENTATION IN NS-3

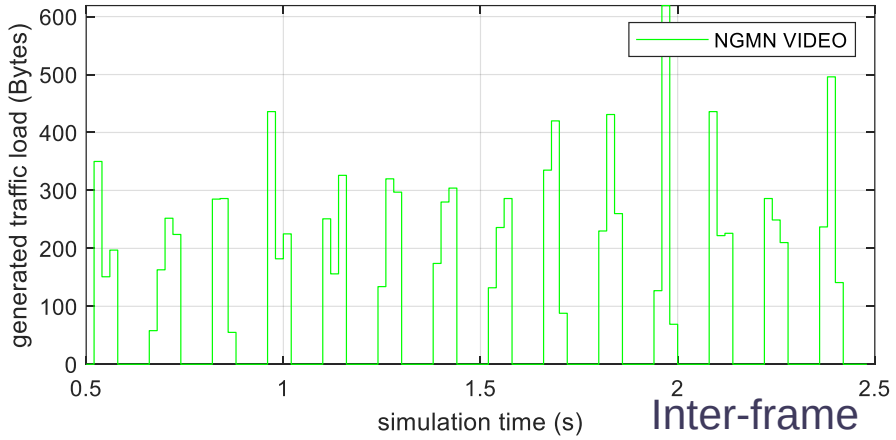
- All NGMN traffics have been implemented and properly tested: FTP, DL Gaming, UL Gaming, Video streaming, VoIP, HTTP web browsing
- **Tests**:
  - Ns-3 tests: A unit test called traffic-generator-test.cc/h has been created for testing NGMN traffics.
    - It is composed of various tests cases that check that the generator works correctly by validating that the probabilistic distributions of specific variables of each of the implemented traffic generators is according to the NGMN document.
  - CDF tests: We have compared the CDF of values generated by the traffic generator with respect to the CDF provided by Matlab
- **Example**: An example has been created to support mixed traffic types: cttc-traffic-example.cc
  - Added traffic configurations to support all NGMN traffic types

RESULTS: TRAFFIC GENERATION PROFILES

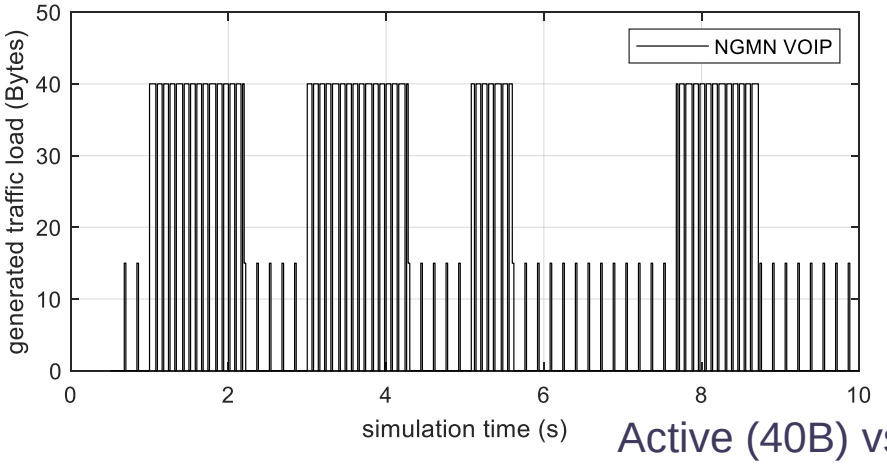
- File source: traffic-generator-example.cc



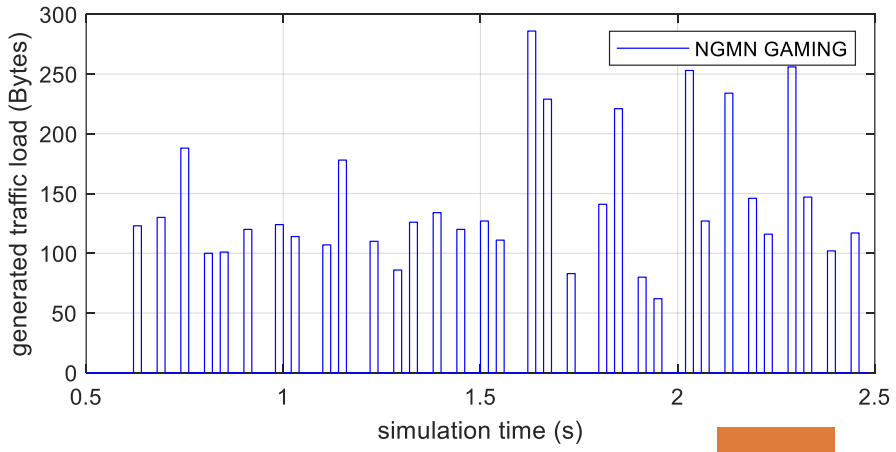
Mean: 2MB



Inter-frame arrival 100ms



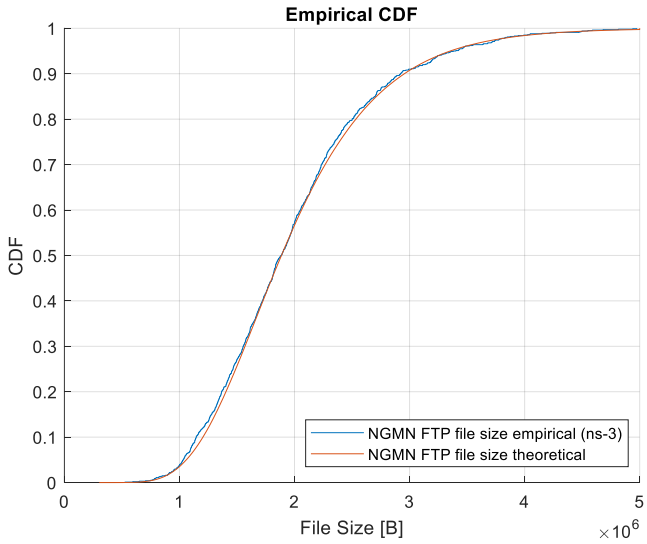
Active (40B) vs inactive (16B)

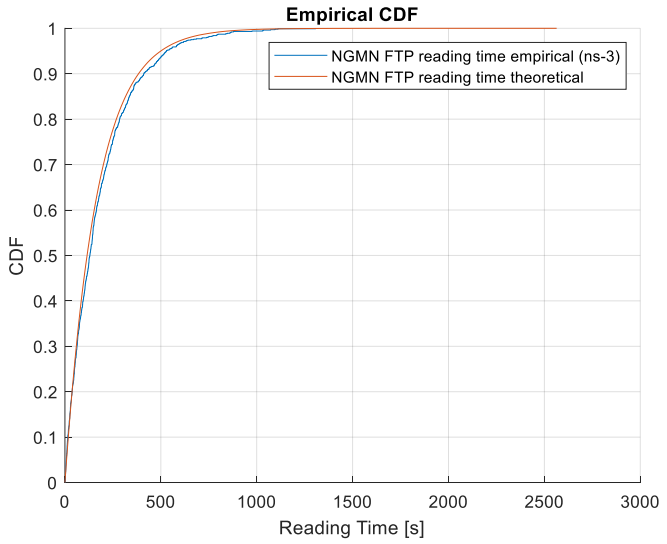


Mean: 140B

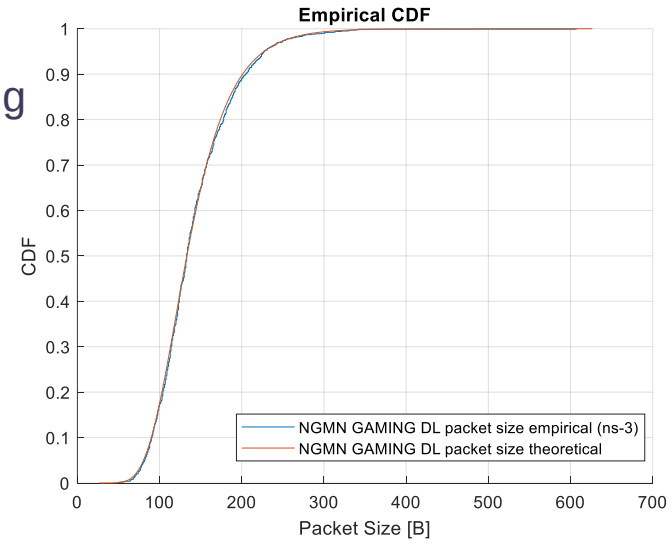
RESULTS: VALIDATION

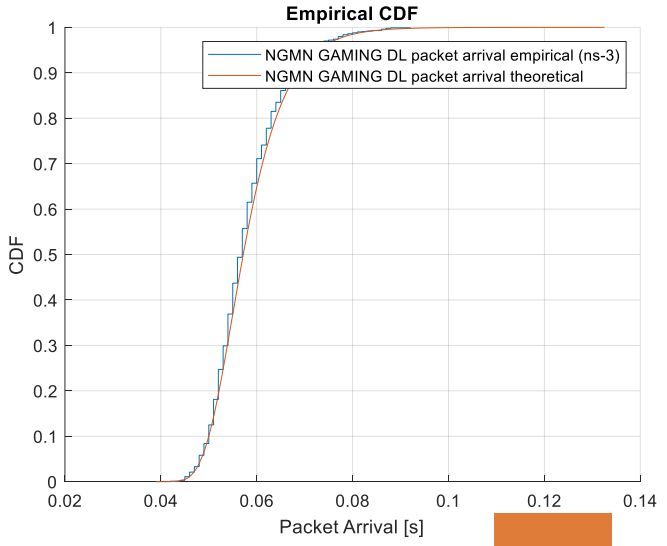
- FTP





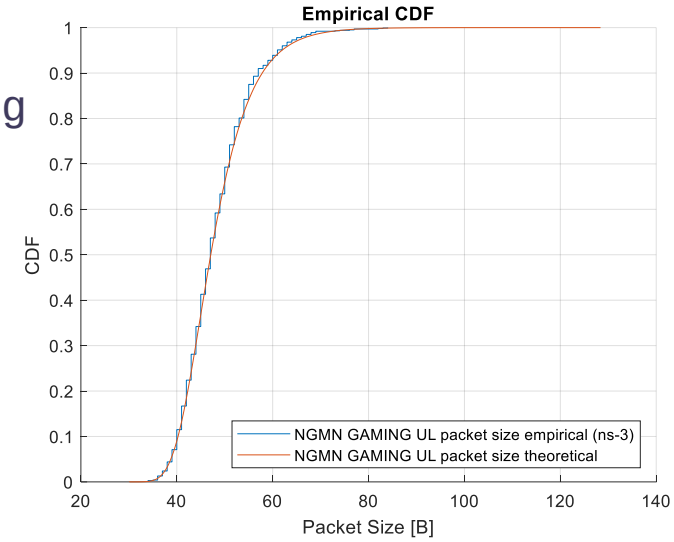
- DL gaming

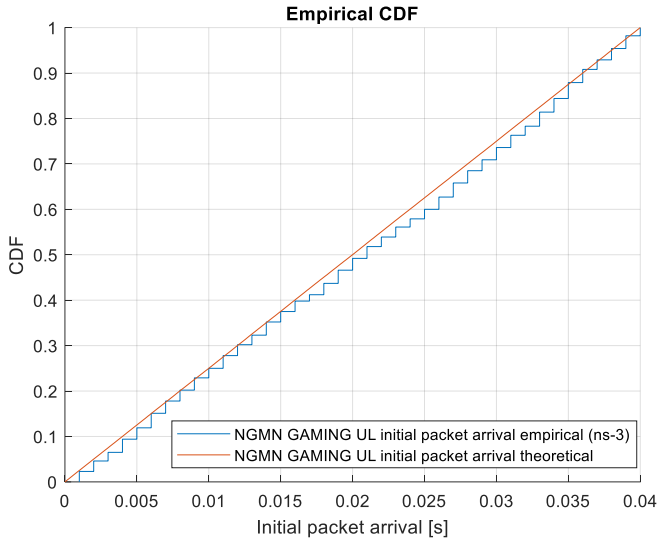




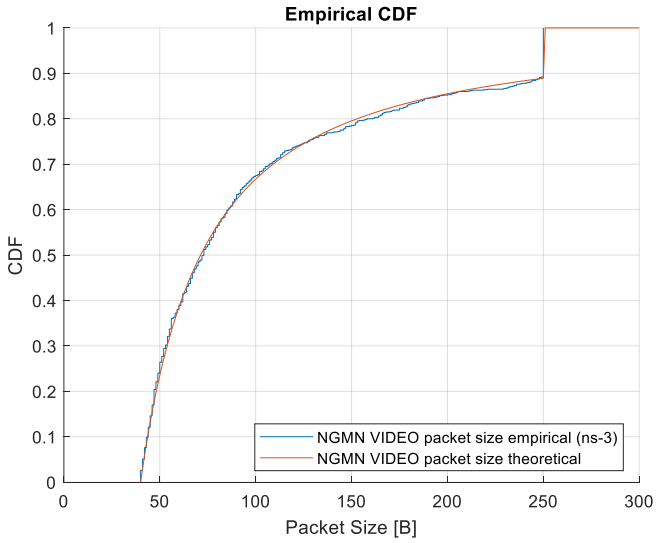
RESULTS: VALIDATION

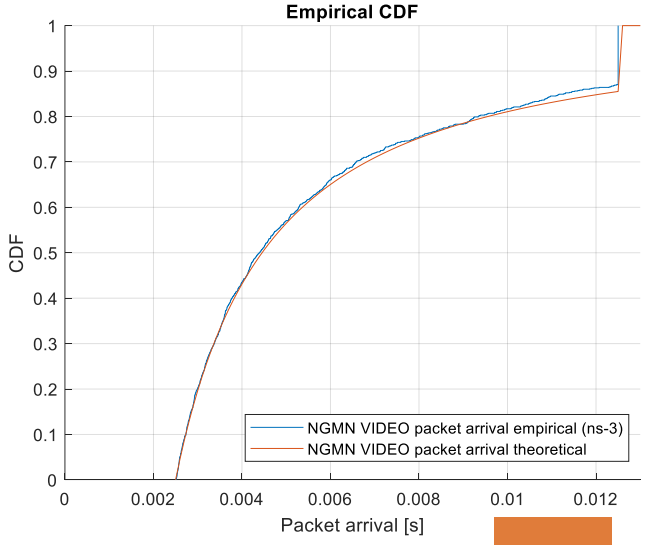
- UL gaming





- video





CONCLUSIONS

- In this paper we have presented the implementation of mixed traffic models in ns-3, as per NGMN specification.
- First, we have reviewed the traffic models.
- Then, we have detailed the developed framework, new API, and the various traffic models' implementation details.
- Finally, we have performed exhaustive tests to check the statistical characterization of each of the various traffics, and we have presented the simulation example.
- We believe this is a great addition to ns-3, since ns-3-dev was missing applications for realistic traffic evaluations.
- Also, the developed framework opens the door for the development of more advanced traffic models, like XR/VR/AR/CG, which will consider mixtures of the traffic models presented in this paper (e.g., video plus VoIP).

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