Quality Estimation Framework for Encrypted Traffic (Q2ET)

Lamine Amour, Van TONG, Sami SOUIHI, Hai Anh TRAN and Abdelhamid MELLOUK
LISSI-TincNET Research Team, UPEC, France

Content

- **Context**
- **Main proposal: Quality Estimation for Encrypted Traffic (Q2ET)**
- **Experimental results**
- **Conclusions and Perspectives**

Context

Contexts

- Cisco's report (April 2019), 80 percent of web traffic will be encrypted by 2019.

- Google has developed Quick UDP Internet Connection (QUIC) [17], a new transport layer network protocol on the top of UDP, and applied for some services (e.g., YouTube, Google Driver, etc.).

Problematic : How estimate User's QoE ?

- Some prior works calculate the QoE using network-based parameters (e.g., bandwidth, delay, packet loss).

- It Is not easy for ISPs to identify the flows corresponding to different kinds of services because some previous solutions cannot be applied (e.g., port-based methods, payload-based methods, etc.).

- Difficult for ISPs to estimate the QoE of the encrypted traffics that hide application information.

Main proposal: Quality Estimation for Encrypted Traffic (Q2ET)

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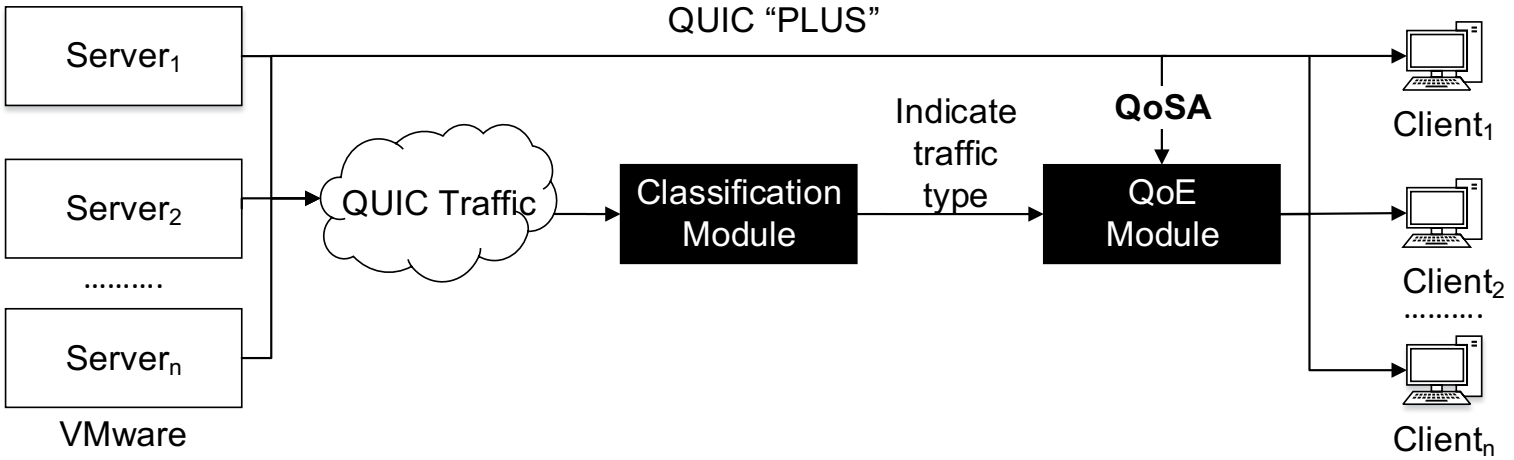
- Allow the ISPs to monitor the user's QoE in the context of encrypted traffic.
- 2 main modules:
  - Service Detection Module
    - Identify the type of services.
  - Quality Assessment Module
    - Estimate the QoE score corresponding to the specific services.
- Architecture:



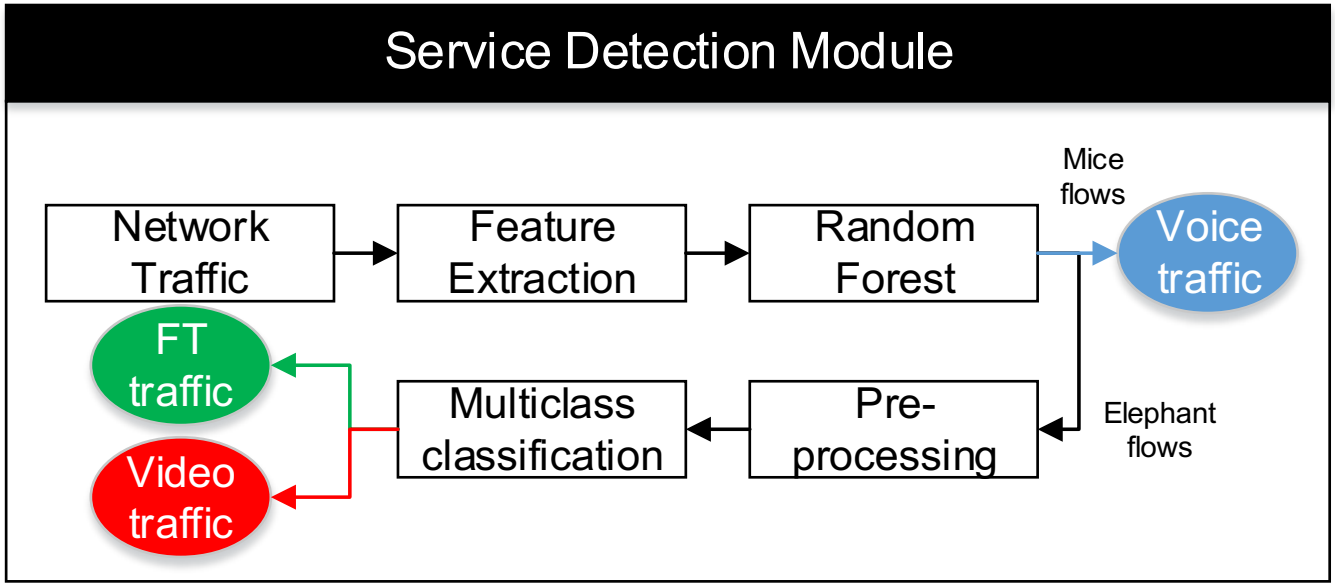
- Comparison:

Existing work	Our Service Detection Module
- Non-encrypted traffic - Encrypted traffic (e.g. Bittorent, Skype, HTPPS, etc)	- Encrypted traffic (QUIC) [1]

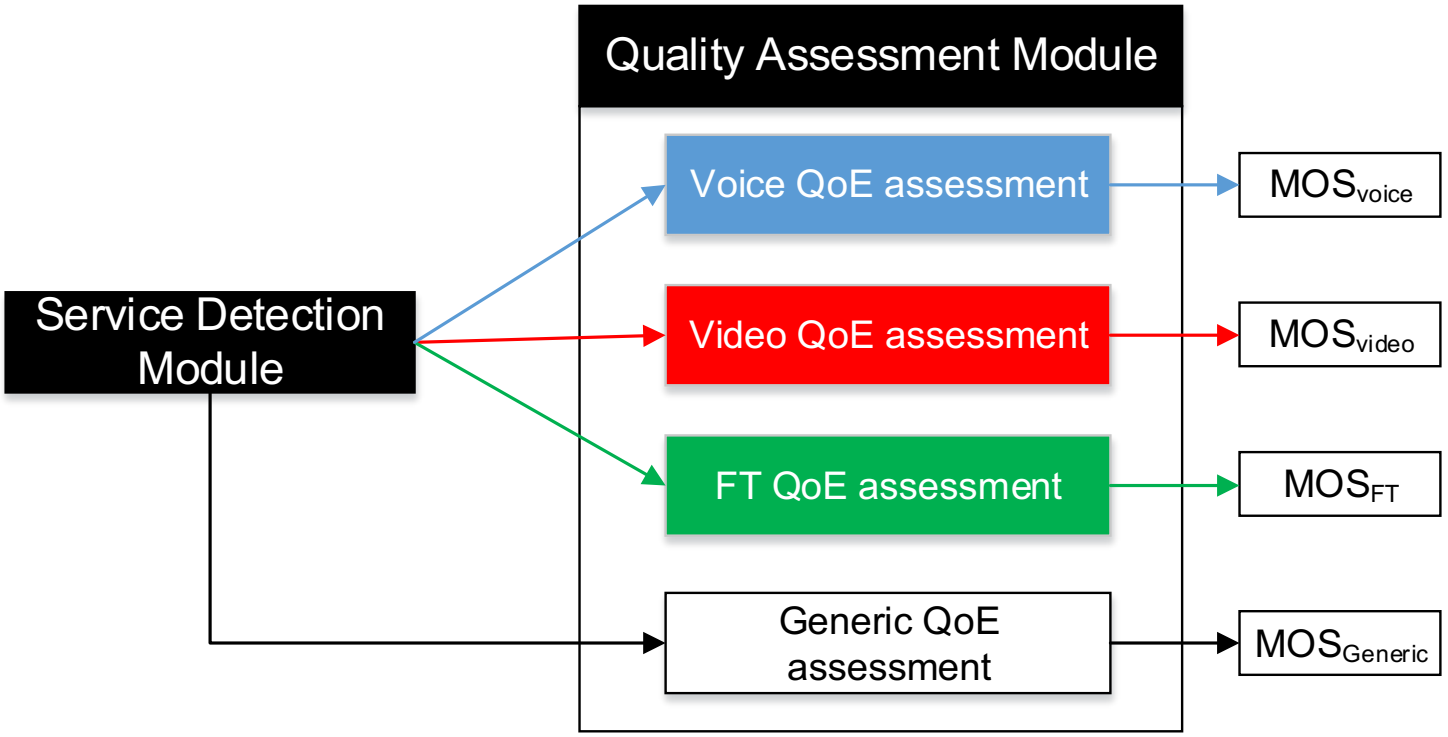
- Objective: Identify the different kinds of traffic to optimize the network systems (e.g. block the specific traffic, re-routing algorithms, etc).
- Classify the traffic using Convolutional Neural Network (CNN).

ANN	CNN
Interact with large portion of neural	Spare connectivity: interact indirectly with the large portion of the input
Element of the weight matrix is utilized only once	Parameter sharing: Use the same parameters for more than one.

- Flow types:
  - Mice flow (VoIP): 8 flow-based features and random forest algorithm.
  - Elephant flows (Video streaming, File Transfer): 1400 packet-based features and CNN.

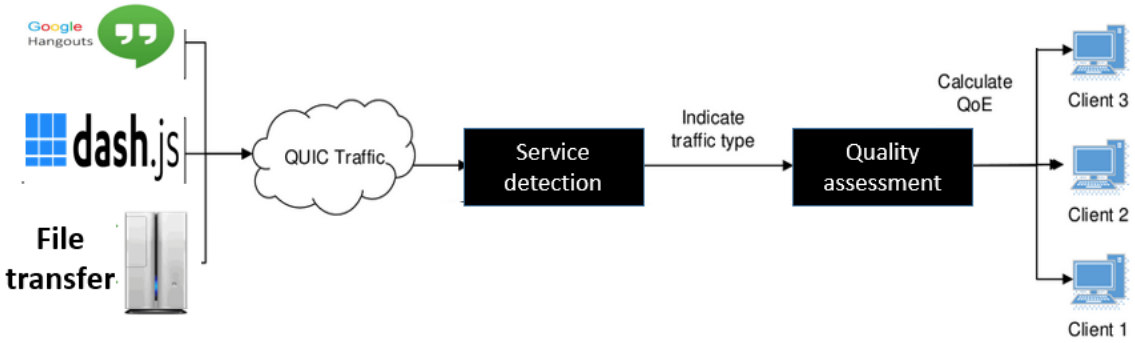


- Calculate Internet user's QoE in the context of end-to-end encrypted traffic.



Experimental results

- Descriptions
  - Real testbed for specific servers.
    - VoIP: Google Hangout
    - Video streaming: Dash.js
    - File transfer: quic-go library [2]



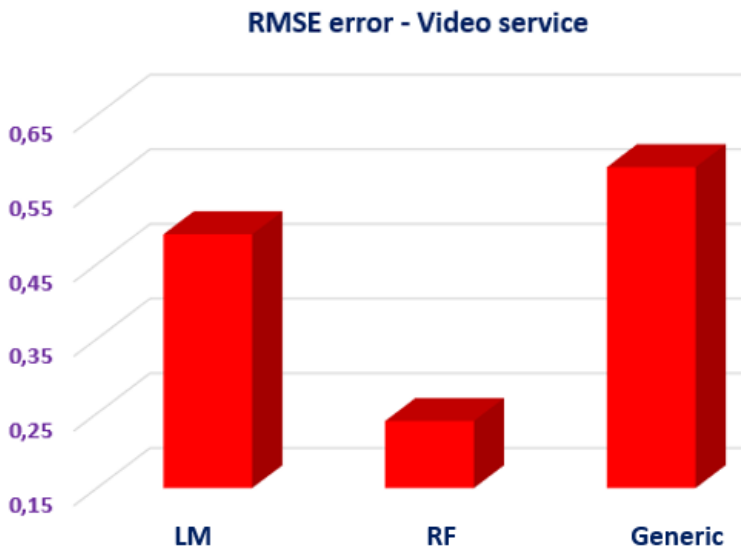
- QoE estimation methods
  - Linear Regression (LM)
  - Random forest (RF)
- Dataset: 67% training, 33% testing

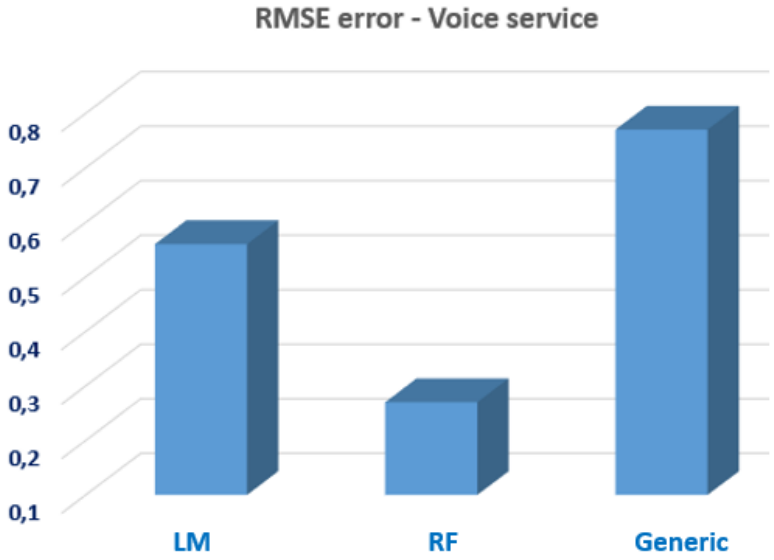
- Descriptions
  - Metrics
    - Root mean squared error (RMSE)

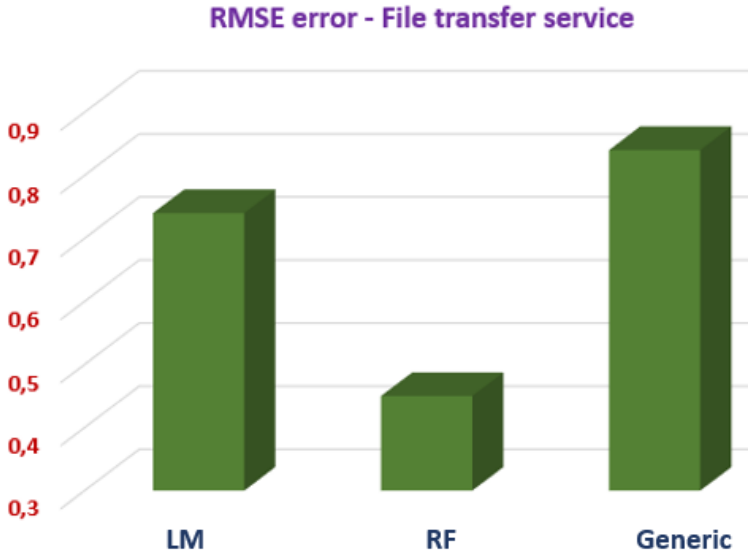
$$RMSE = \sqrt{\frac{\sum_1^n (MOS_i - y_i)^2}{n}}$$

MOS_i : predicted MOS values
y_i : real MOS value
n : total number of samples considered

Experimental results







Conclusion and Perspectives

- Quality Estimation Framework for Encrypted Traffic (Q2ET).
  - Help network operators in improving the quality of their services.
  - 2 modules:
    - Service detection module: Detects three different kinds of QUIC-based services (voice, video and file transfer) with high accuracy.
    - Quality assessment module: Apply the appropriate quality assessment models for each kind of service to accurately estimate the users perceived qualities.
  - Specific QoE estimation model outperforms (by at least 40%) the generic estimation model.

- Adding specific MIoT service parameters like codec, bitrate, etc.
- Improving the traffic classification module to detect additional services that use IoT like gaming, virtual reality (VR), mixed reality (MR) and Ultra HD video.
- Investigating various flow-based features to enhance the classification model in time processing and accuracy.
- Enhancing the QoE estimation module by building a large subjective database. Moreover, we can obtain some additional application parameters from the end-user side using PLUS [3].
- Integrating the proposed solution in a network operator infrastructure to study the performance of the Q2ET solution in a real context.

References

1. Langley, Adam, et al. "The quic transport protocol: Design and internet-scale deployment." Proceedings of the Conference of the ACM Special Interest Group on Data Communication. ACM, 2017.

2. lucas clemente. A quic implementation in pure go. https://github.com/lucas-clemente/quic-go, April 2019.

3. Kühlewind, Mirja, et al. "A path layer for the Internet: Enabling network operations on encrypted protocols." 2017 13th International Conference on Network and Service Management (CNSM). IEEE, 2017.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