Multimedia Content Delivery in Mobile Cloud: Quality of Experience model

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MOTIVATION

- Everyday use of different multimedia services;
- The delivery of network-centric multimedia content;
- The ISP have a technical point of view for the quality;
- QoS parameters to carry out the provision and regulation od service delivery;
- The over-the-top (OTT) service providers will have the main responsibility to maximize the quality of multimedia services provided for the end users;
- They continuously monitor and estimate the Quality of Experience (QoE).

MOTIVATION

- How to estimate the QoE?
- Using the available information of the system parameters, context-aware conditions and users preferences;
- Select and measure these influencing factors that affect the quality of multimedia services;
- Modelling the Quality of Experience for cloud-based services;
- Establish Bayesian-based metrics for the perception of quality.

RELATED WORK

- The Service Level Agreement (SLA) is using the network metric, which is not sufficient for managing the quality of multimedia services.
- The benefit of the cloud offloading can be best utilized by OTT providers for the process of personalizing the multimedia content, before delivering it to the users.
- There has not been a research study that provides complete quality evaluation methodology for delivery of multimedia content.
- Use the benefit of mobile cloud computing services in order to propose new multimedia QoE assessment methodology.

MULTIMEDIA QUALITY OF EXPERIENCE MODEL BASED ON MOBILE CLOUD

- Multimedia content is delivered over heterogeneous networks
- To meet the user requirements, it is necessary to understand the relations and interaction between different influencing factors (IF)
- This research provides estimation on the human perception of the quality for the multimedia content delivery
- The QoE is multi-dimensional value that represents the dynamic and transient appeal of quality [9].
- The cloud computing has been chosen for multimedia processing because it provides flexibility, portability, and scalability
- In this way, less workload is put on the end user mobile device and allow heavy-duty processing actions to be done in the cloud.

[9] P. Le Callet, S. Möller and A. Perkis (eds), "Qualinet white paper on definitions of quality of experience–output version of the dagstuhl seminar 12181," European network on quality of experience in multimedia systems and services, 2012.

MULTIMEDIA QUALITY OF EXPERIENCE MODEL BASED ON MOBILE CLOUD

- Proposed multimedia Quality of Experience (MmQoE) model
- The major advantage is that allows capturing the impact of various influencing factors in the process of delivering media content.
- The delivery of multimedia content is highly influenced by the type of devices used for presenting the delivered content;
- The human cognitive characteristics estimation;
- The context-aware factors for the multimedia delivery;
- We need approach is that considers the subjective and objective characteristics for quality estimation.

MULTIMEDIA QUALITY OF EXPERIENCE MODEL BASED ON MOBILE CLOUD

- Used the benefit of Bayes Network modelling

- clear and intuitive graphical representation

- probabilistic dependencies among the corresponding variables

- The Bayes network theory

$$P(X_1,\ldots X_n)=\prod_{i=1}^{n} p(X_i \mid parents(X_i)) \qquad (1)$$

- The expected utility of the state is given as utility function $U(O_i/S)$ over particular state S and probability of each such cause $P(O_i/S)$

$$EU(S_i^q)=\sum_{i}^{n} U(O_i \mid S)\times P(O_i \mid S) \qquad (2)$$

- The MmQoE metric can be represented as the linear weighted sum of multiple expected utilities (EU)

$$MmQoE=\sum_{i}^{n} w_i \times EU(S_i^q) \qquad (3)$$

MULTIMEDIA QUALITY OF EXPERIENCE MODEL BASED ON MOBILE CLOUD

The multimedia QoE model that has been represented in BN, which uses MAU (Multi-Attribute Utility) node as the sum of the human, system and context-aware utility functions.

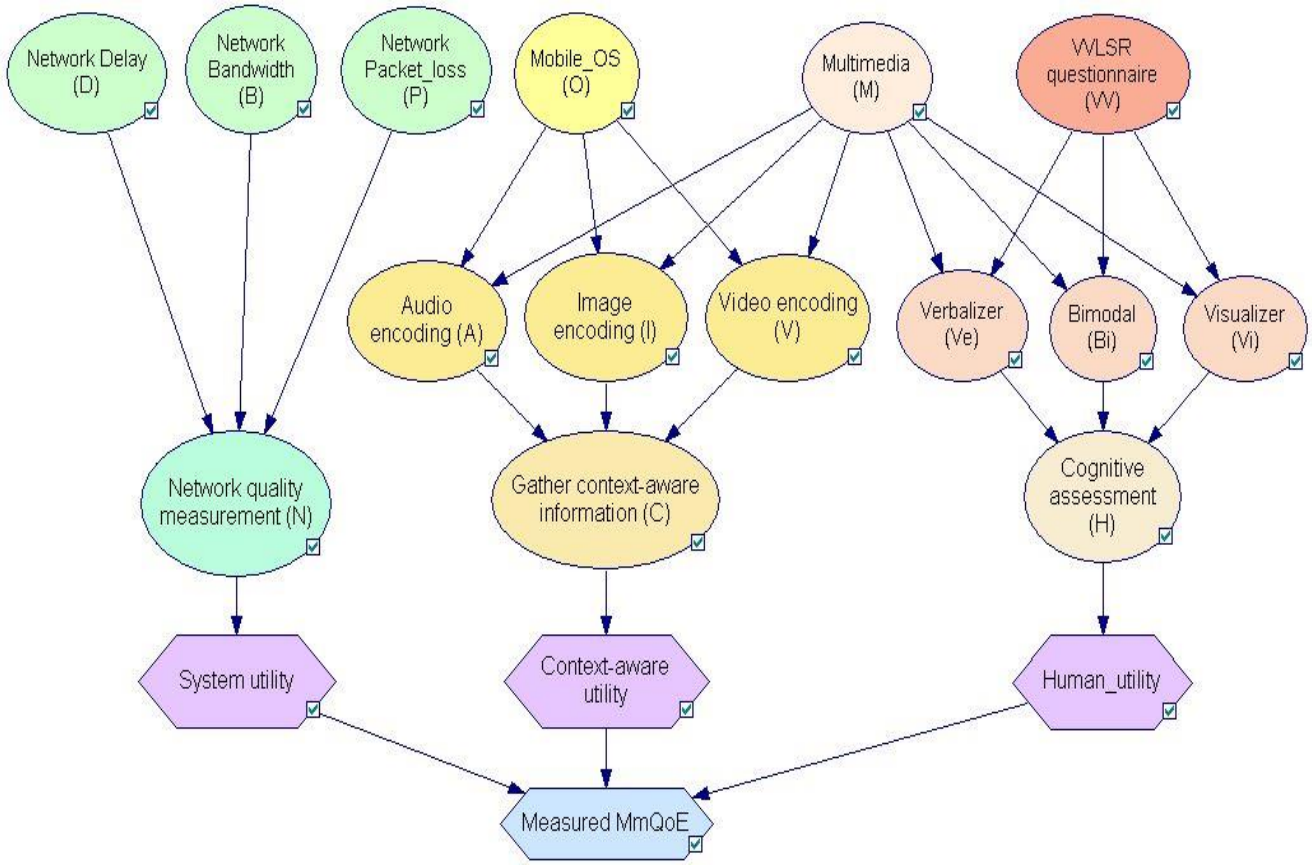

Figure 1. The graphical structure of the MmQoE Bayes network model

IMPLEMENTATION OF MULTIMEDIA QoE METRIC MODEL

- *MmQoE ={5, 4, 3, 2, 1}* final value for the perception of quality is scored on a 5-point Mean Opinion Score (MOS) {“excellent”, “very good”, “good”, “fair” and “poor”} is assigned.
- Estimation of the human cognitive characteristics is done with an original one-item Verbal-Visual Learning Style Rating (VVLSR) questionnaire [17]
- The context-aware estimation, the WURFL (Wireless Universal Resource FiLe) request [18] is sent to the mobile device.
- The WURFL is a software component that maps HTTP Request headers to the profile of the HTTP client (Desktop, Mobile Device, Tablet, etc.) that issued the request [18].
- The network traffic classification for the measured QoS parameters.
- After collecting the relevant influencing factors, such as mobile device capabilities, network conditions, and user preferences, the *multimedia Quality of Experience (MmQoE) assessment* is triggered.

[17] R. E. Mayer and L. J. Massa, “Three facets of visual and verbal learners: Cognitive ability, cognitive style and learning preference,” in Journal of Educational Psychology. vol. 95, Issue 4, 2003, pp: 833-846. DOI: 10.1037/0022-0663.95.4.833.
[18] WURFL - Wireless Universal Resource FiLe, a Device Description Repository (DDR) by ScientaMobile. http://wurfl.sourceforge.net/.

IMPLEMENTATION OF MULTIMEDIA QoE METRIC MODEL

The Bayes network model for measuring the multimedia perception of quality is implemented in *GeNiE* [16].

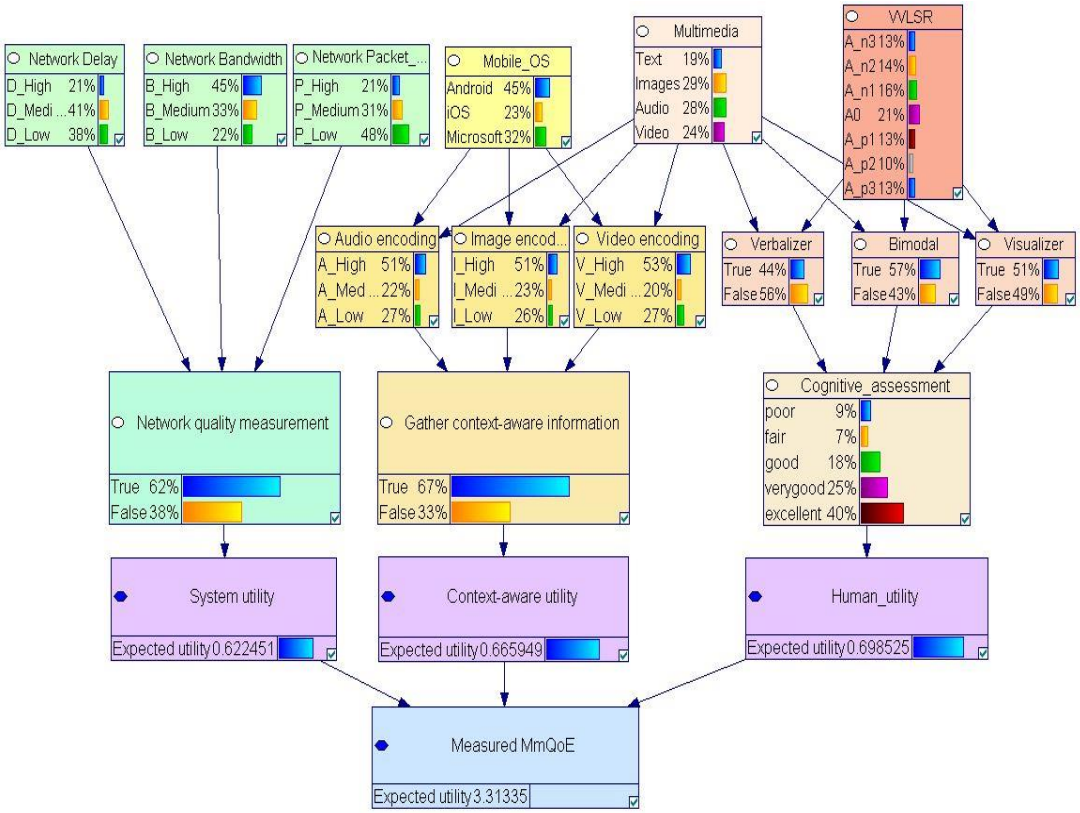

Figure 2. Bayes network model for measuring the multimedia perception of quality.

[16] BayesFusion, GeNIe Modeler software package, Version 2.1.1, https://www.bayesfusion.com/genie-modeler [10/2017].

DISCUSSION AND VALIDATION OF THE PROPOSED MODEL

- The modelling of multimedia Quality of Experience has enabled media resources to be managed and controlled more accurately and proactively for a successful service delivery.
- The confusion matrix for each of the influencing factors will give the first inside information that is relevant for the process of Bayes model validation.
- Receiver Operating Characteristic (ROC) curves for each of the states of each of the class nodes [13].
- This ROC curve plots the true positive rate as a function of the false positive rate.
- The area under the ROC curve (AUC) is close to 1 indicates an excellent performance in terms of the predictive accuracy.

[13] B. Kevin Korb and E. Ann Nicholson. “Bayesian Artificial Intelligence,” Second Edition (2nd ed.). CRC Press, Inc., Boca Raton, FL, USA, 2010, ISBN: 1439815917.

DISCUSSION AND VALIDATION OF THE PROPOSED MODEL

The network quality analysis ROC curve, for small FPRate values, provides higher TPRates, which makes the model reliable in identifying the positive classifications only with strong QoS evidence values.

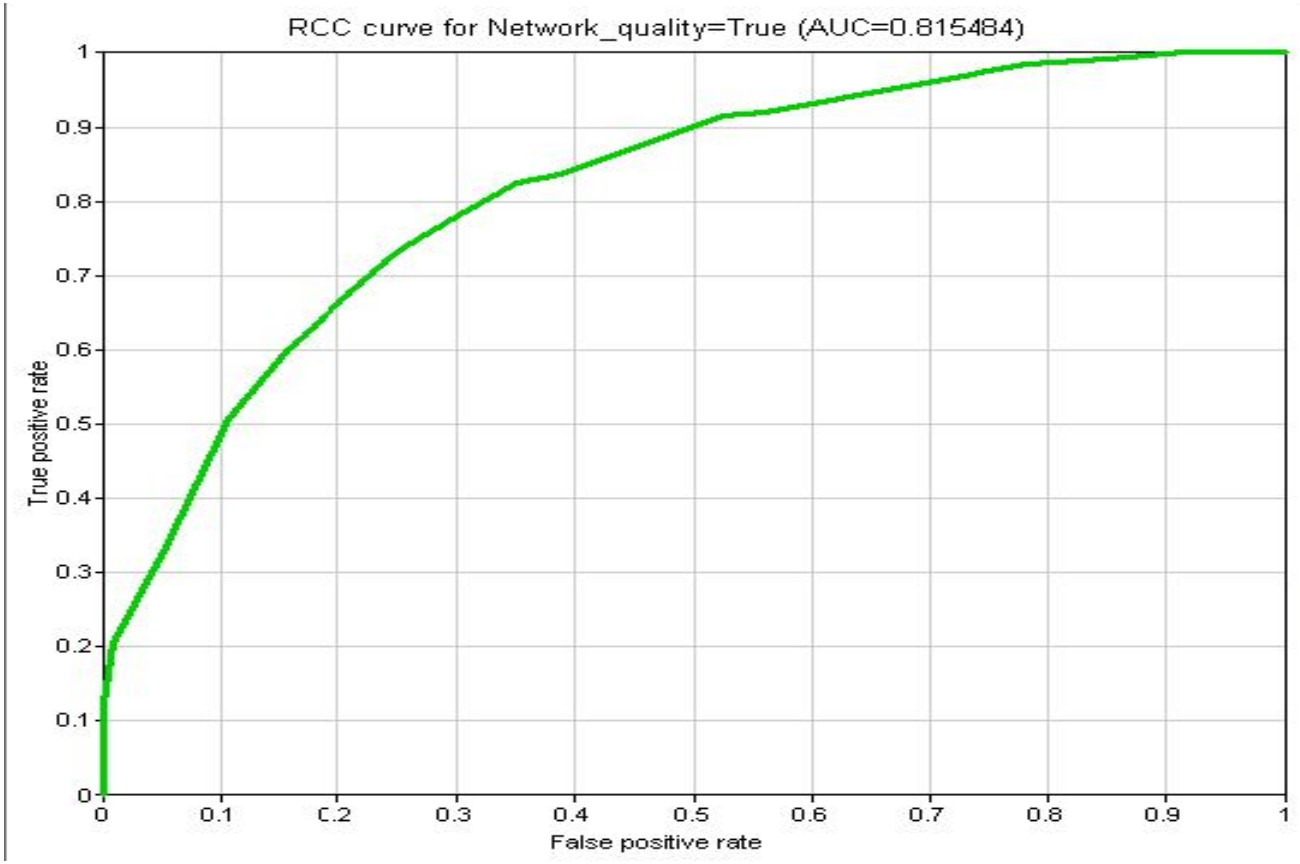

Fig 3. ROC curve for network quality class node of the proposed BN

DISCUSSION AND VALIDATION OF THE PROPOSED MODEL

The context-aware classifier can provide relevant information for the perceived context quality features, which is proven by the AUC value of 0.841, but they will not be very precisely determined for the larger FPRate.

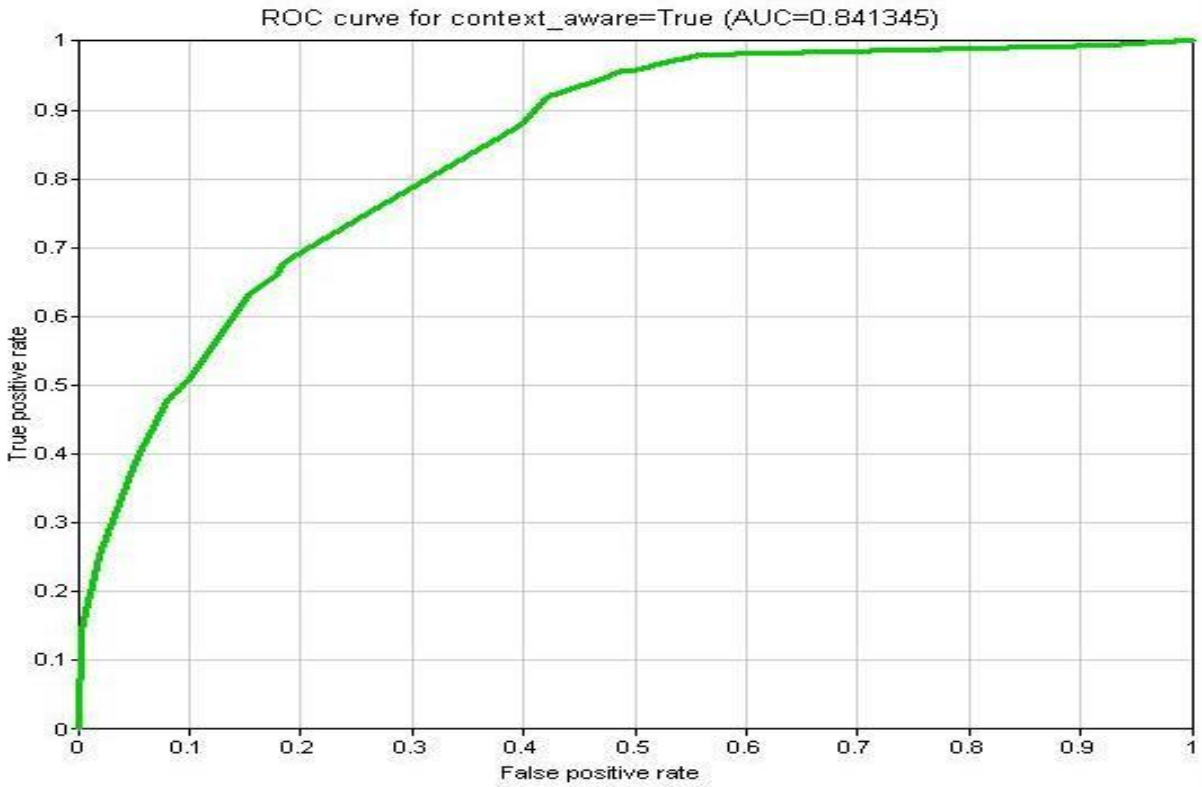

Fig 4. ROC curve for impact of context-aware class node in the proposed BN

DISCUSSION AND VALIDATION OF THE PROPOSED MODEL

The cognitive assessment classifier is that it makes few false positive errors, but for larger FPRate (>0.7) makes a better prediction. The AUC value of 0.886 shows very good classification of the cognitive influencing factors with regards to the whole model.

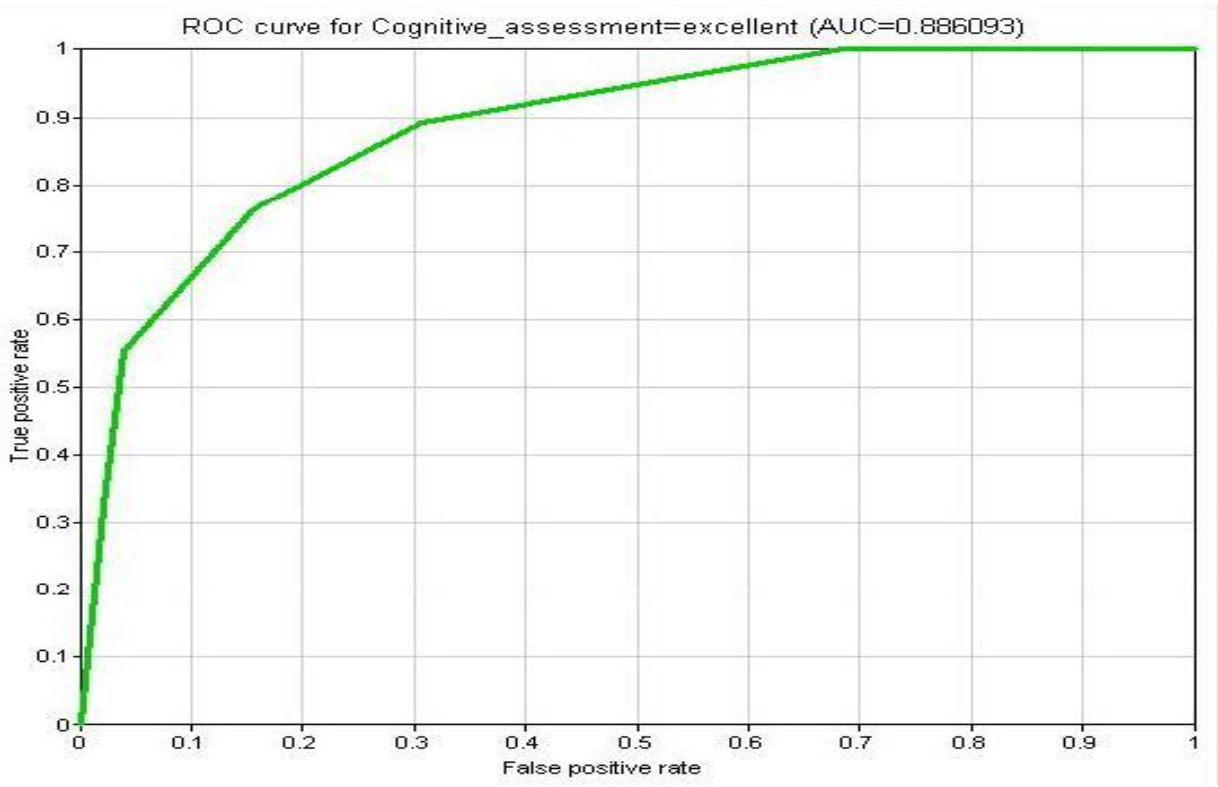

Fig 5. ROC curve for cognitive assessment class node of the proposed BN

CONCLUSION AND FUTURE WORK

- The proposed multimedia Quality of Experience (MmQoE) model demonstrates the potential of novel objective approach for measurements of the user perceived quality.
- This research confirms that in order to increase the end user quality experience, the media contents have to be adapted to the user's preferred style, mobile device capabilities, and QoS conditions.

Future work

- Another interesting challenge imposed from this research is how the OTT providers should charge the mobile users for the delivery of media content.
- The established approach for measurement of the QoE level can be used as indicator for quality that will determine the profit for OTT providers.

QUESTIONS ?