Dynamic Cost/Quality Ratios in a Telecommunication System

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The results in this presentation are described in:

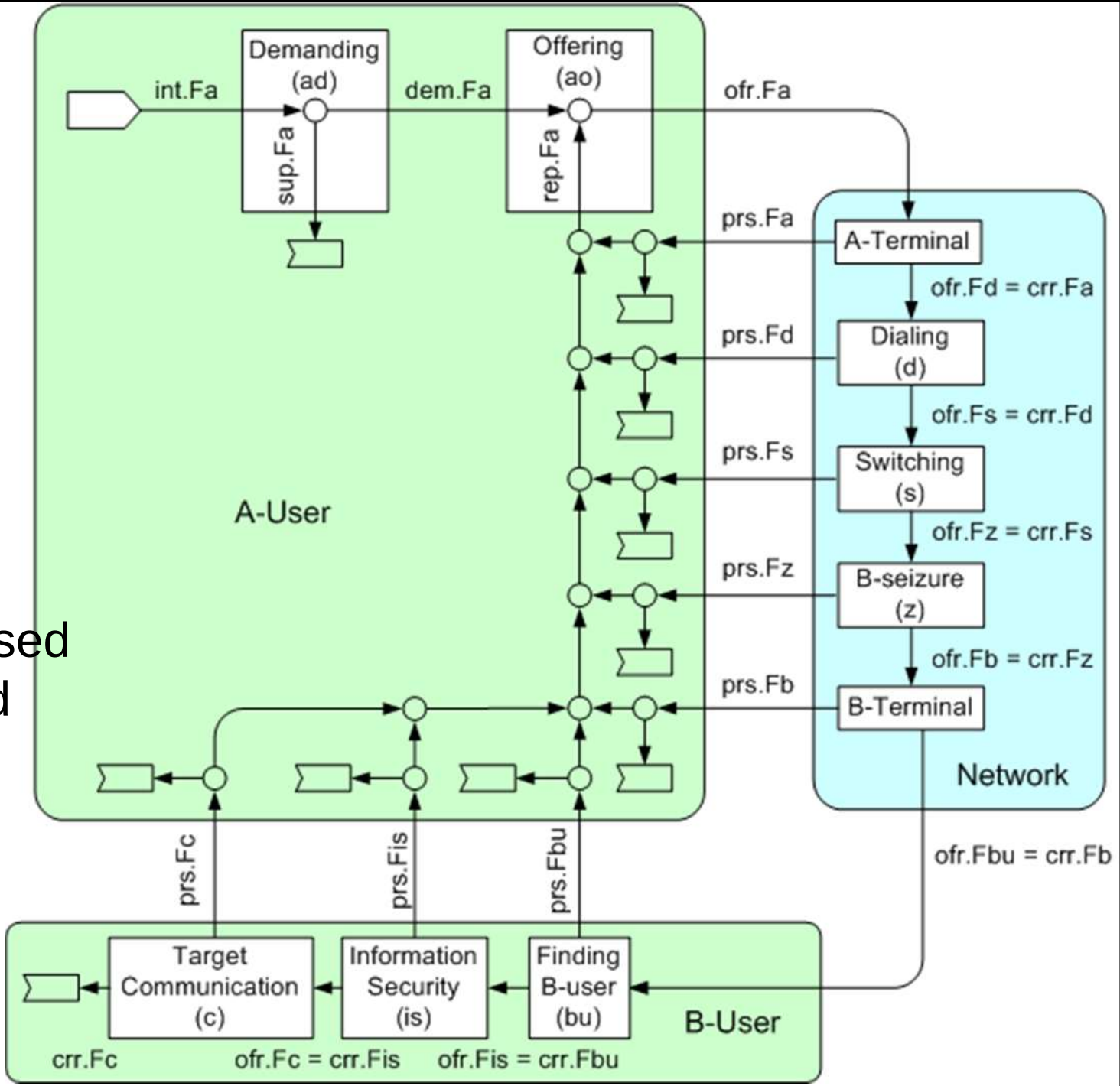
Stoyan Poryazov, Emiliya Saranova, Ivan Ganchev. Scalable QoS Indicators towards Overall Telecom System QoE Management. In: Ivan Ganchev, Rob van der Mai, J.L. (Hans) van den Berg (Editors). Autonomous Control for a Reliable Internet of Services: Methods, Models, Approaches, Techniques, Algorithms and Tools. Springer, LNCS, State-of-the-Art Surveys, 2018 (Accepted for publishing).

Content

1. Target - development of Indicators supporting the Dynamic Pricing;
2. Overall Telecom System – Reference Model;
3. Overall QoS indicators;
4. Assumptions made;
5. Mean Cost-Quality Ratio;
6. Instantaneous Cost-Quality Ratio;
7. Qualitative comparison of the indicators;
8. Prediction of the Normalized Cost-Quality Ratio;
9. Conclusion and Open Issues.

2. QoS in Overall Telecom System – Reference Model

int. = intent
sup. = suppressed
dem. = demand
ofr. = offered
prs. = parasitic
crr. = carried



3. Overall QoS indicators

QoS indicators,
for each service stage,
for example:

$$Qa = \frac{crr.Fa}{ofr.Fa} \qquad Qbu = \frac{crr.Fbu}{ofr.Fbu}$$

System efficiency indicator of the B-User Stage: Ebu

$$Ebu = \frac{crr.Fbu}{ofr.Fa} = Qa\ Qd\ Qs\ Qz\ Qb\ Qbu$$

- Ebu corresponds to the cases of fully successful communication, from the users' point of view, regarding all call attempts, offered to the network (ofr.Fa).
- Ebu is integrated indicator of a composite service.

4. Assumptions made (1/2)

Assumption A-1: The observation time interval Δt is limited;

Assumption A-2: The full System Costs (SC) in the time interval Δt are known;

Assumption A-3: The Cost-Quality Ratio depends of:

- the paid volume of traffic (paid.V), in Δt;
- a QoS Indicator (Q);

4. Assumptions made (2/2)

Assumption A-4: The Full System Costs (SC) don't depend considerably from the served traffic volume, in the time interval Δt ;

Assumption A-5: The Quality of Service Indicator (Q) is:

- dimensionless, $Q \in (0,1]$;
- proportional of the quality (Q = 1 means 'the best quality').

5. Mean Cost-Quality Ratio (1/2)

Cost per Traffic Unit quantity is:

$$Cost\ \ per\ Unit = \frac{Full\ System's\ Costs\ [Euro]}{Paid\ Traffic\ Volume\ [Erlang \times \Delta t]}$$

"The traffic volume in a given time interval is the time integral of the traffic intensity over this time interval" [ITU-T E.600, 1993], or: $paid.V = paid.Y\ \Delta t$

Dividing in the quality indicator (Q), receive:

$$\frac{Cost\ \ per\ Unit}{Quality} = \frac{Full\ System's\ Costs\ [Euro]}{Q\ \ \ paid.V\ [Erlang \times \Delta t]} = \frac{SC}{Q\ \ \ paid.V}$$

5. Mean Cost-Quality Ratio (2/2)

- The definition of the paid traffic may depend from the telecommunication service provider.
- The estimation of the paid traffic volume is a routine operation.
- The definition of the quality indicator Q may be different from users' (a generalized QoE parameter) and from the service provider's perspectives.
- In general, the best case is Q definition to be included in the SLA.

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6. Instantaneous Cost-Quality Ratio (1/3)

The traffic intensity (Y): "The instantaneous traffic in a pool of resources is the number of busy resources at a given instant of time" [ITU-T E.600, 1993]. From assumptions made and Mean Cost-Quality Ratio Definition follows:

$$\frac{Cost\ per\ Unit}{Quality} = \frac{Full\ System's\ Costs\ [Euro]}{\Delta t\ [Time]}\ \frac{1}{Q\ paid.Y\ [Erlang]}.$$

$$\frac{Cost\ per\ Unit}{Quality} = SCI\ NCQR.$$

$$System's\ Costs\ Intensity\ (SCI) = \frac{Full\ System's\ Costs\ [Euro]}{\Delta t\ [Time]}$$

$$Normalized\ Cost\text{-}Quality\ Ratio(\ NCQR\ ) = \frac{1}{Q\ paid.Y\ [Erlang]}.$$

6. Instantaneous Cost-Quality Ratio (2/3)

$$Normalized\ Cost\text{-}Quality\ Ratio\ (NCQR) = \frac{1}{Q \quad paid.Y\ [Erlang]}$$

- The Normalized Cost-Quality Ratio (NCQR) is independent from the absolute system's costs amount.
- It is normalized, because it is cost-quality ratio for one Euro costs.

6. Instantaneous Cost-Quality Ratio (3/3)

- The proposed quantities SCI and NCQR allow estimation of the cost-quality ratio for every suitable (paid) time interval – e.g. for seconds, minutes, and hours.

- The paid traffic intensity (Y) depends from the network traffic load.

- The instantaneous values of the quality indicator (Q) depend of many factors, including network load.

7. Qualitative comparison of the indicators

Mean CQR:

$$\frac{Cost\ \ per\ Unit}{Quality} = \frac{SC}{Q\ \ paid.V}$$

Instantaneous CQR:

$$\frac{Cost\ \ per\ Unit}{Quality} = \frac{SC}{\Delta t}\ \ \frac{1}{Q\ \ paid.Y}$$

- The both concepts are equivalent (the mean of the values of the Instantaneous CQR, in Δt , gives the value of the Mean CQR in Δt);
- Methods of their estimation and usage are different.
- The Mean Cost-Quality Ratio is suitable for relatively long intervals – days, months, years.

8. Prediction of NCQR (1/2)

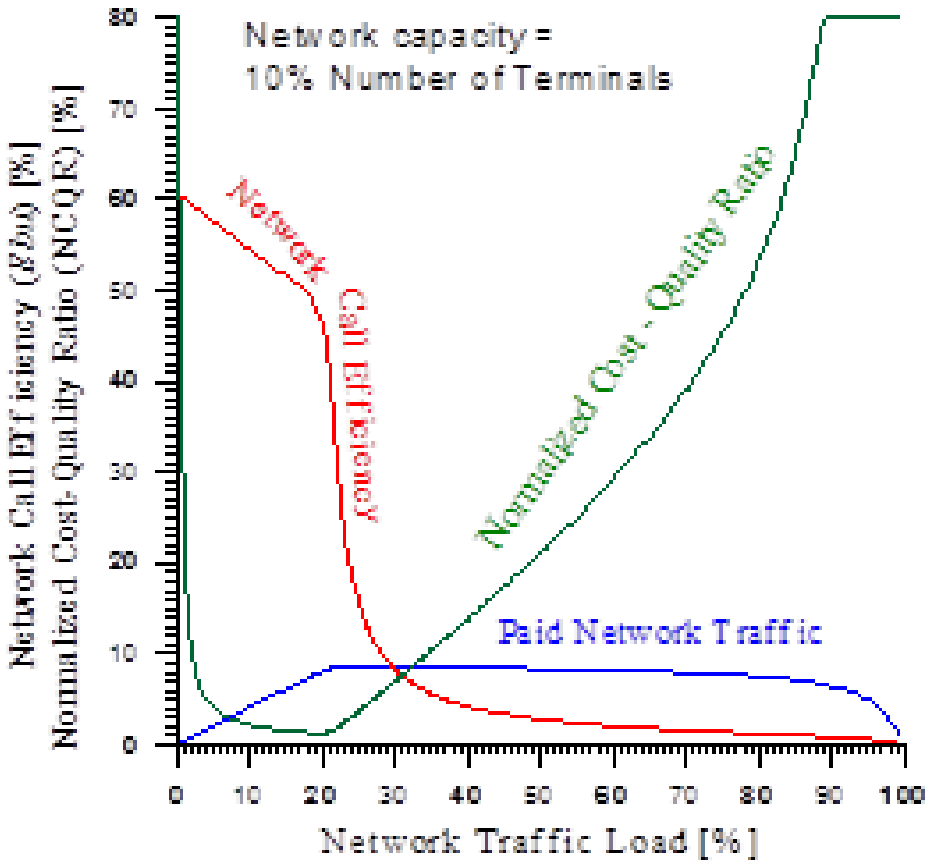
$$Normalized\ Cost\text{-}Quality\ Ratio(\ NCQR\ ) = \frac{1}{Q\ \ paid.Y\ [Erlang]}.$$

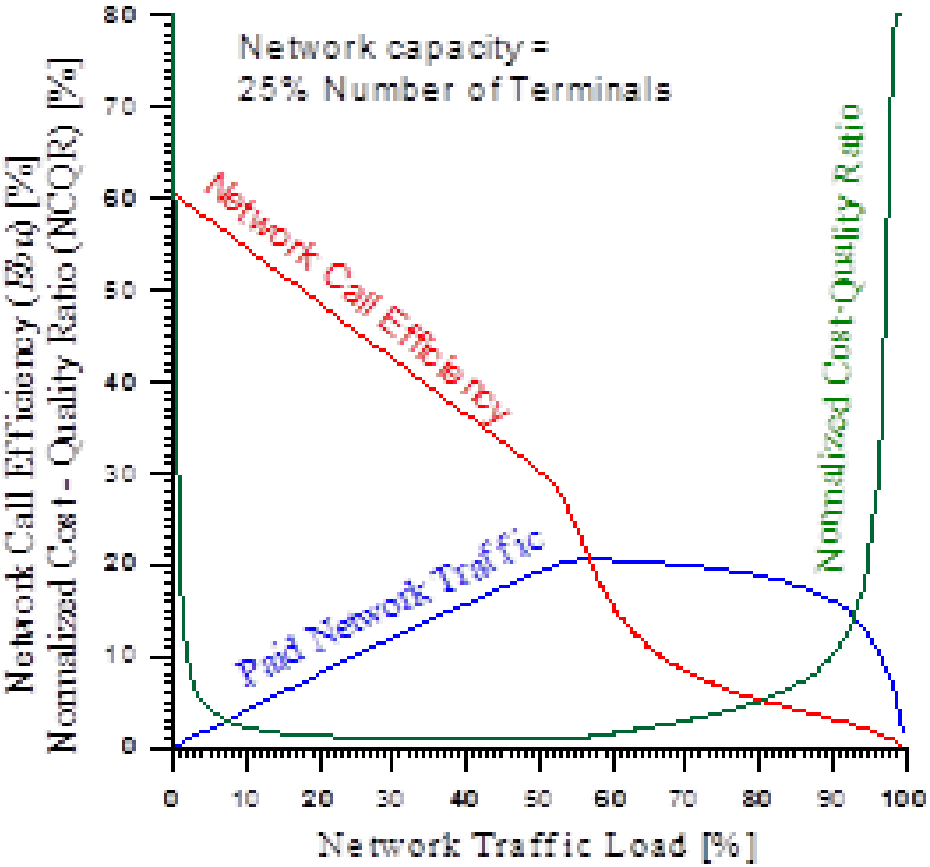
- The NCQR is independent from the absolute system's costs amount.
- This allows separation in estimations of NCQR and System' Cost Intensity (SCI).

In this Section we will estimate NCQR using an overall telecom system model as described in [Poryazov et al 2018], and:

$$NCQR = \frac{1}{Ebu\ \ paid.Y}$$

8. Prediction of NCQR (2/2)





The results show considerable sensitivity of the Normalized Cost-Quality Ratio (NCQR) from the network capacity and traffic load.

9. Conclusion and Open Issues (1/2)

1. There are proposed concepts and analytical expressions of:

- System's Cost Intensity;
- Mean Cost-Quality Ratio
- Instantaneous Cost-Quality Ratio
- Normalized Cost-Quality Ratio

9. Conclusion and Open Issues (2/2)

2. An extended Telecom System Performance Model is proposed,

- including human and technical characteristics,
- allowing value prediction of key QoS indicators of composite services;

3. Development of dynamic pricing policies, using Instantaneous Cost-Quality Ratio is an open issue.

THANK YOU

Questions and remarks are welcome