Body of European Regulators for Electronic Communications

BEREC

BEREC Guidelines on Very High Capacity Networks

Call for initial Stakeholder Input: Comment on DRAFT Questionnaires

11 March 2019

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1 Introduction and objectives

This document invites stakeholders to provide an initial input to the development of the BEREC guidelines on very high capacity networks. Stakeholders expressed their wish to have the possibility to be able to get involved early in the development of BEREC guidelines. This document now provides this opportunity.

Promoting access to and take-up of very high capacity networks is one of the main goals of the European Electronic Communications Code (EECC, Art. 3).[1]

The term "very high capacity network" is defined in the EECC as "*an electronic communications network which consists wholly of optical fibre elements at least up to the distribution point at the serving location or an electronic communications network which is capable of delivering, under usual peak-time conditions, similar network performance in terms of available downlink and uplink bandwidth, resilience, error-related parameters, and latency and its variation*" (Art. 2(2)).

Recital (13) further clarifies that "*in the case of fixed-line connection, this corresponds to network performance equivalent to what is achievable by an optical fibre installation up to a multi-dwelling building, considered as the serving location" and "in the case of wireless connection, this corresponds to network performance similar to what is achievable based on an optical fibre installation up to the base station, considered as the serving location*."

According to Art 82 of the EECC BEREC shall "*by 21 December 2020, […] after consulting stakeholders and in close cooperation with the Commission, issue guidelines on the criteria that a network has to fulfil in order to be considered a very high capacity network, in particular in terms of down- and uplink bandwidth, resilience, error-related parameters, and latency and its variation. The national regulatory authorities shall take those guidelines into utmost account. BEREC shall update the guidelines by 31 December 2025, and regularly thereafter*."

BEREC therefore has to issue Guidelines on the criteria that a network has to fulfil in order to be considered a very high capacity network until 21 December 2020 at the latest. BEREC already started the work on these Guidelines and is now seeking input from stakeholders.

The BEREC guidelines need to define the (quantitative) performance targets a network has to meet in order to be considered a very high capacity network for the QoS parameters downlink and uplink bandwidth, resilience, error-related parameters, and latency and its variation.

In order to be able to do this, BEREC will collect data from stakeholders, in particular from network operators and vendors. **This call for initial stakeholder input will provide the possibility for stakeholders to comment on the draft questionnaires based on which data will be collected**. In a second step, the stakeholders will be asked to fill in the final questionnaires in around June 2019.

[1] Directive (EU) 2018/72 of the European Parliament and the Council establishing the European Electronic Communications Code, OJ L 321/36 of 17 Dec. 2018

The questions to the stakeholders follow immediately after each draft questionnaire.

Please provide comments to the draft questionnaires
but **do not yet fill them in!**

BEREC will ask you **at a later stage** in this project
(around June 2019) to fill in the final questionnaires!

2 General questions to stakeholders

Question 1 Do you know fixed network operators with copper access which have already deployed G.fast in their networks or have pilots or field trials with G.fast?

If this is the case, which operators? Please provide, if possible, also appropriate contact details.

Question 2 Do you know fixed network operators with coax access which have already deployed DOCSIS 3.1 in their networks or have pilots or field trials with DOCSIS 3.1?

If this is the case, which operators? Please provide, if possible, also appropriate contact details.

Question 3 What are in your view the relevant vendors to whom the questionnaires should be sent to? Please provide, if possible, also appropriate contact details.

Question 4 Do you know other data sources (e.g. literature, standards) which might be a useful source of information for the development of the BEREC guidelines on very high capacity networks?

If this is the case, which data sources? Why are they useful?

3 Draft questionnaire for fixed network operators with G.fast on copper twisted pair (at least pilot/field trial)

Please provide comments to the draft questionnaire but **do not yet fill it in!**

(1) Do you have a fixed network with **G.fast** deployment (at least pilot use or field trials) on **twisted pair** (Yes /No)?

If this is not the case, then it is not necessary to fill in this questionnaire.

(2) Do you have a fixed network based on fibre to the building (**FTTB**) with **G.fast** deployment (at least pilot use or field trials) on the in-building **twisted pair** (Yes /No)?

If this is not the case, then it is not necessary to fill in this questionnaire (please still return the questionnaire with your answers to question (1) and (2) to BEREC).

(3) What **end-user QoS** is **typically achievable** in your fixed network based on fibre to the **multi-dwelling building** with **G.fast** deployment on the in-building **twisted pair** with regard to the parameters a) to h) below?

Please provide end-user QoS values under the following conditions:

(i) Under usual peak-time conditions;
(ii) Services are provided to the end-users as it is currently the case; and
(iii) **For the service with the highest data rate (down+up) but in case the data rate would not be intentionally limited**;[2] and
(iv) Without excluding a certain frequency range in order to protect other DSL systems (e.g. VDSL2) (start frequency = 0 MHz).

Please provide (approximate) **typical[3] values** (e.g. median, no "up to" values) for the following QoS parameters:

a) Aggregated data rate[4] (Mbps)?
b) Downlink data rate (Mbps)?
c) Uplink data rate (Mbps)?
d) IP packet error ratio (Y.1540) (%)?
e) IP packet loss ratio (Y.1540) (%)?
f) Round-trip IP packet delay (RFC 2681) (ms)?
g) IP packet delay variation (RFC 3393) (ms)?
h) IP service availability (Y.1540) (%)?

[2] For example, in case the service with the highest data rate offered to end-users provides 300/30 Mbps, then usually the network (e.g. the subscriber access line) will intentionally be configured so that the end-user will generally not get more than 300/30 Mbps. If without such limitations the aggregated data rate is 500 Mbps under usual peak-time conditions, then the answer to parameter a) aggregated data rate should be 500 Mbps.

[3] The achievable QoS may depend on individual circumstances of each end-user (e.g. loop length, copper quality). Therefore, please provide for each QoS parameter a (approximate) typical value (e.g. median, no "up to" values).

[4] Downlink plus uplink data rate

Please provide, if possible, for the parameter a) aggregated data rate also the standard deviation.

Note to the QoS parameters:

- The QoS parameters need to be measured between end-user and the first point in the network where the traffic of the end-user services is handed over to other networks and in case of round-trip parameters back to the end-user.
- In case of the one-way parameters d), e), g) and h) the values should be as much as possible representative for both downlink and uplink. If this is not possible, then please provide the values separately for downlink and uplink.

(4) Your answers to question (3) above are based on:

a) What upper edge of the G.fast frequency spectrum (e.g. 106 MHz, 212 MHz)?

b) How many twisted pairs per end-user service (e.g. 1, 2-bonded)?

c) What typical copper loop length?

d) Which other relevant parameters?

(5) Are the downlink and uplink data rate of your answers to questions (3)b) and (3)c) above freely configurable as long as the sum of them does not exceed the aggregated data rate? If not, why not and what are the limitations?

(6) What is the downlink and uplink data rate of the service with the highest data rate currently provided by your network based on fibre to the multi-dwelling building with copper access and G.fast ?

(7) What is the status of G.fast deployment in your network:
a) Field trials (Yes/No)?
b) Pilot deployment(s) (Yes/No)?
c) Regular operation (Yes/No)?

(8) Since when G.fast has been deployed in your network?

(9) How many end-users are currently provided with services based on G.fast?
a) =< 1000 ?
b) > 1,000 – 10,000 ?
c) > 10,000 – 100,000 ?
d) > 100,000 ?

4 Questions to stakeholders with regard to the draft questionnaire of section 3

The questions to stakeholders in this section refer to the draft questionnaire for fixed network operators with copper access and G.fast (at least pilot/field trial) (see section 3).

Question 5 Are question (3), conditions (i) to (iv) and the note to the QoS parameters of this draft questionnaire clear and is it possible for you to answer this question?

If this is not the case, where would clarification be needed? What would be necessary to be adapted in order to enable you to answer this question?

Question 6 Is it possible for you to answer question (3) for all QoS parameters (a) to h)?

If this is not the case, which QoS parameters you are not able to answer and for what reasons? What would be necessary to adapt in order to enable you to answer them? Would you be able to answer question (3) for a similar QoS parameter? If this is the case, which?

Question 7 The end-user QoS needs to be defined also with regard to "*error-related parameters*" (see EECC Art. 2(2), Art. 82). In your view, are other parameters than IP packet error ratio (Y.1540) and IP packet loss ratio (Y.1540) a more appropriate "*error-related parameter*"?

If this is the case, which parameters and why are they more appropriate? Would you be able to answer question (3) for these parameters?

Question 8 The end-user QoS needs to be defined also with regard to "*resilience*" (see EECC Art. 2(2), Art. 82). In your view, is another parameter than IP service availability (Y.1540) a more appropriate parameter for "resilience"?

If this is the case, which parameter and why is it more appropriate? Would you be able to answer question (3) for this parameter?

Question 9 Do other parameters than those question (4) asks for have a significant impact on your answers to question (3)?

If this is the case, which parameters and why do they have a significant impact on your answers to question (3)?

5 Draft questionnaire for fixed network operators with fibre to the building (FTTB) and coax access

Please provide comments to the draft questionnaire but **do not yet fill it in!**

(1) Do you have a fixed network based on fibre to the building (**FTTB**) and **coax** access (Yes/No)?

If this is not the case, then it is not necessary to fill in this questionnaire.

(2) What **end-user QoS** is **typically achievable** in your fixed network based on fibre to the **multi-dwelling building** with in-building **coax access** with regard to the parameters a) to g) below?

Please provide end-user QoS values under the following conditions:

(i) Under usual peak-time conditions;
(ii) With the technology deployed in the coax access network that enables the highest QoS;
(iii) Services are provided to the end-users as it is currently the case; and
(iv) For the service with the highest data rate (down+up) but in case the data rate would not be intentionally limited.[5]

Please provide (approximate) **typical[6] values** (e.g. median, no "up to" values) for the following QoS parameters:

a) Downlink data rate (Mbps)?
b) Uplink data rate (Mbps)?
c) IP packet error ratio (Y.1540) (%)?
d) IP packet loss ratio (Y.1540) (%)?
e) Round-trip IP packet delay (RFC 2681) (ms)?
f) IP packet delay variation (RFC 3393) (ms)?
g) IP service availability (Y.1540) (%)?

Please provide, if possible, for the parameter a) downlink data rate also the standard deviation.

Note to the QoS parameters:

- The QoS parameters need to be measured between end-user and the first point in the network where the traffic of the end-user services is handed over to other networks and in case of round-trip parameters back to the end-user.

[5] For example, in case the service with the highest data rate offered to end-users provides in downlink 300 Mbps, then usually the network will be intentionally configured so that in downlink the end-user will generally not get more than 300 Mbps. If without such limitations the downlink data rate is 500 Mbps under usual peak-time conditions, then the answer to parameter a) downlink data rate should be 500 Mbps.

[6] The achievable QoS may depend on individual circumstances of each end-user (e.g. length of the coax cable, coax quality). Therefore, please provide for each QoS parameter a (approximate) typical value (e.g. median, no "up to" values).

- In case of the one-way parameters c), d), f) and g) the values should be as much as possible representative for both downlink and uplink. If this is not possible, then please provide the values separately for downlink and uplink.

(3) Your answers to question (2) above are based on:

a) Which access technology:
   i. DOCSIS 3.1 Full Duplex (Yes/No)?
   ii. DOCSIS 3.1 (Yes/No)?
   iii. DOCSIS 3.0 (Yes/No)?
   iv. G.fast (Yes/No)?
   v. Other (Yes/No)?
   If this is the case, which access technology?

b) Which frequency range is used in case of
   i. DOCSIS:
      - In downstream direction (e.g. 620 – 1218 MHz)?
      - In upstream direction (e.g. 5 – 204 MHz)?
   ii. G.fast (e.g. 2.2 – 212 MHz)?
   iii. Other access technologies?

c) How many end-users per multi-dwelling building to whom a service is provided?

d) How many end-users per multi-dwelling building who use their service typically simultaneously during peak-time?

e) What typical length of the coax cable (between optical access node[7] and end-user)?

f) Which other relevant parameters?

(4) What is the downlink and uplink data rate of the service with the highest data rate currently provided by your network based on fibre to the multi-dwelling building with coax access?

(5) What is the status of the deployment of the technology according to question (3)a):
   a) Field trials (Yes/No)?
   b) Pilot deployment(s) (Yes/No)?
   c) Regular operation (Yes/No)?

(6) Since when the technology according to question (3)a) has been deployed in your network?

[7] The optical access node is the node where the fibre-based network ends and the coax-based access network begins (seen in downstream direction).

(7) How many end-users are currently provided with services based on the technology according to question (3)a)?
   a) =< 1000 ?
   b) > 1,000 – 10,000 ?
   c) > 10,000 – 100,000 ?
   d) > 100,000 ?

6 Questions to stakeholders with regard to the draft questionnaire in section 5

The questions to stakeholders in this section refer to the draft questionnaire for fixed network operators with fibre to the building (FTTB) and coax access (see section 5).

Question 10 Are question (2), conditions (i) to (iv) and the note to the QoS parameters of this draft questionnaire clear and is it possible for you to answer this question?

If this is not the case, where would clarification be needed? What would be necessary to be adapted in order to enable you to answer this question?

Question 11 Is it possible for you to answer question (2) for all QoS parameters a) to g)?

If this is not the case, which QoS parameters you are not able to answer and for what reasons? What would be necessary to adapt in order to enable you to answer them? Would you be able to answer question (2) for a similar QoS parameter? If this is the case, which?

Question 12 The end-user QoS needs to be defined also with regard to "*error-related parameters*" (see EECC Art. 2(2), Art. 82). In your view, are other parameters than IP packet error ratio (Y.1540) and IP packet loss ratio (Y.1540) a more appropriate "*error-related parameter*"?

If this is the case, which parameters and why are they more appropriate? Would you be able to answer question (2) for these parameters?

Question 13 The end-user QoS needs to be defined also with regard to "*resilience*" (see EECC Art. 2(2), Art. 82). In your view, is another parameter than IP service availability (Y.1540) a more appropriate parameter for "resilience"?

If this is the case, which parameter and why is it more appropriate? Would you be able to answer question (2) for this parameter?

Question 14 Do other parameters than those question (3) asks for have an significant impact on your answers to question (2)?

If this is the case, which parameters and why do they have a significant impact on your answers to question (2)?

7 Draft questionnaire for fixed network operators with fibre to the home (FTTH)

Please provide comments to the draft questionnaire but **do not yet fill it in!**

(1) Do you have a fixed network based on fibre to the home (**FTTH**) (Yes/No)?
If this is not the case, then it is not necessary to fill in this questionnaire.

(2) What **end-user QoS** is **typically achievable** in your fixed network based on fibre to the home (**FTTH**) with regard to the parameters a) to g) below?

Please provide end-user QoS values under the following conditions:

(i) Under usual peak-time conditions;
(ii) With the technology deployed in the FTTH network that enables the highest QoS (e.g. most advanced PON technology);
(iii) Services are provided to the end-users as it is currently the case; and
(iv) For the service with the highest data rate (down+up) but in case the data rate would not be intentionally limited.[8]

Please provide (approximate) **typical**[9] **values** (e.g. median, no "up to" values) for the following QoS parameters:

a) Downlink data rate (Mbps)?
b) Uplink data rate (Mbps)?
c) IP packet error ratio (Y.1540) (%)?
d) IP packet loss ratio (Y.1540) (%)?
e) Round-trip IP packet delay (RFC 2681) (ms)?
f) IP packet delay variation (RFC 3393) (ms)?
g) IP service availability (Y.1540) (%)?

Please provide, if possible, for the parameter a) downlink data rate also the standard deviation.

Note to the QoS parameters:

- The QoS parameters need to be measured between end-user and the first point in the network where the traffic of the end-user services is handed over to other networks and in case of round-trip parameters back to the end-user.
- In case of the one-way parameters c), d), f) and g) the values should be as much as possible representative for both downlink and uplink. If this is not possible, then please provide the values separately for downlink and uplink.

[8] For example, in case the service with the highest data rate offered to end-users provides in downlink 300 Mbps, then usually the network will be intentionally configured so that in downlink the end-user will generally not get more than 300 Mbps. If without such limitations the downlink data rate is 500 Mbps under usual peak-time conditions, then the answer to parameter a) downlink data rate should be 500 Mbps.

[9] The achievable QoS may depend on individual circumstances of each end-user (e.g. fibre quality). Therefore, please provide for each QoS parameter a (approximate) typical value (e.g. median, no "up to" values).

(3) Your answers to question (2) above are based on:

a) Which access topology:
   (i) Point-to-multi point fibre (PON[10]) (Yes/No)?
   (ii) Point-to-point fibre (Yes/No)?

b) Which access technology:
   (i) NG-PON2 TWDM (Yes/No)?
   (ii) XGS- PON (Yes/No)?
   (iii) XG-PON (Yes/No)?
   (iv) G-PON (Yes/No)?
   (v) Ethernet switch (Yes/No)?
   (vi) Other (Yes/No)?
   If this is the case, which?

c) In case of PON:
   i. How many end-users per OLT[11] to whom a service is provided?
   ii. How many end-users per OLT[11] who use their service typically simultaneously during peak-time?

d) Which other relevant parameters?

(4) What is the downlink and uplink data rate of the service with the highest data rate currently provided by your FTTH network?

(5) What is the status of the deployment of the technology according to question (3)b):
   a) Field trials (Yes/No)?
   b) Pilot deployment(s) (Yes/No)?
   c) Regular operation (Yes/No)?

(6) Since when the technology according to question (3)b) has been deployed in your network?

(7) How many end-users are currently provided with services based on the technology according to question (3)b)?
   a) =< 1000 ?
   b) > 1,000 – 10,000 ?
   c) > 10,000 – 100,000 ?
   d) > 100,000 ?

[10] Passive Optical Network
[11] Optical Line Terminal

8 Questions to stakeholders with regard to the draft questionnaire in section 7

The questions to stakeholders in this section refer to the draft questionnaire for fixed network operators with fibre to the home (FTTH) (see section 7).

Question 15 Are question (2), conditions (i) to (iv) and the note to the QoS parameters of this draft questionnaire clear and is it possible for you to answer this question?

If this is not the case, where would clarification be needed? What would be necessary to be adapted in order to enable you to answer this question?

Question 16 Is it possible for you to answer question (2) for all QoS parameters a) to g)?

If this is not the case, which QoS parameters you are not able to answer and for what reasons? What would be necessary to adapt in order to enable you to answer them? Would you be able to answer question (2) for a similar QoS parameter? If this is the case, which?

Question 17 The end-user QoS needs to be defined also with regard to "*error-related parameters*" (see EECC Art. 2(2), Art. 82). In your view, are other parameters than IP packet error ratio (Y.1540) and IP packet loss ratio (Y.1540) a more appropriate "*error-related parameter*"?

If this is the case, which parameters and why are they more appropriate? Would you be able to answer question (2) for these parameters?

Question 18 The end-user QoS needs to be defined also with regard to "*resilience*" (see EECC Art. 2(2), Art. 82). In your view, is another parameter than IP service availability (Y.1540) a more appropriate parameter for "resilience"?

If this is the case, which parameter and why is it more appropriate? Would you be able to answer question (2) for this parameter?

Question 19 Do other parameters than those question (3) asks for have a significant impact on your answers to question (2)?

If this is the case, which parameters and why do they have a significant impact on your answers to question (2)?

9 Draft questionnaire for mobile network operators with LTE Advanced

Please provide comments to the draft questionnaire but **do not yet fill it in!**

(1) Do you have a mobile network which is at least in some parts based on **fibre** roll-out up **to the base station**, **LTE**, **carrier aggregation**[12] and **MIMO**[12] (Yes/No)?
If this is not the case, then it is not necessary to fill in this questionnaire.

(2) What end-user QoS is **typically achievable** in your mobile network based on **fibre** roll-out up **to the base station, LTE, carrier aggregation** and **MIMO** with regard to the parameters a) to g) below?

Please provide end-user QoS values under the following conditions:

(i) Only consider the part of your mobile network with fibre to the base station, the highest aggregated bandwidth (e.g. 60 MHz) and the highest number of parallel MIMO data streams (e.g. 4x4 MIMO);
(ii) Under usual peak-time conditions;
(iii) Services are provided to the end-users as it is currently the case; and
(iv) For the service with the highest data rate (down+up) but in case the data rate would not be intentionally limited.[13]

Please provide (approximate) **typical**[14] **values** (e.g. median, no "up to" values) for the following end-user QoS parameters:

a) Downlink data rate (Mbps)?
b) Uplink data rate (Mbps)?
c) IP packet error ratio (Y.1540) (%)?
d) IP packet loss ratio (Y.1540) (%)?
e) Round-trip IP packet delay (RFC 2681) (ms)?
f) IP packet delay variation (RFC 3393) (ms)?
g) IP service availability (Y.1540) (%)?

Please provide, if possible, for the parameter a) downlink data rate also the standard deviation.

[12] At least in downstream direction (MIMO stands for Multiple-Input and Multiple-Output)
[13] For example, in case the service with the highest data rate offered to end-users provides in downlink 100 Mbps, then usually the network will be intentionally configured so that the end-user will in downlink generally not get more than 100 Mbps. If without such limitations the downlink data rate is 120 Mbps under usual peak-time conditions, then the answer to parameter a) downlink data rate should be 120 Mbps.
[14] The achievable QoS may depend on individual circumstances of each end-user (e.g. distance of end-user from base station, attenuation of buildings, interferences). Therefore, please provide for each QoS parameter a (approximate) typical value (e.g. median, no "up to" values).

Note to the QoS parameters:

- The QoS parameters need to be measured between end-user and the first point in the network where the traffic of the end-user services is handed over to other networks and in case of round-trip parameters back to the end-user.
- In case of the one-way parameters c), d), f) and g) the values should be as much as possible representative for both downlink and uplink. If this is not possible, then please provide the values separately for downlink and uplink.

(3) Your answers to question (2) above are based on:

a) What aggregated bandwidth of the carrier aggregation:
   i. In downlink direction (e.g. 80 MHz)?
   ii. In uplink direction (e.g. 40 MHz)?

b) What number of parallel MIMO data streams:
   i. In downlink direction (e.g. 8x8 MIMO)?
   ii. In uplink direction (e.g. 4x4 MIMO)?

c) What number of QAM[15]:
   i. In downlink direction (e.g. 256 QAM)?
   ii. In uplink direction (e.g. 64 QAM)?

d) How many end-users per cell who use their service typically simultaneously during peak-time?

e) Which other relevant parameters?

(4) What is the downlink and uplink data rate of the service with the highest data rate currently provided by your network based on fibre roll-out up to the base station, LTE, carrier aggregation and MIMO?

(5) Since when LTE with carrier aggregation and MIMO has been deployed in your network?

(6) How many base stations are currently connected with fibre and equipped with LTE with the highest aggregated bandwidth (e.g. 60 MHz) and the highest number of parallel MIMO data streams (e.g. 4x4 MIMO)?
   a) =< 100 ?
   b) > 100 – 1,000 ?
   c) > 1000?

[15] Quadrature Amplitude Modulation

10 Questions to stakeholders with regard to the draft questionnaire in section 9

The questions to stakeholders in this section refer to the draft questionnaire for mobile network operators with LTE Advanced (see section 9).

Question 20 Are question (2), conditions (i) to (iv) and the note to the QoS parameters of this draft questionnaire clear and is it possible for you to answer this question?

If this is not the case, where would clarification be needed? What would be necessary to be adapted in order to enable you to answer this question?

Question 21 Is it possible for you to answer question (2) for all QoS parameters a) to g)?

If this is not the case, which QoS parameters you are not able to answer and for what reasons? What would be necessary to adapt in order to enable you to answer them? Would you be able to answer question (2) for a similar QoS parameter? If this is the case, which?

Question 22 The end-user QoS needs to be defined also with regard to "*error-related parameters*" (see EECC Art. 2(2), Art. 82). In your view, are other parameters than IP packet error ratio (Y.1540) and IP packet loss ratio (Y.1540) a more appropriate "*error-related parameter*"?

If this is the case, which parameters and why are they more appropriate? Would you be able to answer question (2) for these parameters?

Question 23 The end-user QoS needs to be defined also with regard to "*resilience*" (see EECC Art. 2(2), Art. 82). In your view, is another parameter than IP service availability (Y.1540) a more appropriate parameter for "resilience"?

If this is the case, which parameter and why is it more appropriate? Would you be able to answer question (2) for this parameter?

Question 24 Do other parameters than those question (3) asks for have an significant impact on your answers to question (2)?

If this is the case, which parameters and why do they have a significant impact on your answers to question (2)?

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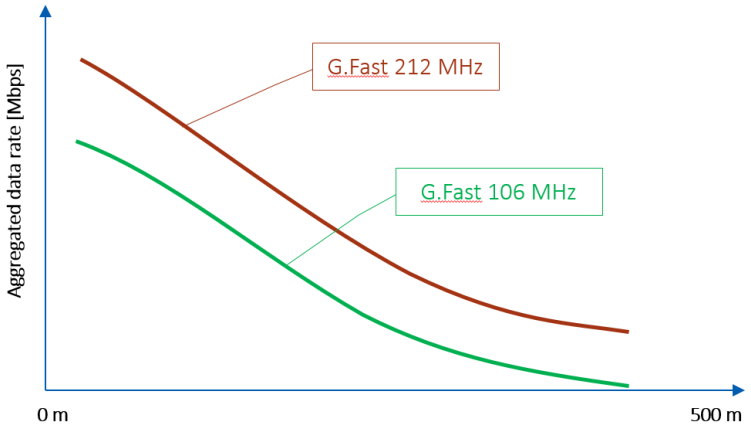
11 Draft questionnaire for vendors of equipment for fixed networks with G.fast

Please provide comments to the draft questionnaire but **do not yet fill it in!**

(1) What aggregated data rate is **typically achievable** in a fixed network with copper or coax access and **G.fast** under the conditions mentioned below?

Since the answer depends on the length of the copper loop please provide a chart which shows the data rate (y-axis) as a function of the copper loop length up to 500 m (x-axis).



a) Copper (twisted pair) access and G.fast 212 MHz (start frequency 0 MHz)
b) Copper (twisted pair) access and G.fast 106 MHz (start frequency 0 MHz)
c) Coax access and G.fast 212 MHz (start frequency 0 MHz)
d) Coax access and G.fast 106 MHz (start frequency 0 MHz)

Conditions:

(i) Based on one copper line (twisted pair) per end-user (no bonding)
(ii) Based on typical European operators' copper lines (e.g. with regard to diameter, quality); and
(iii) All copper lines of a cable (binder) are controlled by one vectoring system.

In case the downstream and upstream data rate is not completely free configurable (as long as the sum of them does not exceed the aggregated data rate), please describe the limitations which apply.

(2) What **maximum end-user QoS** is **typically achievable** in a **copper (twisted pair)** based **access network** with **G.fast** and a loop length of **up to 100 m**?

Please provide (approximate) QoS values under the following conditions:

(i) Under usual peak-time conditions;
(ii) Not limiting the data rate e.g. through configurations, traffic policing etc.;
(iii) Based on one copper line (twisted pair) per end-user (no bonding);
(iv) Based on typical European operators' copper lines (e.g. with regard to diameter, quality); and
(v) All copper lines of a cable (binder) are controlled by one vectoring system

Access technology	**Downlink data rate (Mbps)**	**Uplink data rate (Mbps)**	**IP packet error ratio (Y.1540) (%)**	**IP packet loss ratio (Y.1540)(%)**	**Round-trip IP packet delay (RFC 2681) (ms)**	**IP packet delay variation (RFC 3393) (ms)**	**IP service availability (Y.1540) (%)**
G.fast 106 MHz (start frequency 0 MHz)							
G.fast 212 MHz (start frequency 0 MHz)							

Note to the QoS parameters:

- The QoS parameters refer to the distance between end-user and **port at the network side** of the **access node** (e.g. DPU[16]) where the copper access network ends and the fibre-based network begins and in case of round-trip parameters back to the end-user.
- In case of the one-way parameters, the values should be as much as possible representative for both downlink and uplink. If this is not possible, then please provide the values separately for downlink and uplink.

[16] Distribution Point Unit

12 Questions to stakeholders to the draft questionnaire in section 11

The questions to stakeholders in this section refer to the draft questionnaire for vendors of equipment for fixed networks with G.fast (see section 11).

Question 25 Are question (1) and conditions (i) and (iii) of this draft questionnaire clear and is it possible for you to answer this question?

If this is not the case, where would clarification be needed? What would be necessary to be adapted in order to enable you to answer this question?

Question 26 Are question (2), conditions (i) to (v) and the note to the QoS parameters clear and is it possible for you to answer this question?

If this is not the case, what would need clarification? What would be necessary to adapt in order to enable you to answer this question?

Question 27 Is it possible for you to answer question (2) for all QoS parameters listed in the table?

If this is not the case, which QoS parameters you are not able to answer and for what reasons? What would be necessary to adapt in order to enable you to answer them? Would you be able to answer question (2) for a similar QoS parameter? If this is the case, which?

Please note, for comparison reasons all QoS parameters need to be applicable not only to the copper-based access but to an entire network which includes e.g. also the fibre-based aggregation.

Question 28 The end-user QoS needs to be defined also with regard to "*error-related parameters*" (see EECC Art. 2(2), Art. 82). In your view, are other parameters than IP packet error ratio (Y.1540) and IP packet loss ratio (Y.1540) a more appropriate "*error-related parameter*"?

If this is the case, which parameters and why are they more appropriate? Would you be able to answer question (2) for these parameters?

Please note, for comparison reasons the “*error-related parameters*” need to be applicable not only to the copper-based access but to an entire network which includes e.g. also the fibre-based aggregation.

Question 29 The end-user QoS needs to be defined also with regard to “*resilience*” (see EECC Art. 2(2), Art. 82). In your view, is another parameter than IP service availability (Y.1540) a more appropriate parameter for “*resilience*”?

If this is the case, which parameter and why is it more appropriate? Would you be able to answer question (2) for this parameter?

Please note, for comparison reasons the parameters for “*resilience*” need to be applicable not only to the copper-based access but to an entire network which includes e.g. also the fibre-based aggregation.

13 Draft questionnaire for vendors of equipment for fixed networks with coax access

Please provide comments to the draft questionnaire but **do not yet fill it in!**

(1)What downlink and uplink data rate is **typically achievable** in a fixed network with **coax** access with **DOCSIS 3.0** and **DOCSIS 3.1**?

Since the answer depends on the number of end-users that use the coax network simultaneously please provide a chart which shows the data rate (y-axis) as a function of the number of end-users that use the coax network simultaneously (x-axis).

Please answer this question for a typical European operators' coax access network (e.g. with regard to quality, interferences).

a) DOCSIS 3.0
b) DOCSIS 3.1
c) DOCSIS 3.1 Full Duplex

(2) What **maximum end-user QoS** is **typically achievable** in a **coax access network** which provides services to **10 or 30 end-users** per optical access node[17] based on **DOCSIS 3.0** and **DOCSIS 3.1**?

Please provide (approximate) QoS values under the following conditions:

(i) Under usual peak-time conditions;

(ii) Not limiting the data rate e.g. through configurations, traffic policing etc.

(iii) For a typical European operators' coax access network (e.g. with regard to quality, interferences).

For 10 end-users	**Downlink data rate (Mbps)**	**Uplink data rate (Mbps)**	**IP packet error ratio (Y.1540) (%)**	**IP packet loss ratio (Y.1540) (%)**	**Round-trip IP packet delay (RFC 2681) (ms)**	**IP packet delay variation (RFC 3393) (ms)**	**IP service availability (Y.1540) (%)**
DOCSIS 3.0							
DOCSIS 3.1							
DOCSIS 3.1 Full Duplex							

For 30 end-users	**Downlink data rate (Mbps)**	**Uplink data rate (Mbps)**	**IP packet error ratio (Y.1540) (%)**	**IP packet loss ratio (Y.1540) (%)**	**Round-trip IP packet delay (RFC 2681) (ms)**	**IP packet delay variation (RFC 3393) (ms)**	**IP service availability (Y.1540) (%)**
DOCSIS 3.0							
DOCSIS 3.1							
DOCSIS 3.1 Full Duplex							

Note to the QoS parameters:

- The QoS parameters refer to the distance between end-user and **port at the network side** of the **optical access node**[17] where the coax access network ends and the fibre-based network begins and in case of round-trip parameters back to the end-user.
- In case of the one-way parameters, the values should be as much as possible representative for both downlink and uplink. If this is not possible, then please provide the values separately for downlink and uplink.

[17] The optical access node is the node where the fibre-based network ends and the coax-based access network begins (seen in downstream direction).

14 Questions to stakeholders to the draft questionnaire in section 13

The questions to stakeholders in this section refer to the draft questionnaire for vendors of equipment for fixed networks with coax access (see section 13).

Question 30 Is question (1) of this draft questionnaire clear and is it possible for you to answer this question?

If this is not the case, where would clarification be needed? What would be necessary to be adapted in order to enable you to answer this question?

Question 31 Are question (2), conditions (i) to (iii) and the note to the QoS parameters clear and is it possible for you to answer this question?

If this is not the case, what would need clarification? What would be necessary to adapt in order to enable you to answer this question?

Question 32 Is it possible for you to answer question (2) for all QoS parameters listed in the table?

If this is not the case, which QoS parameters you are not able to answer and for what reasons? What would be necessary to adapt in order to enable you to answer them? Would you be able to answer question (2) for a similar QoS parameter? If this is the case, which?

Please note, for comparison reasons all QoS parameters need to be applicable not only to the coax-based access but to an entire network which includes also the fibre-based part of the network.

Question 33 The end-user QoS needs to be defined also with regard to "*error-related parameters*" (see EECC Art. 2(2), Art. 82). In your view, are other parameters than IP packet error ratio (Y.1540) and IP packet loss ratio (Y.1540) a more appropriate "*error-related parameter*"?

If this is the case, which parameters and why are they more appropriate? Would you be able to answer question (2) for these parameters?

Please note, for comparison reasons the "*error-related parameters*" need to be applicable not only to the coax-based access but to an entire network which includes also the fibre-based part of the network.

Question 34 The end-user QoS needs to be defined also with regard to "*resilience*" (see EECC Art. 2(2), Art. 82). In your view, is another parameter than IP service availability (Y.1540) a more appropriate parameter for "resilience"?

If this is the case, which parameter and why is it more appropriate? Would you be able to answer question (2) for this parameter?

Please note, for comparison reasons the parameters for "*resilience*" need to be applicable not only to the coax-based access but to an entire network which includes also the fibre-based part of the network.

15 Draft questionnaire for vendors of equipment for mobile network operators

Please provide comments to the draft questionnaire but **do not yet fill it in!**

(1) What end-user QoS is **typically achievable** in a mobile network based on **fibre** roll-out up **to the base station**, **LTE**, **carrier aggregation** and **MIMO**?

Please provide (approximate) QoS values under the following conditions:

(i) Under usual peak-time conditions;

(ii) Services are provided to the end-users as it is currently the case; and

For the service with the highest data rate (down+up) without limiting the data rate to what the end-user has subscribed for.

Access technology		Downlink data rate (Mbps)	Uplink data rate (Mbps)	IP packet error ratio (Y.1540) (%)	IP packet loss ratio (Y.1540) (%)	Round-trip IP packet delay (RFC 2681) (ms)	IP packet delay variation (RFC 3393) (ms)	IP service availability (Y.1540) (%)
Carrier Aggregation	MIMO							
Down 100 MHz Up 80 MHz	Down 8x8 Up 4x4							
Down 80 MHz Up 60 MHz	Down 8x8 Up 4x4							
Down 80 MHz Up 40 MHz	Down 6x6 Up 4x4							
Down 60 MHz Up 40 MHz	Down 6x6 Up 2x2							
Down 60 MHz Up 20 MHz	Down 4x4 Up 2x2							

Note to the QoS parameters:

- The QoS parameters need to be measured between end-user and the first point in the network where the traffic of the end-user services is handed over to other networks and in case of round-trip parameters back to the end-user.
- In case of one-way parameters the values should be as much as possible representative for both downlink and uplink. If this is not possible, then please provide the values separately for downlink and uplink.

(2) Please provide any information which could be used to answer question (1) above or question (2) of the draft questionnaire for mobile network operators (see section 9).

16 Questions to stakeholders to the draft questionnaire in section 15

The questions to stakeholders in this section refer to the draft questionnaire for vendors of equipment for mobile network operators (see section 15).

Question 35 Are question (1), conditions (i) to (ii) and the note to the QoS parameters clear and is it possible for you to answer this question?

If this is not the case, what would need clarification? What would be necessary to adapt in order to enable you to answer this question?

Question 36 Is it possible for you to answer question (1) for all QoS parameters listed in the table?

If this is not the case, which QoS parameters you are not able to answer and for what reasons? What would be necessary to adapt in order to enable you to answer them? Would you be able to answer question (1) for a similar QoS parameter? If this is the case, which?

Question 37 The end-user QoS needs to be defined also with regard to "*error-related parameters*" (see EECC Art. 2(2), Art. 82). In your view, are other parameters than IP packet error ratio (Y.1540) and IP packet loss ratio (Y.1540) a more appropriate "*error-related parameter*"?

If this is the case, which parameters and why are they more appropriate? Would you be able to answer question (1) for these parameters?

Question 38 The end-user QoS needs to be defined also with regard to "*resilience*" (see EECC Art. 2(2), Art. 82). In your view, is another parameter than IP service availability (Y.1540) a more appropriate parameter for "resilience"?

If this is the case, which parameter and why is it more appropriate? Would you be able to answer question (1) for this parameter?

Question 39 Would you be able to provide information which could be used to answer question (1) of section 15 or question (2) of the draft questionnaire for mobile network operators (see section 9)?

If this is the case, which information and how could it be used to answer these questions?