EBG FEDERATION

EBG Federation's Response to TRAI Consultation Paper on Review Interconnection Usage Charges (IUC)

EBG Federation (EBG) was established on 11th March, 2015 as a Section 8 company under the Companies Act 2013 in order to ensure long term stability and clarity on its purpose as a not for profit organization offering support and advocacy for European businesses in India. Founded as the European Business Group (EBG), in 1997, as a joint initiative of the European Commission and the European Business Community in India, EBG has come to be recognized by the Indian Government and the European Commission as the industry advocacy group representing the interest of European companies in India.

EBG Federation is supported by the Delegation of the European Union to India and represents the 28 Member States of the European Union as well as accession countries and its partners in European Economic Area (EEA). The EU Ambassador is our Patron. Currently EBG has Chapters in Delhi, Mumbai, Bangalore and Chennai with approximately 170 companies as Members including a number of companies from the Telecom Sector. Mr. TV Ramachandran is currently the Chairman of the Telecom Sector Committee of the EBG.

The primary objective of EBG is to actively support growth in India-EU trade relations, become the most relevant advocate for European business in India and ensure that the needs of European business are well presented to policy and decision makers.

Introduction

1. An Interconnection Usage Charge (IUC) regime is an essential requirement to enable subscribers of one service provider to communicate with subscribers of another service provider. Providing interconnection entails costs for which service providers need to be fairly compensated. The IUC regime not only determines the revenue accruable to the service providers but also how this revenue is to be distributed among them.*

2. An efficient interconnection and charging regime is central to efficient and seamless connectivity between various networks, but more importantly a facilitator for rural investment and connectivity due to the usage profiles of rural customers, many of whom can only be connected in an economically feasible way with the recovery of their costs through IUCs.

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3. In fact, setting the level of IUC has a direct impact on promoting growth of subscribers (namely, the low income subscribers due to their specific traffic profile), maintaining network quality standards to the optimum level and investment in rural areas, as they represent a revenue source for operators who continue to deepen the reach of their networks. By adopting these types of strategies for network deployment, operators have a significant role to play in the promotion of economic benefits by allowing a broader range of consumers to access mobile communication services and, therefore promoting inclusion and economic growth

4. In the present multi-operator multi-service environment, it is necessary to define an effective Interconnection Usage Charges (IUC) regime that enables interconnection at a fair charge. **Providing interconnection network service involves costs for which telecom service providers need to be adequately compensated**.

5. Considering the ambitious government goals in connecting rural areas and national digital literacy mission in rural areas, it is key that the IUC regime balances public and private interests so that the continuous investments in network expansion and upgrades are incentivized while at the same time competition and consumer welfare is enhanced. Therefore, the IUC regime should be established in such a manner so that it promotes the closing of the existing digital divide in India while, protecting operators' investments.

6. **There is a consensus** amongst economists, accountants, engineers, experts, operators and regulators that **interconnection prices based on cost are most likely to lead to desirable outcomes**. While we understand the challenge to define an appropriate "cost-measure", we believe that it can be solved through proper cost analysis of financial and Non-financial information which are available in the annual and accounting separation reports of telecom service providers. *

7. Also, while choosing a specific cost methodology, one must take into utmost consideration the market situation and the main goals to drive market development. Therefore while some methodologies promote further investments in network deployment and increase of coverage and subscribers (such as FAC and LRAIC), other methodologies might be more suitable for countries with higher penetration rates, high coverage levels, high average revenues per users and mature markets (such as LRIC and Pure LRIC models). So, in assessing which is the most adequate cost

methodology to adopt, there are various factors that should be taken into consideration such as penetration rates (as measured by the number of people with access to mobile telephony rather than the number of active SIMs), available networks and coverage, network topologies spectrum allocations and cost of spectrum to total capital employed.

Bearing in mind the need for further investments in network deployment, increase in coverage and subscribers, we believe that adoption of an approach that achieves this end objective is crucial for the future development of the Indian market and achievement of stated Government policies. It is therefore imperative that the IUC/Termination Charges (Mobile Termination Rate/Fixed Termination Rate) should be cost based and compensatory.

8. The most important policy aspect for India is rural connectivity and bridging the urban-rural digital divide, which has hardly changed over the years.
In rural India, where income levels are much lower, the customer's incoming calls are 65-70% of the total. Hence, if the domestic termination rate i.e. mobile termination charge (MTC) doesn't cover the cost of terminating the call, there is no incentive for the operator to roll out the network at great cost and with much difficulty in the villages. We note that in Malaysia, some years ago, the regulator fixed MTC above cost in order to bridge the urban-rural divide existing at that time. TRAI must consider this if Digital India is to be realised.

9. Mobile networks benefit from the economics of density. The costs per unit of output are lower when sites, distribution outlets and customers are clustered together. Thus, it costs more to serve rural customers. Given the proportion of rural customers has increased from 28% in FY08 to about 40% now, the average cost of serving customers has increased. Termination charges, thus, should reflect the economics of expanding networks aggressively to connect the unconnected. It is a double-whammy for the operator if it extends the network to rural areas at high costs and then bleeds due to MTC not covering the termination cost.

Question-wise response

Q1: In view of the recent technological developments in the telecommunication services sector, which of the following approaches is appropriate for prescribing domestic termination charge (viz. mobile termination charge and fixed termination charge) for maximization of consumer welfare (i.e. adequate

choice, affordable tariff and good quality of service), adoption of more efficient technologies and overall growth of the telecommunication services sector in the country?
(i) Cost oriented or cost based termination charges; or
(ii) Bill and Keep (BAK)?
Please provide justification in support of your response.

EBG ANS 1:

1. TRAI data shows[1] that almost all the mature and advanced networks of developed regimes as well as developing regimes follow cost oriented or cost based MTC, not BAK.
2. Therefore ,It is submitted that domestic termination charges should be determined on cost based and work done principle.
3. To ensure investments on expanding network, the actual cost of call termination must be paid to operators. This means the terminating network must be compensated for the value of the resources it uses to provide the service—including the capital cost of those resources. While the method of calculating the value of these resources may be debated, compensating the company for resources used must be the touchstone.
4. We note that worldwide, wherever CPP regime is applied, regulators have implemented cost based/cost oriented costing approaches for interconnect pricing/IUC. To the best of our knowledge, we have not observed any country where CPP regime is in place in the retail market and a Bill and Keep (B&K) regime applies at the wholesale level. The following table published by TRAI in its consultation paper on Review of Interconnection Usage Charges, dated 27th April 2011 illustrates the same.

SL. No.	Country	Charging Method	Approach	MTC/FTC Regulated
1	**Australia**	CPP	Cost Based/ Cost Oriented	Yes
2	**Brazil**	CPP	Cost Based	Yes
3	**Canada**	RPP/BAK (Effective Bill and Keep)	Cost Based/ Cost Oriented	Yes
4	**China**[2]	RPP	Cost Oriented	Yes

[1] Please refer to the annexure of the Consultation Paper Page 37-40 – International experience on Mobile Termination Charges.

5	**Egypt**	CPP	Cost Oriented	Yes
6	**France**	CPP	Cost Based/ Cost Oriented	Yes
7	**Germany**	CPP	Cost Based/ Cost Oriented	Yes
8	**Hong Kong**	RPP	-	Free to set parties agree for "BAK"
9	**Italy**	CPP	Cost Oriented	Yes
10	**Korea**	RPP	Cost Based/ Cost Oriented	Yes
11	**Malaysia**	CPP	Cost Based/ Cost Oriented	Yes
12	**Pakistan**	CPP	Cost Based/ Cost Oriented	Yes
13	**South Africa**	CPP	Cost Based/ Cost Oriented	Yes
14	**UK**	CPP	Cost Based/ Cost Oriented	Yes (Capping of MTRs)
15	**USA**	RPP	F to M & M to F- **Reciprocal**	F to M & M to F- **Yes**
			M to M- Commercially Negotiated	M to M- **No**
Source: TRAI's CP on review of IUC dated 27th April 2011				

it is submitted that even in Europe, wherever Regulators have mandated IP based interconnection (IPvIC) in such cases also there is a cost based termination charges (MTC/FTC) is payable by respective operators (Please refer to annexure 1 and 2) *ANNEXURE 1:* ***Termination rates at European level, January 2016****: This document is an updated version of the benchmark of fixed and mobile Termination Rates (TRs) across Europe prepared by the BEREC Benchmarking Expert Working Group in cooperation with the BEREC Remedies Expert Working Group and the BEREC Office and aims to offer a picture of the regulated rates for fixed and mobile interconnection services in Europe. Fixed and mobile termination services in Europe are subject to price regulation.*

ANNEXURE 2: ***Case Studies on IP-based Interconnection for Voice Services in the European Union:*** *conclusion that from an overall perspective the IPvIC are rather*

[2] In 2010 China has switched to CPP from RPP

similar in general and important technical characteristics to TDMvIC. The operators analysed have to offer IPvIC support the migration from TDM-based interconnection for voice services (TDMvIC) to IPvIC with the obligation that both types of voice IC have to be offered.

5. We therefore fully support the TRAI's decision with respect to Bill and Keep (B&K) as concluded in its IUC Regulation 2009[3] *"The bill and keep proposal of the service providers was analyzed and it was noted that this could mean return to situation prevalent before the present IUC regime was established i.e receiving party used to pay for incoming calls. One of the fundamental principles of prescribing IUC regime was work done principle. It was also noted that tariff before the IUC regime were very high tariff. The service providers may again resort to charging their own subscribers for receipt of calls or increase fixed charges of providing the services.* ***As the service providers do not have to pay for termination of calls into other service provider networks they may offer plans with free calls which could load other service providers' networks.*** *Bill and keep regime may also reduce call completion rate as the terminating network will not have any incentive to complete the call.* ***Bill and keep scheme would not necessarily lead to the lower tariff as is evident from the tariff offered by the service provider in case of SMS etc"*** *(Emphasis added)*

6. We support the TRAI's decision on the principle of 'cost-oriented IUC regime' as indicated in the IUC Regulation 2015[4], the relevant portion of the decision is reproduced below

> *"--since 2003, when the IUC regime was first put in place in the country, the Authority has generally followed the principle of a cost-oriented IUC regime. While devising regulatory frameworks for telecom services in the country, the Authority has always aimed to balance the following twin objectives, viz.*
> *(i) to protect the interests of consumers - by way of ensuring adequate choice and affordable services to them by promoting competition and efficiency in the market, and; ii) to create incentives for TSPs - by way of ensuring adequate (fair) returns on investment so as to stimulate orderly growth and innovation in the sector."*

[3] Reference: Para 5.3.13 of explanatory memorandum to the telecommunication interconnection usage charges (tenth amendment) regulation, 2009 (2 of 2009) dated 9th March 2009.
[4] Reference: Para 23 of the explanatory memorandum to the IUC (11th Ammendment) Regulation 2015 (1 of 2015) dated 23rd February, 2015.

7. We note that the TRAI has very clearly indicated the reasons for implementation of cost based or cost oriented MTR in India in its various explanatory memorandums to the various IUC regulations. These reasons are summarized[5] below ;
   a. Tariff flows between the TSPs are significantly asymmetric because of their sizes, age of their networks and profiles of their customers are vastly different.
   b. Investment in the rural networks- the investment in rural telecom networks have lacked momentum because of
      i. The Customer-life time –value (CLV) of rural customers is far lower than that of urban customers
      ii. The level of utilization of the radio access network remains much lower in rural area (i.e. cost of servicing per customer is much higher in rural areas for a considerable period
      iii. The average rural customer's willingness –to-pay (WTP) for consumption of telecom service is relatively lower due to lower per capita income and higher incidence of poverty in rural areas (i.e. average revenue per rural customer is lower).
      iv. Break-event point (BEP) levels on investment in rural areas come much later than they do in urban areas.
   c. To maintain the network quality standards to the optimum level.

8. It is submitted that "the change in retail charging approach" i.e. cost oriented / cost based or Bill and Keep (BAK) under CPP regime was also examined by the Hon'ble Authority's during the IUC review of 2014-15 and finally it was decided to continue to prescribe a cost –oriented MTC in the country . The relevant portion of the decision is reproduced below;

> *"33. The Authority is of the view that, in the present day telecom market, the MTC should be fixed at a level which compensates TSPs adequately for the work done by them in terminating off-net incoming calls. The absence of a cost-oriented MTC (including one where 'MTC=0' as in the BAK regime) would discourage TSPs from investing in rural areas and maintaining network quality standards to the optimum.* ***Accordingly, the Authority has decided to continue to prescribe a cost-oriented MTC in the country****."*

[5] Reference : Para No 25 to 33 of the explanatory memorandum to the IUC (11th Ammendment) Regulation 2015 (1 of 2015) dated 23rd February, 2015.

9. The current regulatory and industry environment in India thus calls for continuation of a cost-based regime considering in particular:
   a. The applicability of 'Calling Party Pays' (CPP- regime).
   b. Policy objectives to accelerate rural network roll-out and socio-equitable service reach under consideration of significant income disparities.
   c. The fact of different network sizes and ultimately different network coverage areas and reach.
   d. The traffic flows between the TSPs are significantly asymmetric.
   e. The present 'ZERO MTR/FTR' on wireline networks has not produced any fruitful results for overall growth of wireline segment per *se*.
   f. The strong "economic rationale" of cost oriented or cost based IUC price regulation as acknowledged by TRAI in its recommendations till date. In accordance with economic theory, market prices should be set with reference to the costs of resources used to deliver the terminating voice service.

   In view of above, we submit that under the CPP regime only "Cost based or Cost Oriented" approach would be more relevant for maximization of consumer welfare, adoption of more efficient technologies and overall growth of the telecommunication services sector in the country. .

Q2: In case your response to the Q1 is 'Cost oriented or cost based termination charges', which of the following methods is appropriate for estimating mobile termination cost?
(i) LRIC+
(ii) LRIC
(iii) Pure LRIC
(iv)Any other method (please specify)
Please provide justification in support of your response.

EBG ANS 2:

Many complex and theoretical discussions about whether MTC derivation should be by LRIC (Long Range Incremental Cost) or LRIC+ or pure LRIC or FAC (Fully Allocated Cost), etc, still rage. The reality, however, is that most advanced economies have adopted LRIC or pure LRIC only a couple years ago, after attaining almost 95% coverage of both population and geography—generally, with both voice and data. India is far away from that. We have a billion connections, but these represent only about 600 million or less unique users

and, that too, largely for voice. Thus, a LRIC—whether pure or hybrid—makes little sense. We must first connect the unconnected.

The adoption of **an Accounting Separation Reports (ASR) based FAC model** maybe a more appropriate approach which may also considered the future cost of spectrum paid by the operators, for the determination of the termination charge.

We further note that TRAI has not used LRIC or its variants for any other telecom pricing of other network services/ products i.e. IPLC (half Circuits), Port Charges, Cable Landing Station (CLS) Access Charges and ILD Calling Card Access Charges etc.; therefore, we recommend for similarity in the costing approach for termination charges.

Q3: In view of the fact that the estimates of mobile termination cost using LRIC method and LRIC+ method yielded nearly the same results in year 2011 (as filed in the Hon'ble Supreme Court on 29.10.2011) and in year 2015 (as estimated for the Telecommunication Interconnection Usage Charges (Eleventh Amendment) Regulations, 2015 dated 23.02.2016), would it be appropriate to put to use the estimates of mobile termination cost arrived in the exercises of year 2011 and year2015 in the present exercise?

And

Q4: If your response to the Q3 is in the negative, whether there is a requirement of running the various LRIC methods afresh using the information on subscriber, usage and network

EBG ANS 3 & 4:

Nothing has been published and made available in the public domain for evaluation purposes to allow comment on the costing models (2011 and 2015) that have been developed.

Q5: In what manner, the prescription of fixed termination charge as well as the mobile termination charge from wire-line networks as 'zero' through the Telecommunication Interconnection Usage Charges (Eleventh Amendment) Regulations, 2015 is likely to impact the growth of the Indian telecommunication services sector as a whole? Please support your viewpoint with justifications.

EBG ANS 5:

It is submitted that the prescription of fixed termination charge (FTC) should be cost based and work done approach. We have not observed any growth in the wire line segment due to ZERO termination charge. In fact, it is against the TRAI's own costing approach and regulation .

It is important to mention that we have not come across the world that any ITU member state has prescribed 'ZERO Termination Rate' for fixed line network whereas in the case of mobile network there is a termination rate under CPP regime. Therefore, we suggest that both termination rates (Fixed Termination Rate and Mobile termination rates) should be cost based and work done approach.

Q6: Whether termination charges between different networks (e.g. fixed-line network and wireless network) should be symmetric?

EBG ANS 6:

It is submitted that Termination charges should be determined on cost based and work done principle. We believe that the termination charges should be the same for substitutable services.

Q7: Which approach should be used for prescribing International Termination Charge in the country? Should it be kept uniform for all terminating networks?

EBG ANS 7:

We believe that the present differential pricing approach for international termination calls is reasonable if compared with other jurisdictions ILD pricing approach.

A second option could be a regime of 'reciprocal arrangements' i.e. mandating the same international settlement rate for calls from a country as that is applicable for calls from India to the country as it benefits the country in foreign exchange earnings.

Q8: Whether, in your opinion, in the present regulatory regime in the country, the standalone ILDOs are not able to provide effective competition owing to the presence of integrated service providers (having both ILDO and access service

licenses) and, therefore, there are apprehensions regarding sustainability of the stand-alone ILDOs in the long-run?

And

Q9: If your response to the Q8 is in the affirmative, which of the following approach should be used as a counter-measure?
(i) Prescription of revenue share between Indian ILDO and access provider in the International Termination Charge; or
(ii) Prescription of a floor for international settlement rate (levied by ILDO upon the foreign carrier) for international incoming calls; or
(iii) Any other approach (please specify)
Please provide justification in support of your response.

EBG ANS 8 & 9:

We note that TRAI has not provided any kind of market/regulatory analysis which may demonstrate that the standalone ILDOs are facing regulatory challenges /disadvantages because of the present regulatory regime in the country. Therefore, we are of the opinion that there is no apprehension regarding sustainability of the stand-alone ILDOs in the long run.

We do not suggest any regulatory intervention for revenue share between access provider and ILDOs in view of high competition in both the categories and thus it best be left to be decided by market forces on mutual agreement basis.

Q10: Is there any other relevant issue which should be considered in the present consultation on the review of Interconnection Usage Charges?

EBG ANS 10:

We note that in 2015 IUC regulations, TRAI has very clearly decided that it shall review the termination charges regime two years after it has been in force, the relevant portion is reproduced below for ready reference

"The Authority is of the view that setting a specific timeline for undertaking such a review would impart a modicum of certainty which is in the interest of all stakeholders. ***Hence, the Authority has decided that it shall review the termination charges regime two years after it has been in force, i.e., the review will be undertaken and concluded in financial year 2017-18.****" (Emphasis added)*

In view of the above IUC notification we believe that the present IUC review should be started only during the financial year 2017-18 as there has been no

major development to warrant a break with a recent recommendation. Therefore, this review may be postponed till 31st March 2017.

It may be premature to anticipate interconnect charges changing drastically with the introduction of NGN networks. An NGN network element has extremely high capacities as compared to legacy network elements. Regulating prices based on LRIC and small increments may not reflect true costs. The definition for increments would have to be redefined to reflect the actuality of network capacities in NGN networks.

Nevertheless, the costing of NGN networks is still in its infancy as legacy networks are gradually replaced by NGN networks around the world. Costing methodologies and regulations must develop hand-in-hand with technological developments, keeping in mind that the objective of cost models is to reflect the reality of networks.

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Body of European Regulators for Electronic Communications

BEREC

BoR (16) 90

Termination rates at European level

January 2016

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1. Executive Summary

This document is an updated version of the benchmark of fixed and mobile Termination Rates (TRs) across Europe prepared by the BEREC Benchmarking Expert Working Group in cooperation with the BEREC Remedies Expert Working Group and the BEREC Office and aims to offer a picture of the regulated rates for fixed and mobile interconnection services in Europe. Fixed and mobile termination services in Europe are subject to price regulation.

The European Commission Recommendation on relevant product and service markets 2014 identifies:

- wholesale call termination on individual public telephone networks provided at a fixed location as a relevant market susceptible of ex-ante regulation (market 1)
- wholesale voice call termination on individual mobile networks as a relevant market susceptible of ex-ante regulation (market 2).

Because of the structure of these two markets, in general each network operator has an SMP position (i.e. a monopoly) for termination on its own network and therefore its termination rates are regulated.

The present overview of TRs is based upon the results of a request for information sent to all NRAs in January 2016, referring – if not differently indicated – to data as of 1st January 2016. It includes rates from the thirty six (36) NRAs[1] that provided responses to our request.

As of January 2016, this is the situation regarding TRs in Europe:

- The FTR simple average of incumbents at the European level (all 36 countries) stands at 0.29 eurocents per minute for Layer 1. The average for Layer 2 stands at 0.43 and for Layer 3 at 0.43 eurocents per minute.

- The FTR simple average of European Union incumbents operating at Layer 1 stands at 0.26 eurocents per minute. The average for Layer 2 stands at 0.21 and for Layer 3 at 0.35 eurocents per minute.

- The MTR simple average (A(s)) at the European level (all 36 countries) stands at 1.41 eurocents per minute, whereas the weighted average (A(w)) at European level is estimated at 1.17 eurocents per minute.

- The MTR A(s) at the EU level (only EU member states) stands at 1.06 eurocents per minute, whereas A(w) at EU level is estimated at 1.11 eurocents per minute.

- The SMS TR A(s) at the European level is 2.57 eurocents per SMS, whereas A(w) is reported to be 2.25 eurocents per SMS.

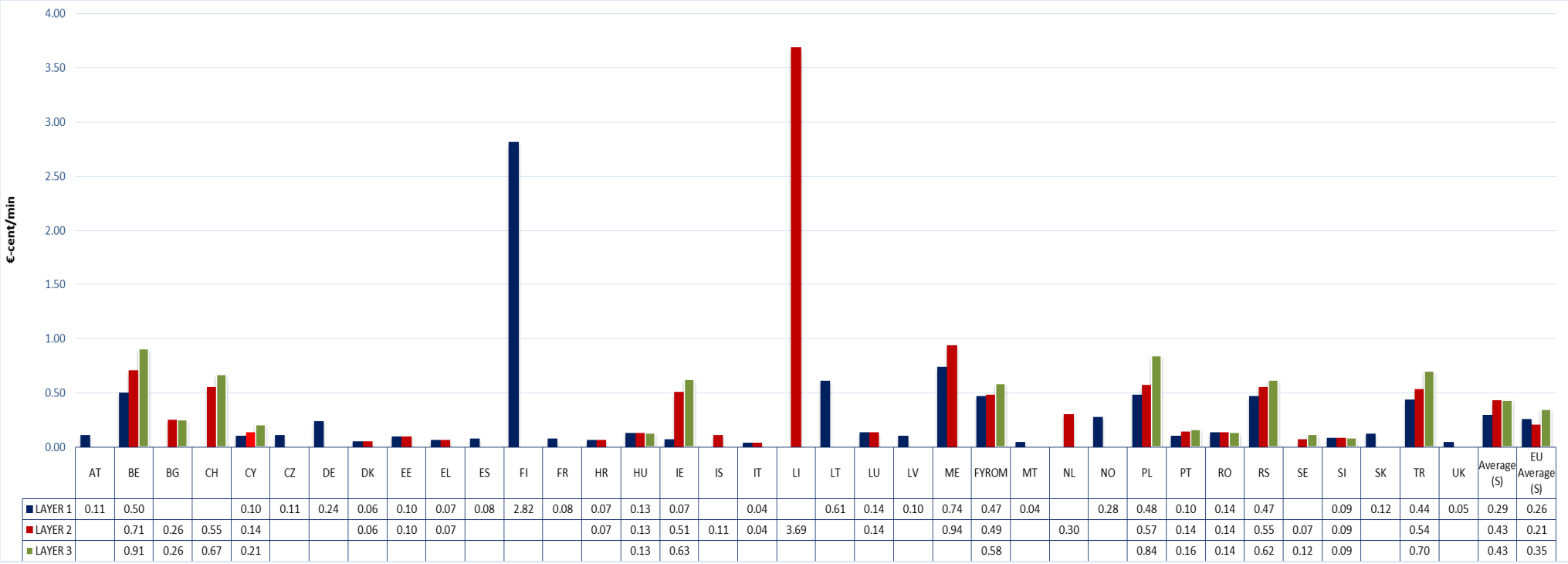
[1] 28 EU member states plus 4 EFTA states (Switzerland, Iceland, Norway and Liechtenstein) and 4 candidate states Montenegro, FYROM, Serbia and Turkey.

- Since not all EU member states report their SMS TR, no averages at the EU level could be calculated.

For non-euro countries, the average exchange rate for the second quarter of the year (Q4 2015) was used for the calculation of MTRs and SMS TRs. The exchange rates used are reported in Annex 8.

Overview of incumbents' fixed termination rates per country and layer – January 2016 (Euro cents per minute of service)

Figure 1 FTRs

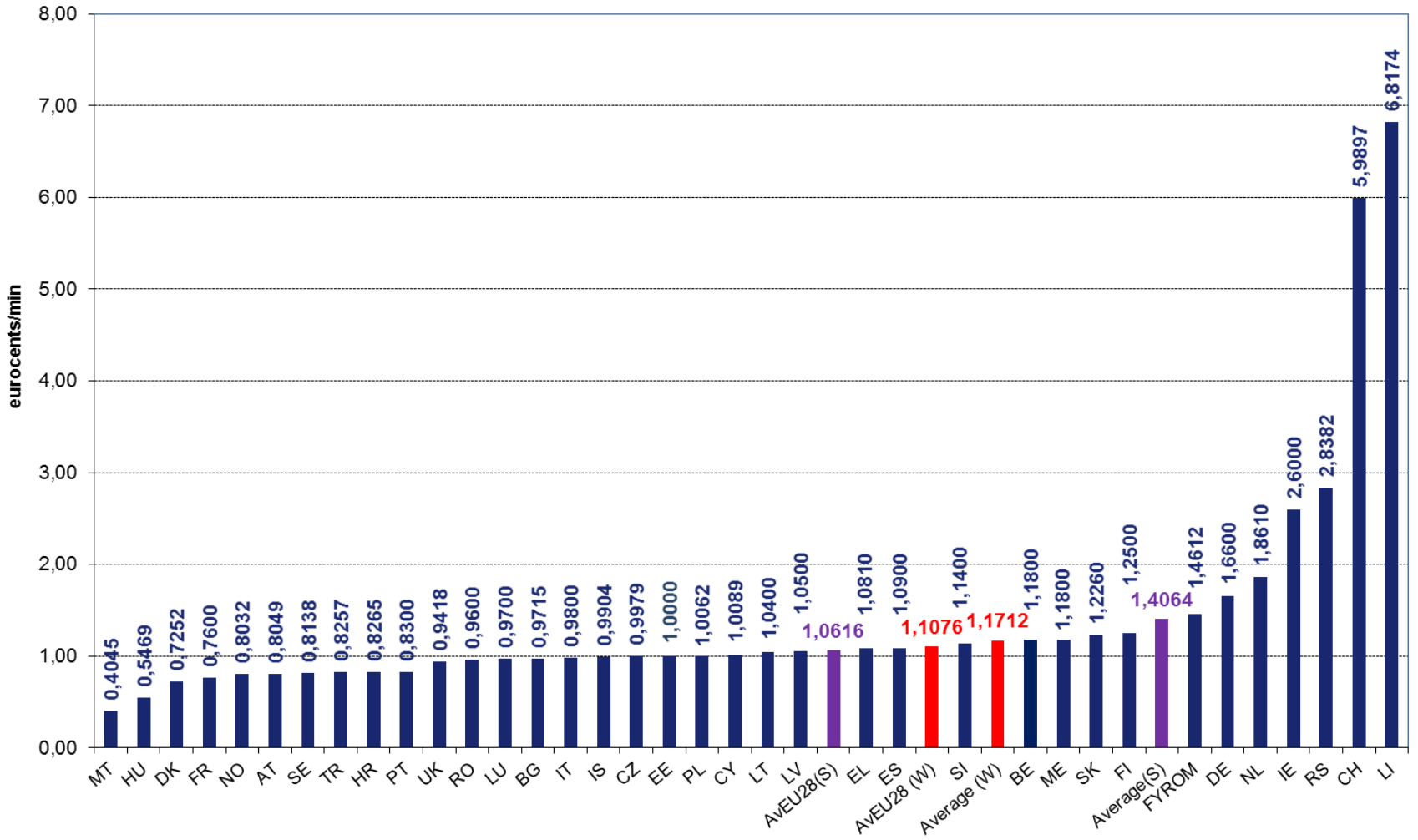


	AT	BE	BG	CH	CY	CZ	DE	DK	EE	EL	ES	FI	FR	HR	HU	IE	IS	IT	LI	LT	LU	LV	ME	FYROM	MT	NL	NO	PL	PT	RO	RS	SE	SI	SK	TR	UK	Average (S)	EU Average (S)
LAYER 1	0.11	0.50			0.10	0.11	0.24	0.06	0.10	0.07	0.08	2.82	0.08	0.07	0.13	0.07		0.04		0.61	0.14	0.10	0.74	0.47	0.04		0.28	0.48	0.10	0.14	0.47		0.09	0.12	0.44	0.05	0.29	0.26
LAYER 2		0.71	0.26	0.55	0.14			0.06	0.10	0.07				0.07	0.13	0.51	0.11	0.04	3.69		0.14		0.94	0.49		0.30		0.57	0.14	0.14	0.55	0.07	0.09		0.54		0.43	0.21
LAYER 3		0.91	0.26	0.67	0.21										0.13	0.63								0.58				0.84	0.16	0.14	0.62	0.12	0.09		0.70		0.43	0.35

Simple averages are provided for all layers. The simple average for EU countries (as represented per layer) is available in the last column. For more information see Annex 1.

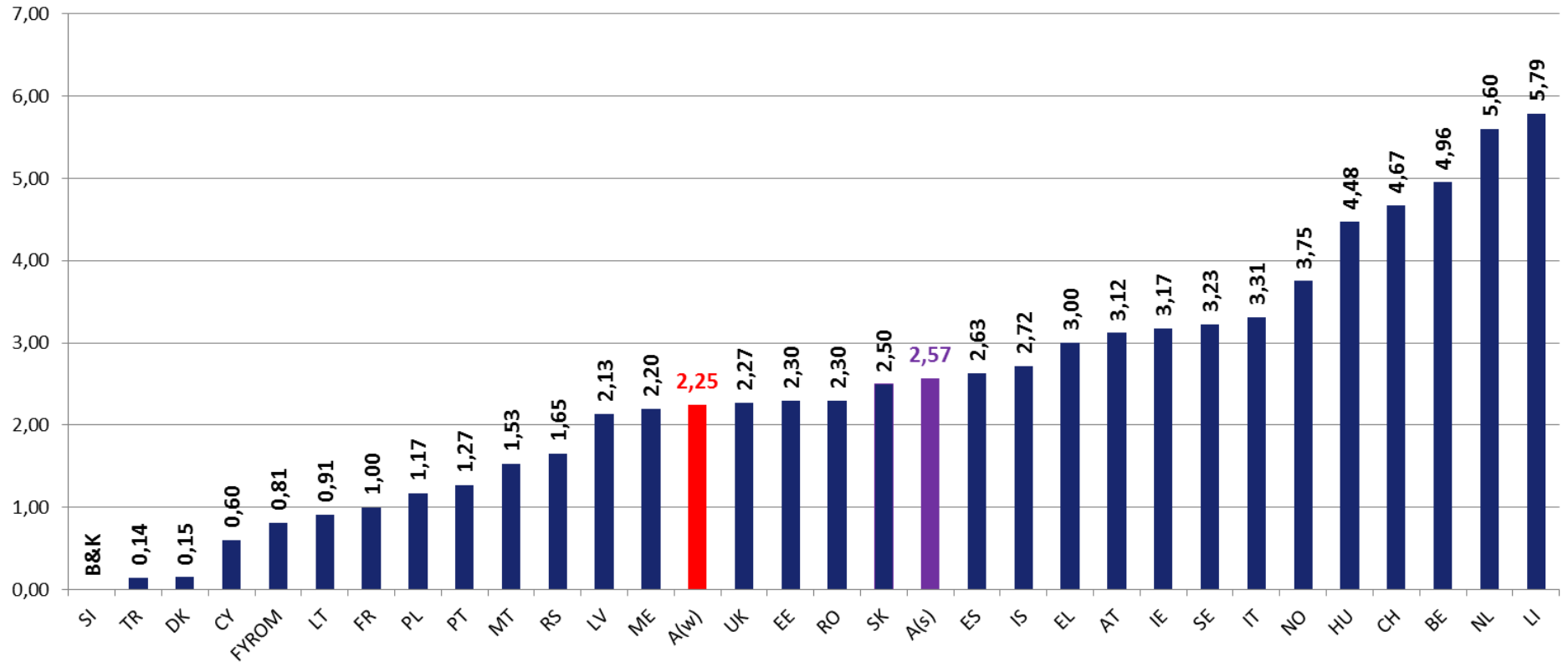
MTR per country – January 2016 (Euro cents per minute of service)

Figure 2 MTR



SMS TR per country – January 2016 (Euro cent per message)

Figure 3 SMS TR



2. Fixed networks – voice interconnection

The regulation of FTRs has been harmonized by the Recommendation of 7.5.2009 on the Regulatory Treatment of Fixed and Mobile Termination Rates in the EU (C (2009) 3359 final). However, some differences can be found across the national regulatory regimes:

1) In some cases the termination rate is a two-part tariff, i.e. composed of a variable part (to be paid for each minute of a call) plus a set-up or fixed part (to be paid for each call). In other cases, termination prices consist only of the variable part.
2) Interconnection services in fixed networks are provided at different levels in the hierarchy of the incumbents' networks, called layers. Even though some peculiarities in specific countries are present, in general three main layers for interconnection are defined: i) layer 1, or local level service provision, ii) layer 2, or regional level service provision (single transit), and iii) layer 3, national level service provision (or double transit).

2.1. Assumptions made for benchmarking

The following assumptions have been made in order to make tariffs comparable:

- In order to obtain a homogeneous comparison of average prices per minute across operators, a 3-minute average call duration has been assumed, using the standard formula: (fixed set-up charge + price per minute*3)/3.
- Nominal tariffs are reported only when the NRA has set out the maximum price per minute that operators may charge each other.
- For those countries which have not set a single tariff and which apply distinct rates for the peak/off-peak period, an average price has been calculated taking into account the traffic distribution between peak and off-peak time. When this distribution has not been made available, a 50/50 distribution has been assumed.

2.2. FTR benchmark

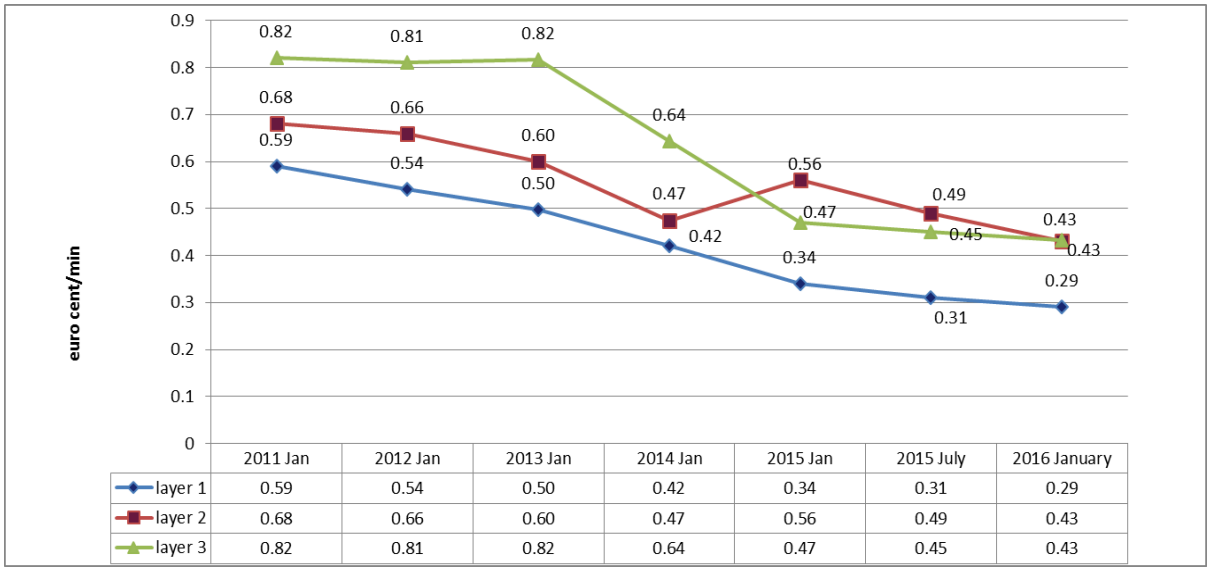
In Annex 1 the interconnection prices of operators listed by countries are presented. For each country, the NRA has provided information on the incumbent and some alternative or cable

operators offering interconnection services. Peak and off-peak rates are differentiated, as well as the layer of interconnection. In the last column a weighted average of peak/off-peak prices is provided.

2.3. Incumbent interconnection rates trend (from January 2011 to January 2016)

This section presents the trend of simple average of effective average price per minute of each layer of interconnection service provided by incumbent operators. The averages for January 2016 comprise information available in Annex 1.

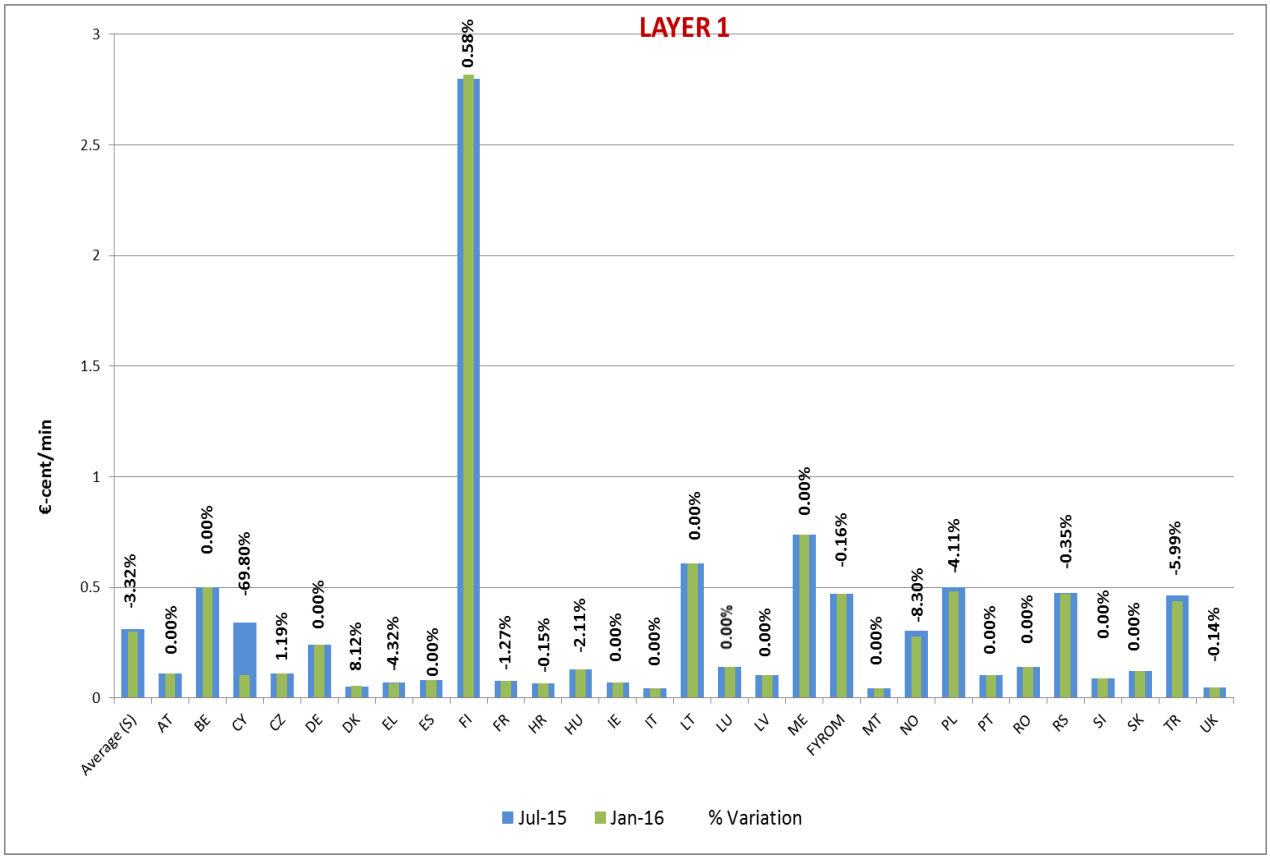
Figure 4 Simple averages[2,3] of incumbents' fixed termination rates at the European level per layer



[2] The average of Layer 2 is slightly higher in January 2015 compared to January 2014, due to the inclusion of additional countries that did not provide information for January 2014.
[3] The average of Layer 3 in July 2015 is slightly higher compared to January 2015, due to the inclusion of different countries that did not provide information for January 2015.

Short term evolution of incumbents' fixed termination rates per layer and country (from July 2015 to January 2016 in Euro cent)

Figure 5 Layer 1 short term evolution[4,5]

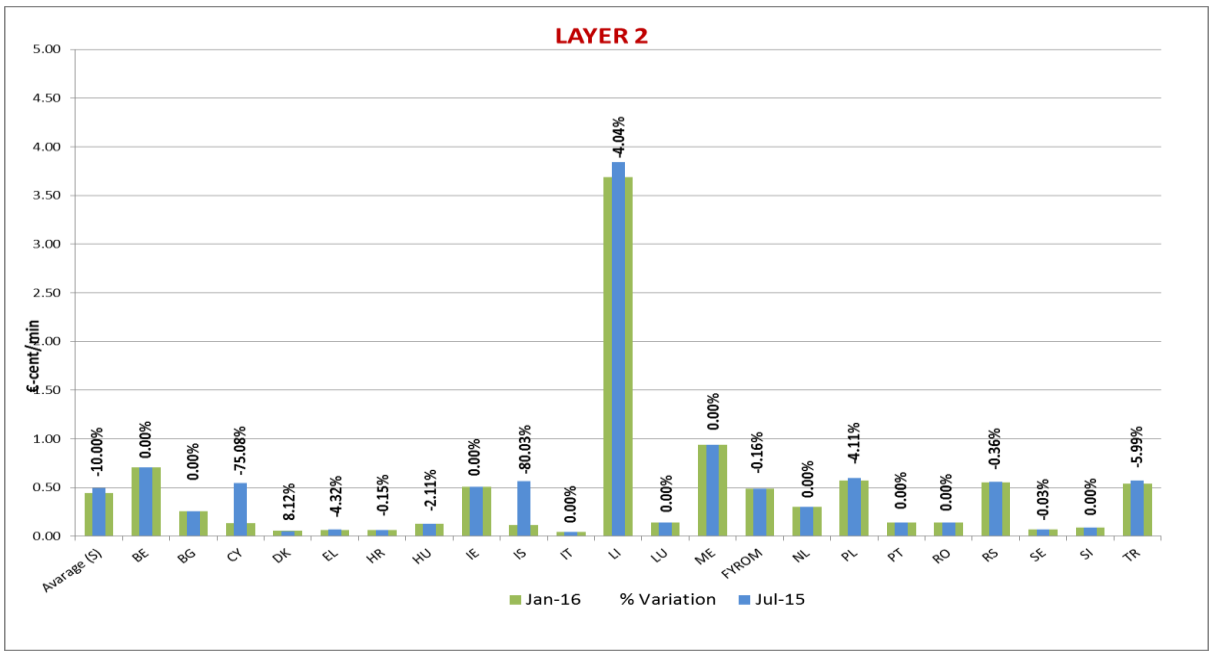


The percentage variation of FTRs in non-Euro zone countries shows change in case of Croatia, where the price in national currency increased by 0.50% and in Denmark by 6.15% .

[4] The rates and variation for Finland reflect the average across all operators.

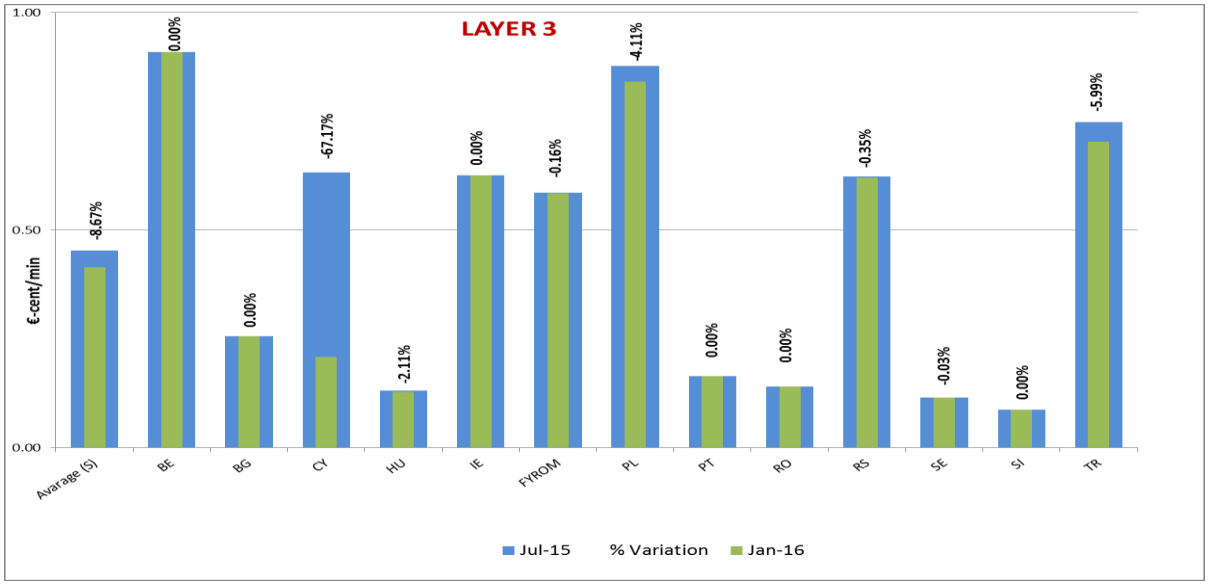
[5] For more information regarding decrease of rates in Cyprus, please consult notes of Table 4 in Annex 2.

Figure 6 Layer 2 short term evolution[6]



The percentage variation of FTRs in non-Euro zone national currency shows a decreasing trend in the case of Iceland by 80.88%. The prices in national currency increased in Denmark by 6.15% and Croatia by 0.50%.

Figure 7 Layer 3 short term evolution [7]

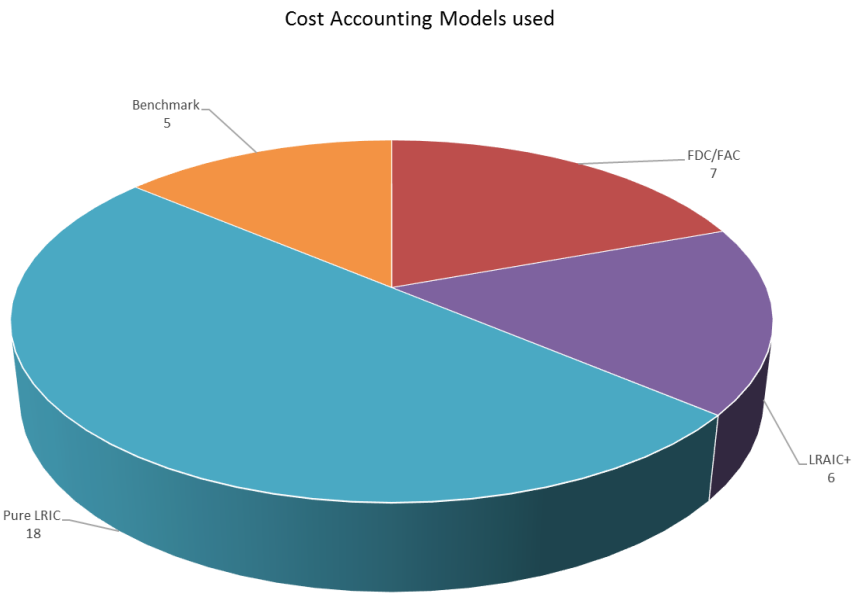


[6] For more information regarding decrease of rates in Cyprus, please consult notes of Table 4 in Annex 2.
[7] For more information regarding decrease of rates in Cyprus, please consult notes of Table 4 in Annex 2.

2.4. FTR regulatory model implemented and symmetry overview

Eighteen of the NRAs use Pure BULRIC models to set FTRs. The second most common model is FDC/FAC, used by seven NRAs. Six NRAs reported using LRAIC+etc. models and five NRAs use Benchmarking approaches.

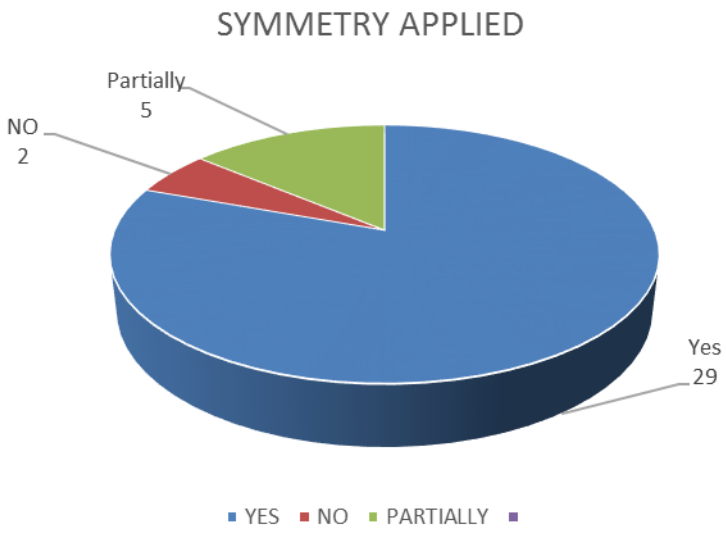
Figure 8 Cost accounting models used by NRAs



For more information consult Annex 2 .

In most of the respondent countries FTRs are symmetric across all operators. Five of the NRAs reported partial symmetry while prices are not symmetric only in 2 of the reporting countries.

Figure 9 FTRs Symmetry



For more information consult Annex 3.

2.6. Number of lines and market shares

In Annex 4 the number of active fixed telephony lines in the retail market is provided for each operator included in the report. For a number of countries this information is confidential.

3. Mobile networks – voice interconnection

This section presents the benchmark of mobile termination rates (MTR) with data as of 1 January 2016 and its recent evolution. The purpose of this comparison is to provide an indication of the level of MTRs across the NRAs, their variations and the cost models adopted for setting MTRs. Moreover this benchmarking exercise includes a section devoted to the future evolution of MTRs.

The present overview of MTRs is based upon the results of a request for information sent to all NRAs in January 2016. It includes data from thirty-six (36) NRAs that provided responses.

3.1. Assumptions made for the benchmarking

For the present benchmarking exercise the following assumptions have been made in order to make tariffs comparable[8]:

- Operators with a market share below 1.5% have been excluded from the national MTR average calculation.
- Only nominal tariffs are represented in the report, defining them as "the price (in Euro cent/minute) set out by the regulator that represents the maximum price per minute which operators may charge each other (without any adjustment for purchasing power parity or real effects – inflation)."
- Average MTRs per country have been obtained by weighting the MTR of each operator by its market share, measured in terms of subscribers. Four general averages have been calculated: a simple average and a weighted average, each at the European level (including all 36 countries reporting data) and at EU level (including only the 28 EU member states). The weighted averages weight each country's average rate with the share of the country's subscribers (total subscribers per country / total subscribers in all countries).
- Regarding the number of subscribers, it must be considered that different estimation methods are used among European countries (especially in the case of pre-paid consumers).

[8] Generally speaking, these assumptions may create margins of error in the present comparison, making it difficult to draw valid conclusions for policy purposes.

- VAT is not included in the revenues.
- For non-Euro countries, the average exchange rate for the fourth quarter of the year (Q4 2015) was used to convert the currencies. The exchange rates used are reported in Annex 10.

Regarding the short-term MTR evolution (from July 2015 to January 2016), some variation may be a consequence of any of the following reasons:

i. Modifications in the tariff structure (for instance, disappearance of the set-up charge or initial period);
ii. Currency exchange rate variations in non-Euro countries[9];
iii. Changes in operators' market shares may have an effect on the average MTR for an individual country;
iv. Inclusion of new operators that were not present in the previous benchmarks;

3.2. Average MTR per country: rates per voice minute (as of January 2016)

Table 1 - Average MTR per country

Country	Average MTR per country (€cent)
AT	0.8049
BE	1.1800
BG	0.9715
CH	5.9897
CY	1.0089
CZ	0.9979
DE	1.6600
DK	0.7252
EE	1.0000
EL	1.0810
ES	1.0900
FI	1.2500
FR	0.7600
HR	0.8265
HU	0.5469

[9] This only affects short-term MTR evolution (figure 13) because the percentage of tariff variation in each country (figure 14) has been calculated by comparing rates expressed in terms of the national currency.

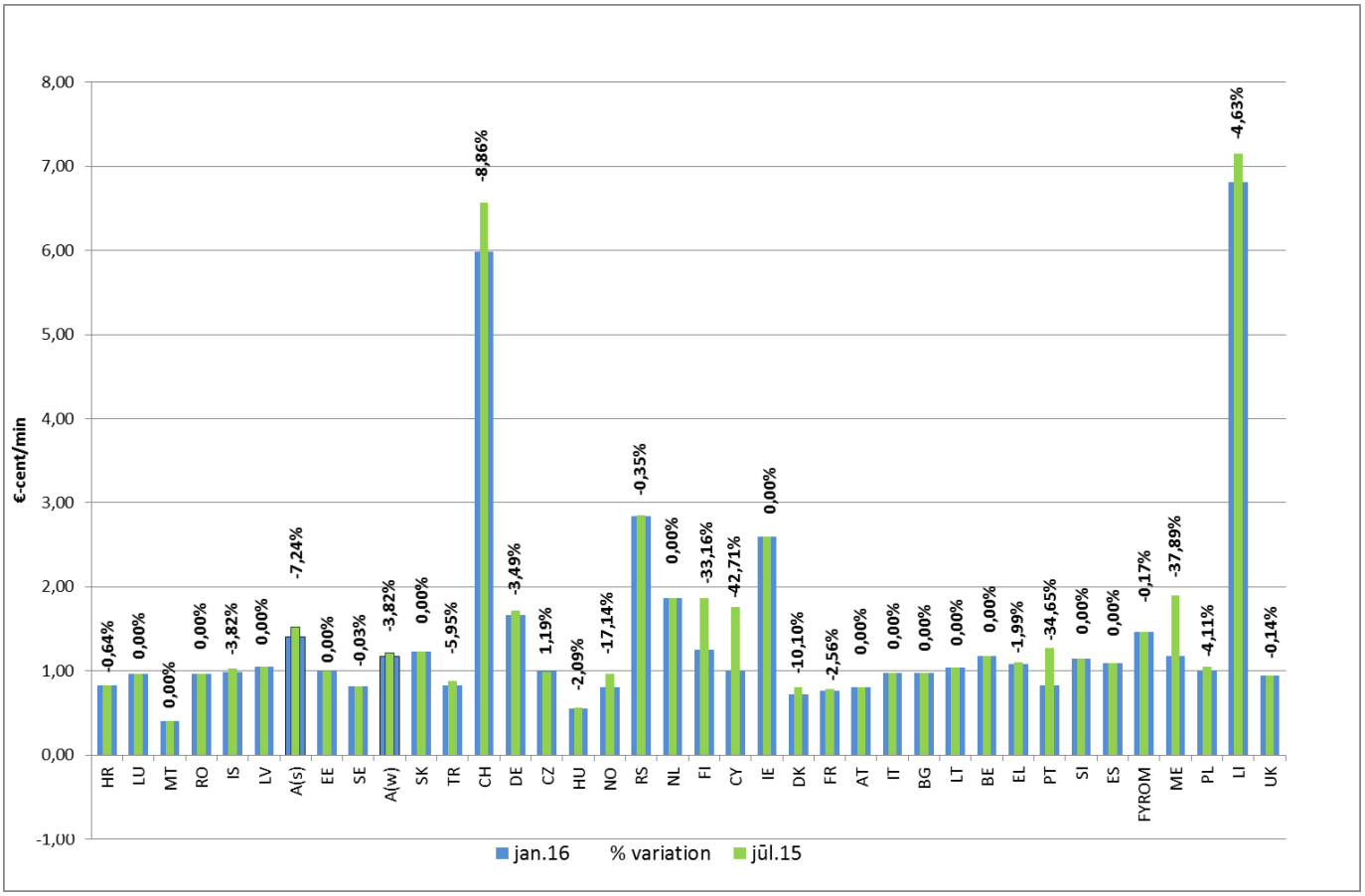
IE	2.6000[10]
IS	0.9904
IT	0.9800
LI	6.8174
LT	1.0400
LU	0.9700
LV	1.0500
ME	1.1800
FYROM	1.4612
MT	0.4045
NL	1.8610
NO	0.8032
PL	1.0062
PT	0.8300
RO	0.9600
RS	2.8382
SE	0.8138
SI	1.1400
SK	1.2260
TR	0.8257
UK	0.9418
Average(S)	**1.4064**
Average (W)	**1.1712**
Average EU 28 (S)	1.0616
Average EU 28 (W)	1.1076

Figures 10 and 11 show the short term variations of MTRs in Euro and in national currency. These two figures illustrate the effect of the exchange rate on the short term evolution.

[10] For information purposes, following publication of ComReg decision D02/16, from 1 September 2016 until 31 December 2018 the maximum MTRs will be determined in accordance with the BU Pure LRIC Model (as per that decision). The MTR from 1 September 2016 to 31 December 2016 is 0.84 euro cent per minute.

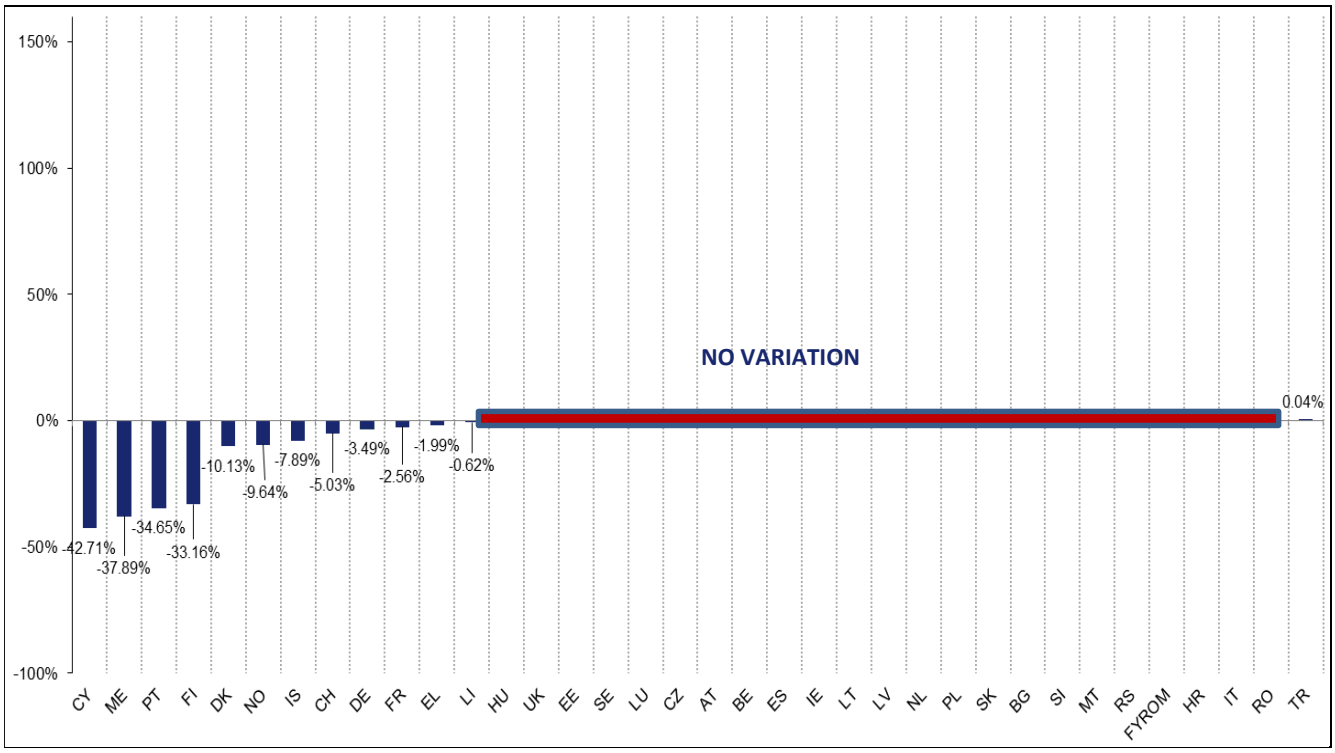
Percentage variation of average MTRs in Euro cent per country (from July 2015 to January 2016,)

Figure 10 variation in Euros



Percentage variation of average MTRs in national currency per country (from July 2015 to January 2016)

Figure 11 variation in national currency



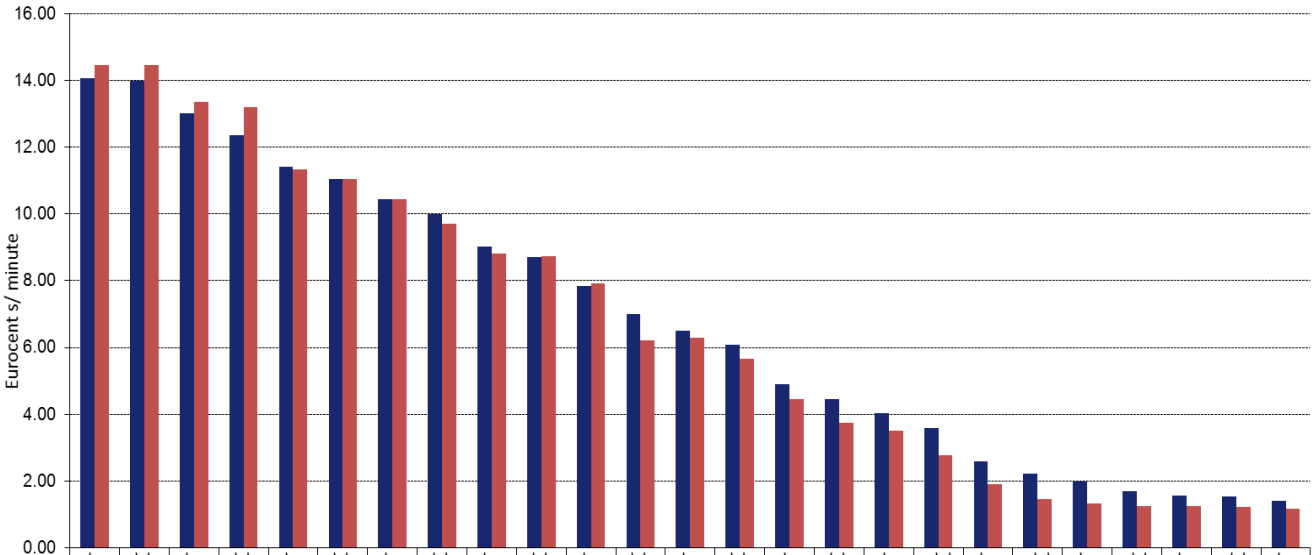
3.3. Average MTR per operator

There are a number of countries where information regarding number of subscribers and/or market share has been declared as confidential data and for this reason this report does not publish this data. Nevertheless, market shares have been taken into account for the average MTR calculations.

For further details see Annex 5 .

3.4. Average MTR: Times series of simple average and weighted average at European level

Figure 12 Evolution of simple A(s) and weighted A(w) averages



	Jan 2004	July 2004	Jan 2005	July 2005	Jan 2006	July 2006	Jan 2007	July 2007	Jan 2008	July 2008	Jan 2009	July 2009	Jan 2010	July 2010	Jan 2011	July 2011	Jan 2012	Jul 2012	Jan 2013	Jul 2013	Jan 2014	Jul 2014	Jan 2015	Jul 2015	Jan 2016
A(s)	14.08	14.00	13.01	12.36	11.43	11.06	10.44	10.01	9.02	8.70	7.83	7.00	6.50	6.07	4.91	4.45	4.03	3.57	2.58	2.21	1.97	1.69	1.55	1.52	1.41
A(w)	14.47	14.48	13.37	13.20	11.33	11.06	10.44	9.71	8.81	8.74	7.92	6.21	6.29	5.65	4.46	3.74	3.50	2.76	1.90	1.46	1.32	1.23	1.23	1.22	1.17

Note to figure 12: Averages are based on nominal rates per minute of service. The number of countries and operators considered has increased over the years, thus affecting the average slightly. Moreover the Weighted Average does not take into account countries not providing the total number of subscribers and those that could have changed over the years. Considering these caveats, the graph shows the general trend.

Figures 13 and 14 show the cumulative declines of the simple and the weighted average of European MTRs since 2004.

Figure 13 European MTRs simple average cumulative decline

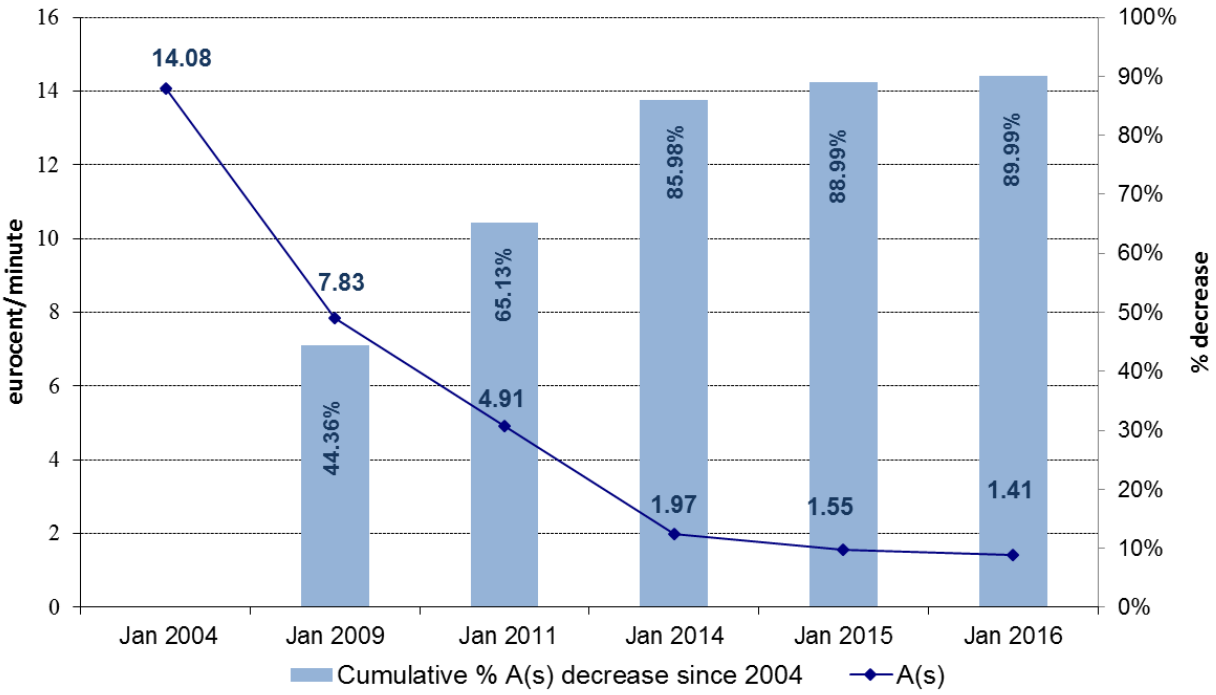
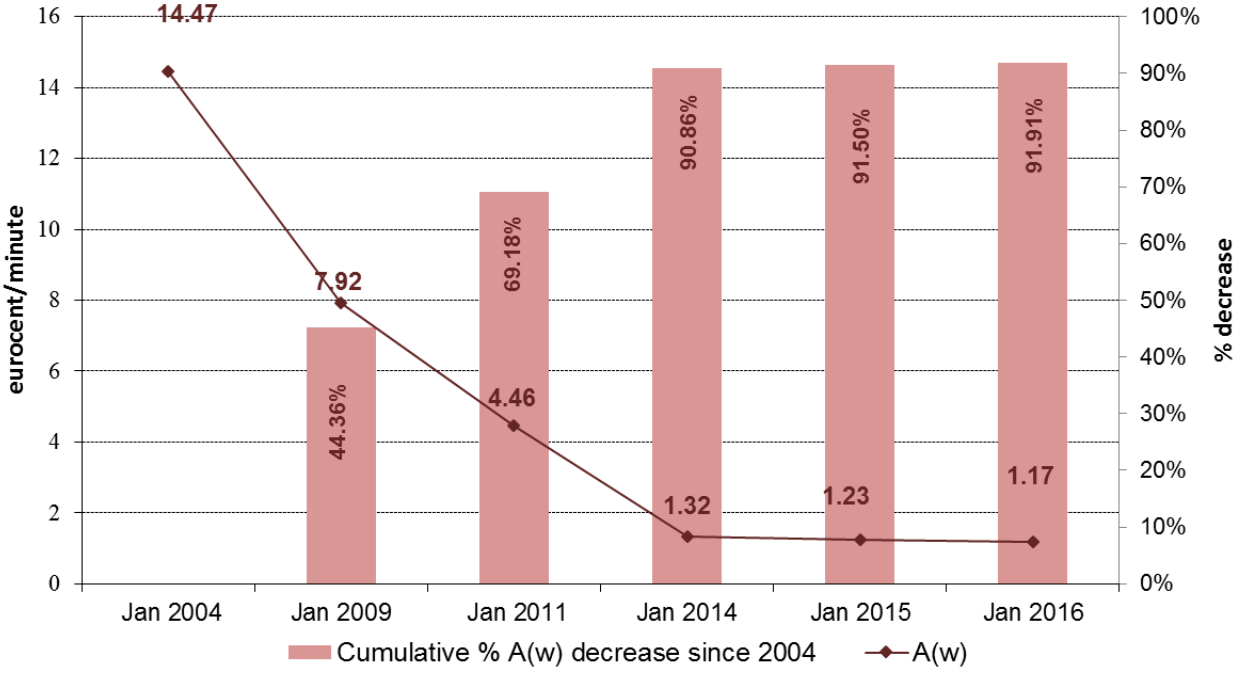


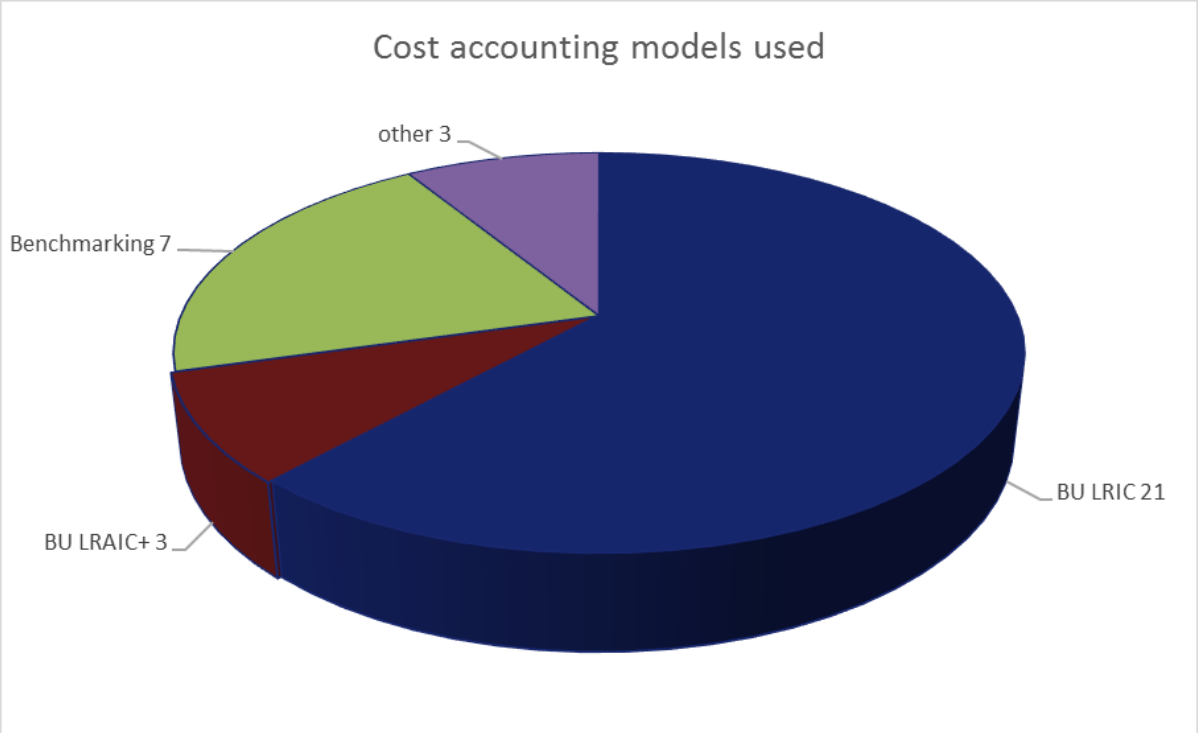
Figure 14 European MTRs weighted average cumulative decline



3.5. Regulatory model implemented and glide paths for MTRs

In the majority of countries BU LRIC models are used to calculate the MTRs. But still a significant number of NRAs base their price decision on a BU LRAIC+ model or benchmarking. Two NRAs did not indicate the model used.

Figure 15 Cost accounting models used by NRAs



For further details see Annex 6 .

4. Mobile networks - SMS interconnection

The short message service (SMS) offered by operators is used every day by millions of people all over the world. This service is not regulated in most EU countries, but the evolution of wholesale SMS termination rates is monitored in most cases by NRAs.

The present SMS benchmark report bases its results on the data provided by NRAs as of January 2016. Thirty-six (36) countries provided data, but some NRAs – following national law provisions – asked to treat the SMS Termination Rates as confidential information.

The benchmark aims at keeping track of the main trends in wholesale SMS TRs in Europe. The scope of the report is limited to describe termination prices at national level (no international SMS TR are therefore considered[11]).

4.1. Assumptions made for benchmarking

The SMS TRs collected in this report reflect wholesale rates applied among domestic operators for an off-net SMS exchange, excluding VAT. They may diverge from the "average revenue from an SMS at wholesale level".

In this report individual, i.e. operator specific, SMS TRs are presented, as well as averages calculated for each country as a whole. Regarding the number of subscribers, it must be considered that different estimation methods are used among European countries (especially in the case of pre-paid consumers). In some countries, SMS wholesale rates are considered to be confidential information.

The following characteristics of SMS TRs make the collection and comparison of data more straightforward (as compared to the exercise of benchmarking the FTRs and the MTRs):

- No countries differentiate between peak time, off-peak time and weekend hours.
- The price for SMS termination is related to each delivered domestic off-net SMS; therefore, no assumption is necessary about set-up charges or average call durations. Slovenia is the only country where "Bill & Keep" agreements are in place for traffic between all domestic operators.
- Average SMS TRs per country have been obtained by weighting the average TR of each operator by its market share, measured in terms of subscribers. Two general averages at the European level have been calculated: a simple average and a weighted average. The latter weights each country's average with the share of the country's subscribers (total subscribers per country / total European subscribers). In the case of the European weighted average, only the countries that reported TRs and the number of subscribers are taken into account. Since not all countries report complete sets of data, the calculated averages might vary slightly.

[11] International SMS TRs in most European countries are also based on bilateral negotiations among operators, which generally result in higher levels than the domestic rates that are reflected in this report.

On the other hand and due to the generally unregulated environment existing for SMS TRs in most European countries, there is a high degree of bilateral negotiation among operators. Therefore, some peculiarities in setting SMS TRs could emerge and require additional assumptions (as compared to the exercise of benchmarking the FTRs and the MTR):

- In some countries, operators have bilateral contract agreements implying different rates depending on the volume of SMS sent across the two networks. These non-linear relationships imply different average rates depending on the volume of SMS exchanged. In this case, the lowest average rate expected (corresponding to the highest volume of SMS) has been considered.
- Additionally, in some countries, operators will negotiate different SMS TRs vis-à-vis each one of the other operators. In this case, if not differently indicated, a TR simple average is considered.

Due to these considerations, for some countries the benchmarking proposed in this exercise may represent – with different levels of accuracy – the average SMS TR effectively charged for an off-net SMS.

For non-Euro countries, the exchange rates reported in the Annex 8 are used.

For more information consult Annex 7: SMS TR per operator.

4.2. Average SMS TR per country and per message (as of January 2016)

Table 2 - **Average SMS TR per country**

Country	Average SMS TR per country (€cent)
AT	3.12
BE	4.96
BG	confidential
CH	4.67
CY	0.60
CZ	confidential
DE	n.a.
DK	0.15
EE	2.30
EL	3.00
ES	2.63

FI	confidential
FR	1.00
HR	n.a.
HU	4.48
IE	3.17
IS	2.72
IT	3.31
LI	5.79
LT	0.91
LU	n/a
LV	2.13
ME	2.20
FYROM	0.81
MT	1.53
NL	5.60
NO	3.75
PL	1.17
PT	1.27
RO	2.30
RS	1.65
SE	3.23
SI	Bill & keep
SK	2.50
TR	0.14
UK	2.27
Average(S)	**2.57**
Average(W)	**2.25**

Annex

Annex 1 Fixed termination rates as of 1 January 2016

Table 3

			Average effective price per operator €cents		
Country	**Operator**	**Layer**	**peak**	**Off-peak**	**WA**
AT	Telekom Austria	Layer 1	0.1370	0.0850	**0.1110**
	Other operators	Layer 1	0.1370	0.0850	**0.1110**
BE	Proximus	Layer 1	0.6187	0.3247	**0.5020**
		Layer 2	0.8747	0.4583	**0.7090**
		Layer 3	1.1213	0.5883	**0.9090**
	Other operators	Layer 1	0.8747	0.4583	**0.7090**
		Layer 2	1.1213	0.5883	**0.9090**
BG	Bulgarian Telecommunication Company	Layer 2	0.2556	0.2556	**0.2556**
		Layer 3	0.2556	0.2556	**0.2556**
	Telenor Bulgaria	Layer 3	0.2556	0.2556	**0.2556**
	Mobiltel	Layer 3	0.2556	0.2556	**0.2556**
	Blizoo Media and Broadband	Layer 3	0.2556	0.2556	**0.2556**
CH	Swisscom	Layer 2	0.7436	0.3718	**0.5540**
		Layer 3	0.8972	0.4486	**0.6684**
CY	CYTA	Layer 1	N/A	N/A	**0.1033**
		Layer 2	N/A	N/A	**0.1363**
		Layer 3	N/A	N/A	**0.2075**
	PRIMETEL	Layer 2	N/A	N/A	**0.1363**
		Layer 3	N/A	N/A	**0.2075**
	CABLENET	Layer 2	N/A	N/A	**0.1363**
		Layer 3	N/A	N/A	**0.2075**
	MTN FIXED	Layer 2	N/A	N/A	**0.1363**
		Layer 3	N/A	N/A	**0.2075**
CZ	O2 Czech Republic a.s.	Layer 1	N/A	N/A	**0.1109**
	UPC Česká republika, s.r.o.	Layer 2	N/A	N/A	**0.1109**
	T-Mobile Czech Republic a.s.	Layer 2	N/A	N/A	**0.1109**
	Vodafone Czech Republic a.s.	Layer 2	N/A	N/A	**0.1109**
	České Radiokomunikace a.s.	Layer 2	N/A	N/A	**0.1109**
	IPEX a.s.	Layer 2	N/A	N/A	**0.1109**
DE	Telekom Deutschland GmbH	Layer 1	0.2400	0.2400	**0.2400**
DK	TDC	Layer 1	0.0590	0.0322	**0.0555**
		Layer 2	0.0590	0.0322	**0.0555**
EE	Telia Eesti	Layer 1	0.0970	0.0970	**0.0970**

		Layer 2	0.0970	0.0970	**0.0970**
	Starman	Layer 1	0.0970	0.0970	**0.0970**
	Elisa	Layer 1	0.0970	0.0970	**0.0970**
	STV	Layer 1	0.0970	0.0970	**0.0970**
EL	OTE	Layer 1	N/A	N/A	**0.0665**
		Layer 2	N/A	N/A	**0.0665**
	Forthnet	Layer 1	N/A	N/A	**0.0665**
		Layer 2	N/A	N/A	**0.0665**
	HOL	Layer 1	N/A	N/A	**0.0665**
		Layer 2	N/A	N/A	**0.0665**
	WIND	Layer 1	N/A	N/A	**0.0665**
		Layer 2	N/A	N/A	**0.0665**
	Other operators	Layer 1	N/A	N/A	**0.0665**
		Layer 2	N/A	N/A	**0.0665**
ES	Telefónica de España	Layer 1	0.0817	0.0817	**0.0817**
	Orange	Layer 1	0.0817	0.0817	**0.0817**
	Vodafone	Layer 1	0.0817	0.0817	**0.0817**
	Vodafone - Ono	Layer 1	0.0817	0.0817	**0.0817**
	Jazztel	Layer 1	0.0817	0.0817	**0.0817**
	Other operators	Layer 1	0.0817	0.0817	**0.0817**
FI	DNA Oyj	N/A	N/A	N/A	**2.800**
	Elisa Oyj	N/A	N/A	N/A	**2.800**
	TeliaSonera Finland Oyj	N/A	N/A	N/A	**2.800**
	Other operators (weighted average)	N/A	N/A	N/A	**2.8161**
FR	Orange	Layer 1	N/A	N/A	**0.0780**
	Other operators	Layer 1	N/A	N/A	**0.0780**
HR	HT	Layer 1	0.0787	0.0394	**0.0651**
		Layer 2	0.0787	0.0394	**0.0651**
	Optima Telekom	Layer 2	0.0787	0.0394	**0.0122**
	VIPnet	Layer 2	0.0787	0.0394	**0.0666**
	H1 Telekom	Layer 1	0.0787	0.0394	**0.0719**
		Layer 2	0.0787	0.0394	**0.0719**
HU	Magyar Telekom	Layer 1	0.1279	0.1279	**0.1279**
		Layer 2	0.1279	0.1279	**0.1279**
		Layer 3	0.1279	0.1279	**0.1279**
	Invitel	Layer 1	0.1279	0.1279	**0.1279**
		Layer 2	0.1279	0.1279	**0.1279**
		Layer 3	0.1279	0.1279	**0.1279**
	UPC	Layer 1	0.1279	0.1279	**0.1279**
	Other operators		0.1279	0.1279	**0.1279**
IE	Eircom	Layer 1	0.0690	0.0690	**0.0716**
		Layer 2	0.6057	0.3348	**0.5098**
		Layer 3	0.7496	0.4147	**0.6264**
IS	Siminn	Layer 2	0.1132	0.1132	**0.1132**
	Vodafone	Layer 2	0.1132	0.1132	**0.1132**
IT	Telecom Italia S.p.A.	Layer 1	0.0430	0.0430	**0.0430**
		Layer 2	0.0430	0.0430	**0.0430**
	Wind Telecomunicazioni S.p.A.	Layer 1	0.0430	0.0430	**0.0430**

	Fastweb S.p.A.	Layer 1	0.0430	0.0430	**0.0430**
	Vodafone Omnitel B.V	Layer 1	0.0430	0.0430	**0.0430**
LI	Telecom Liechtenstein AG	Layer 2	3.6873	3.6873	**3.6873**
LT	TEO LT AB	Layer 1	0.6100	0.6100	**0.6100**
	CSC Telecom	Layer1	0.6100	0.6100	**0.6100**
	Lietuvos gelezinkeliai	Layer 1	0.6100	0.6100	**0.6100**
LU	EPT	Layer 1	0.1400	0.1400	**0.1400**
		Layer 2	0.1400	0.1400	**0.1400**
LV	Lattelecom	Layer 1	0.1037	0.1037	**0.1037**
	Telefons	Layer 1	0.1037	0.1037	**0.1037**
	Megatel	Layer 1	0.1037	0.1037	**0.1037**
	Telekom Baltija	Layer 1	0.1037	0.1037	**0.1037**
	Other operators	Layer 1	0.1037	0.1037	**0.1037**
ME	Crnogorski Telekom	Layer 1	0.7400	0.7400	**0.7400**
		Layer 2	0.9400	0.9400	**0.9400**
	Mtel	Layer 1	0.9400	0.9400	**0.9400**
FYROM	Makedonski Telekom AD	Layer 1	0.4708	N/A	**0.4708**
		Layer 2	0.4871	N/A	**0.4871**
		Layer 3	0.5845	N/A	**0.5845**
	ONE Telecom services	Layer 3	0.5845	N/A	**0.5845**
	Robi	Layer 3	0.5845	N/A	**0.5845**
	Blizoo	Layer 3	0.5845	N/A	**0.5845**
	Other operators	Layer 3	0.5845	N/A	**0.5845**
MT	GO plc	Layer 1	N/A	N/A	**0.0443**
	Melita plc	Layer 1	N/A	N/A	**0.0443**
	Vodafone	Layer 1	N/A	N/A	**0.0443**
	Ozone	Layer 1	N/A	N/A	**0.0443**
	SIS	Layer 1	N/A	N/A	**0.0443**
	Vanilla	Layer 1	N/A	N/A	**0.0443**
NL	KPN	Layer 2	N/A	N/A	**0.3020**
	Ziggo	Layer 2	N/A	N/A	**0.3020**
	UPC	Layer 2	N/A	N/A	**0.3020**
	Tele2	Layer 2	N/A	N/A	**0.3020**
NO	Telenor	Layer 1	0.2784	0.2784	**0.2784**
	NextGen Tel	Layer 1	0.2784	0.2784	**0.2784**
	Get	Layer 1	0.2784	0.2784	**0.2784**
	TeliaSonera		0.2784	0.2784	**0.2784**
	Phonero	Layer 1	0.2784	0.2784	**0.2784**
PL	Orange Polska S.A.	Layer 1	0.6403	0.3213	**0.4808**
		Layer 2	0.7623	0.3800	**0.5711**
		Layer 3	1.1211	0.5606	**0.8408**
	Netia	Layer 1	0.6403	0.6403	**0.6403**
	Multimedia Polska S.A.	Layer 1	0.6403	0.6403	**0.6403**
	Multimedia Polska Poludnie S.A.	Layer 1	0.6403	0.6403	**0.6403**
PT	MEO	Layer 1	0.1026	0.1026	**0.1026**
		Layer 2	0.1411	0.1411	**0.1411**

		Layer 3	0.1642	0.1642	**0.1642**
	NOS Group	Layer 1	0.1114	0.1114	**0.1114**
	Vodafone	Layer 1	0.1114	0.1114	**0.1114**
	ONI/Cabovisão	Layer 1	0.1114	0.1114	**0.1114**
RO	Telekom RC S.A. (former Romtelecom)	Layer 1	N/A	N/A	**0.1400**
		Layer 2	N/A	N/A	**0.1400**
		Layer 3	N/A	N/A	**0.1400**
	Other operators	Layer 1	N/A	N/A	**0.1400**
RS	Telekom Srbija	Layer 1	0.4717	0.4717	**0.4717**
		Layer 2	0.5544	0.5544	**0.5544**
		Layer 3	0.6206	0.6206	**0.6206**
	Orion telekom	Layer 1	0.5130	0.5130	**0.5130**
	Telenor	Layer 1	0.5130	0.5130	**0.5130**
	SBB	Layer 1	0.5130	0.5130	**0.5130**
SE	TeliaSonera	Layer 2	N/A	N/A	**0.0710**
		Layer 3	N/A	N/A	**0.1150**
SI	Telekom Slovenije	Layer 1	0.0876	N/A	**0.0876**
		Layer 2	0.0876	N/A	**0.0876**
		Layer 3	0.0876	N/A	**0.0876**
	Telemach	Layer 1	0.0876	N/A	**0.0876**
	T-2	Layer 1	0.0876	N/A	**0.0876**
	Amis	Layer 1	0.0876	N/A	**0.0876**
SK	Slovak Telekom	Layer 1	0.1234	0.1234	**0.1234**
	Orange Slovensko	Layer 1	0.1234	0.1234	**0.1234**
	UPC	Layer 1	0.1234	0.1234	**0.1234**
	Swan	Layer 1	0.1234	0.1234	**0.1234**
TR	Türk Telekom	Layer 1	N/A	N/A	**0.4363**
		Layer 2	N/A	N/A	**0.5367**
		Layer 3	N/A	N/A	**0.7031**
	Other operators	Layer 3	N/A	N/A	**1.0043**
UK	BT	Layer 1	0.0623	0.0277	**0.0485**
	TalkTalk	Layer 1	0.0623	0.0277	**0.0485**
	Sky	Layer 1	0.0623	0.0277	**0.0485**
	Virgin Media	Layer 1	0.0623	0.0277	**0.0485**
	Vodafone	Layer 1	0.0623	0.0277	**0.0485**
	Other operators	Layer 1	0.0623	0.0277	**0.0485**

Notes to Table 3

Incumbents per country are indicated first.

BE: The same levels are applicable to other operators. However they usually provide L2 IC (except a cable incumbent that also provides L3).
Average FTRs are not based on actual data (i.e. revenues/volumes) as no data is available for each layer. Rather, the 'average FTR' per minute per Layer is calculated by de-averaging the

setup/conveyance and peak/off-peak tariffs (peak/off-peak gradient is 1.22/0.64 and the setup amounts to 16% of the total cost of a 3.2 minute call).

BG: The incumbent' core network is conditionally divided into two logical hierarchy levels: Layer 2 and Layer 3, referring to regional and national coverage. Layer 1 (local) termination is no longer applied in Bulgaria. The segmentation of the network is based on geographical codes served by the media gateways in the network. The applied fixed terminating rate is cost-oriented based on Pure Bu-LRIC model– 0,005 BGN/minute and there is no differentiation between peak/off-peak or hierarchy levels. At the moment CRC is in process of updating the Bu-LRIC model.

CH: The prices indicated are taken from the Swisscom price manual for TDM-Interconnection. For IP-Interconnection the same prices as the ones for regional TDM-interconnection (layer 2) apply. Furthermore, there exists a "clause of reciprocity", meaning that the tariffs of other operators have to be same as the ones of Swisscom.

CY: Only one rate applies. There is no separation of rates to peak and off-peak. CYTA uses layer 1 interconnection for local and regional coverage and layer 2 for national coverage. Alternative operators use layer 2 and layer 3 interconnection.

CZ: In the Czech Republic hypothetic Layer 3 with national coverage can be achieved through transit of traffic between two regional POI. However, this is not supposed to be part of fixed termination and transit prices are not regulated. Currently all OLOs active on the relevant market are interconnected only on Layer 2 (regional coverage).

EL:

1) Since 1/1/2014 there is no distinction between peak and off peak FTRs.

2) Since 28/5/2014 (a) there is no difference between the FTRs of Layer 1 and Layer 2 and (b) Layer 3 is a non-regulated interconnection layer (the respective FTR cannot be defined since the transit rate has been deregulated).

FI: The FTR average for the Other operators (combined market share 23 %) is a weighted average as of 1.1.2016.

FR: The FTR average per minute for the incumbent includes a capacity-based component: derived from a unit price of 874,80 euros per E1 per year, divided by an average load of 3.3 million minutes per E1 per year.

IS: The country is a single interconnection area with one pricing structure and SINGLE TRANSIT.

LI: Telecom Liechtenstein AG does not use differentiated Peak/Off-peak FTRs.

LT: Data as of Q3 2015.

LU: Data are valid as of 1 July 2015.

MT: Data reflect the position as at Q3 2015.

PT: Termination price is charged on a per second basis from the first second. There is no differentiation on prices concerning peak and off peak hours.

SK: Operators do not differentiate between peak and off-peak traffic.

UK: BT is subject to a charge control where the average price cap for the year must equal 0.035ppm. BT is free to set prices within this cap. BT has set different rates for day, evening and weekend traffic. The off-peak rate shown above corresponds to the evening rate. Its weekend rate is 0.016ppm. All other CPs must set rates that are fair and reasonable rates, which are presumed to be symmetric to BT.

Annex 2 FTR regulatory model implemented

Table 4

Country	COST ACCOUNTING MODEL
AT	Pure BU LRIC
BE	TD
BG	Pure BU LRIC
CH	BU LRAIC+
CY	Benchmark
CZ	Pure BU LRIC
DE	BU LRAIC+
DK	Pure BU LRIC
EE	Benchmark
EL	Pure BU LRIC
ES	Pure BU LRIC
FI	FDC
FR	Pure BU LRIC
HR	Pure BU LRIC
HU	Pure BU LRIC
IE	Pure BU LRIC
IS	Benchmark
IT	Pure BU LRIC
LI	TD
LT	BU LRAIC+
LU	Pure BU LRIC
LV	Benchmark
FYROM	TD LRIC
ME	TD
MT	Pure BU LRIC
NL	BU LRAIC+
NO	BU LRAIC+
PL	TD
PT	Benchmark
RO	Pure BU LRIC
RS	TD-FAC-CCA
SE	Pure BU LRIC
SI	Pure BU LRIC
SK	Pure BU LRIC
TR	BU LRAIC+
UK	Pure BU LRIC

Notes to Table 4

BE: The principle of setting Pure BULRIC FTRs dates back from our previous FTR market analysis (March, 2nd, 2012), however the cost model was not readily available so BIPT engaged to set Pure BULRIC FTRs in a separate decision. The draft decision on tariffs has been consulted for national

consultation in 2015, work is still in progress to adapt the cost model and the draft decision before the final decision is taken. Final decision is expected in the course of H1 2016.
BG: With Decision 134 from 14 February 2013 CRC approved cost-oriented fixed terminating rates based on Pure Bu-LRIC model as follows:
from 01.07.2013 - 0,005 BGN/minute
from 01.01.2014 - 0,005 BGN/minute
from 01.01.2015 - 0,005 BGN/minute.
CH: Source of the Swisscom-Tariffs: https://www.swisscom.ch/dam/swisscom/de/ws/documents/D_IC-Dokumente/Handbuch%20Preise_IC_V1-15.pdf, p.11 and https://www.swisscom.ch/dam/swisscom/de/ws/documents/D_IC-Dokumente/voip-ic/DE_Handbuch%20Preise_VoIP-IC_V1-1.pdf, p. 5.
CY: Until 31/12/2015 termination rates were calculated on TD-LRAIC basis. The rates for all the operators that were found to have significant market power are based on CYTA's rates (incumbent).This year OCECPRare in the process to develop a BULRIC model. With the last market analysis which was concluded in July 2015 benchmarking has been set for the calculation of the new termination rates starting1/1/2016.
CZ: Calculation of FTR is based on pure BU-LRIC model. For purposes of FTR regulation CTU has determined one level of FTR without differentiation between peak and off-peak time or POI.
DE: No glide path regulation. FTR are valid from 01.12.2014 until 31.12.2016. The decision is preliminary and still subject to Phase II investigation.
DK: All prices are of 1st January 2016.
Number of lines as of medio 2015. Data for subscribers for ultimo 2015, will be released ultimo April 2016.
EL: A Pure BU LRIC model applies since 28/5/2014 as a result of EETT's decision 714/09/10-4-2014 (Official Gazette 1049/28-04-2014).
ES: From November 1st 2015 onwards, new regulation for FTR is applied. There is no differentiation between peak/off-peak, there is symmetry in tariffs and only local level is regulated.
FI: FTR average for the rest of operators (combined market share 23 %) is a weighted average as of 1.1.2016.
IE: In relation to fixed termination for layer 1 (ie primary) ComReg Decision D12/12 imposed symmetrical blended rate of 0.085 cent per minute for all SMP fixed operators from 1 July 2014. This blended FTR will reduce to 0.072 cent per minute from 1 July 2015. Please refer to Annex 1 in ComReg Decision D12/12 at http://www.comreg.ie/_fileupload/publications/ComReg12125.pdf.
IS: The country is a single interconnection area with one pricing structure and SINGLE TRANSIT. Cost model is Benchmark - Target rate in glide path based on historical cost reached 4.dec 2012.
IT: The numbers of subsrcribers are estimates. AGCOM does not distinguish between national and local FTR, since had imposed one rate irrespective of the level of termination.
LI: FTR regulation is not finalized.
Current FTR was decided in 2007. Market analysis and remedies M3 decided in 2010. New FTR decision expected in 2016, based on TD-FDC and Benchmarking. (EFTA Surveillance Authority Recommendation of 13 April 2011 on the Regulatory Treatment of Fixed and Mobile Termination Rates in the EFTA States).
LT: Prices of termination on alternative fixed networks should not be higher than prices applied by TEO LT, AB at particular network level.
RRT finalised market research and FTR based on pure BULRIC will be set from 01/01/2016.
No differentiation Peak/Off-peak FTR.
LU: Règlement 15/186/ILR du 3 février 2015 portant sur la fixation des plafonds tarifaires pour les prestations de la terminaison d'appel sur divers réseaux téléphoniques publics individuels en position déterminée (Marché 3/2007).
LV: Latvian operators don't differentiated peak/off peak traffic.
ME: Current prices are regulated according to the CCA LRIC top down costing methodology.
FYROM: The current prices are calculated according to Top Down LRIC from the Incumbent and approved by the Agency. The prices are in national currency (denars), termination rates are 0,29 denars

or 0,0047 euro (no euro cents) local. 0,30 denars or 0,0048euro (no euro cents) regional.0,36 denars or 0,0058euro (no euro cents) national.
NO: Numbers of subscribers are provided as 30.06.2015. The total number of subscribers according to 1st of January 2016 will not be able before Q2 2016.
PT: ANACOM has set the fixed termination rates by benchmarking against the BU pure LRIC prices in countries that had already applied those prices. The benchmark has therefore taken into account the prices established by the following countries: Denmark; France; Ireland; Malta; Bulgaria; Austria and Slovakia.
These prices are in place as from 1 October 2013, and they will be replaced by new prices based on the results of the pure LRIC model developed for that purpose.
Based on the referred benchmark, ANACOM set a pure LRIC price per minute of 0.1114 EUR cents. In light of MEO's interconnection structure, which is comprised of three different interconnection levels (local, single transit and double transit), there are different prices for each level but on average the price applied is 0.1114 eurocents.
RO: For Telekom RC S.A. (former Romtelecom S.A.) the 0.14eurocents/min FTR apply irrespective of the interconnection level.
RS: Termination rates are as of 01/01/2016. Other data provided are for 2014. Data for 2015 will be available by April 2016.
SK: RU has not used any glide path.
TR: ICTA does not regulate FTRs via glide path, and the approvals don’t occur periodically.

Annex 3 FTR symmetry

The following table emphasises the level of **symmetry** among the operators when interconnection in fixed networks is offered. The information below is directly reported by each NRA explaining its particular situation.

Table 5

Country	Symmetry	Comments
AT	YES	
BE	YES	
BG	YES	
CH	YES	Symmetry is ensured on the basis of geographical coverage from a certain point of interconnection (e.g. regional termination is priced the same both ways regardless of actual network hierarchy). Symmetry is evaluated on the basis of average FTRs (i.e. pricing flexibility is left for operators).
CY	YES	Until 31/12/2015 the alternative operators' termination rate was set at the incumbent's (CYTA) national rate (0,632 euro cents). From 1/1/2016 the same regulated terminations rates apply for all providers.
CZ	YES	There is only one FTR valid irrespective of time and place of interconnection.
DK	YES	
DE	YES	More than 50 alternative fixed network operators (i. e. BT Germany, Telefónica Germany, Verizon, Versatel, Vodafone et al) have applied to have their FTR approved symmetrically, based on a tariff comparison with the approved Telekom Deutschland GmbH FTR.
EE	YES	
EL	YES	Symmetry applies since 28 May 2014.
ES	YES	The FTR is symmetrical for all the operators and established in market analysis. As the FTR is based on an efficient NGN-based operator, there is no longer the concept of level of interconnection, as there was in the past, because the architecture of NGN operators is not hierarchical. However, it was decided in the market analysis that, just for the case of termination in the incumbent network, the interconnected operator should be connected at 21 Points of Interconnection, if TDM based interconnection is used. If the operator connects to less than these 21 PoI, then a transit for terminating at the other PoIs should be paid. For IP interconnection the number of PoIs for termination in incumbent operator is still pending of decision. For the termination in alternative operators, there is no remedy concerning the minimum number of PoIs for FTR. It is subject to commercial negotiation, as it was in the past.
FI	PARTIALLY	In Finland there are no price caps on FTRs. FTRs are symmetrical among most fixed operators.

FR	PARTIALLY	Operators with significant market influence as specified in the Annex A of the 2014-1485 decision.
HR	YES	Symmetry in fixed network is prescribed for all operators as of the 1 January 2013.
HU	YES	
IE	PARTIALLY	Please note that ComReg Decision D12/12 set fixed termination rates at layer one (ie ericom's primary). ComReg Decision D12/12 imposed symmetrical blended rate of 0.085 cent per minute for all SMP fixed operators from 1 July 2014. This blended FTR will reduce to 0.072 cent per minute from 1 July 2015. Please refer to Annex1 in ComReg Decision D12/12 at http://www.comreg.ie/_fileupload/publications/ComReg12125.pdf
IS	YES	
IT	YES	
LI	NO	There is only one fixed network operator in Liechtenstein: Telecom Liechtenstein AG. National interconnecting partners are MNOs. Fixed net interconnection partners of Telecom Liechtenstein are regulated by other NRAs and are not obliged to apply Liechtenstein's FTR regulation.
LT	YES	FTRs of all fixed operators having SMP are symmetric, i.e. the FTRs are the same, irrespective of the number of customers, the difference in network topologies, level of interconnection and so on.
LU	PARTIALLY	A maximum price cap is defined by the regulation, but operators may implement the solution in their own way.
LV	YES	
ME	YES	
FYROM	YES	
MT	YES	
NL	YES	
NO	YES	
PL	YES	
PT	YES	Prices applied by operators with SMP in the wholesale markets for call termination on the public telephone network at a fixed location must be symmetric and they were set at the level of 0.1114 euro cents per minute.

		With regard to MEO: Local, single and double transit prices were set at a level that, weighted with the traffic, the average price is 0,1114 eurocents. For the other SMP operators: Whenever the operator decides to offer a pricing structure with several levels of interconnection prices: The applicable termination prices may not exceed the maximum prices established for the local, single and double transit charged by MEO. Whenever the operator decides to offer a simplified pricing structure with only one level of prices, the termination price may not exceed 0.1114 EUR cents per minute. All SMP operators shall apply a per second billing system that does not include any set-up fee.
RO	YES	
RS	PARTIALLY	Operators have different network topologies and different number of levels of interconnection. Telekom Srbija (incumbent) have 3 levels of interconnection. Other operators have 1 level of interconnection. Other operators have unique FTRs, which is calculated as a weighted average price based on the incumbent's FTRs for 3 levels of interconnection and traffic volume.
SE	YES	The incumbent is regulated with a cost orientation obligation, whilst all other operators have an obligation to set fair and reasonable prices. The definition of fair and reasonable is in line (symmetry) with the cost oriented price of the incumbent.
SI	YES	
SK	YES	The operators offer non-discriminatory FTRs to all their interconnect partners without any exception.
TR	NO	
UK	YES	Termination is regulated only at the point of interconnection closest to the called customer. At this point, BT has rates set via a charge control. All other CPs' rates are required to be set on fair and reasonable terms, and it is presumed that this means rates should be symmetric with the charge controlled rates unless the CP can demonstrate why a higher rate is necessary and in the interests of consumers. Rates for regional and national level interconnection are not regulated.

Annex 4 Market shares

Table 6

	Operator	Number of lines	Total number of lines	Market shares
AT	A1 Telekom Austria	2,228,803	3,417,117	65.2%
	Operator 2	490,598		14.4%
	Operator 3	211,409		6.2%
	Operator 4	184,409		5.4%
	Operator 5	80,332		2.4%
	Operator 6	51,069		1.5%
	Other operators	170,497		5.0%
BE	Proximus	2.591.961	4.488.711	57,5%
	Other operators	1.896.750		42,5%
BG	Bulgarian Telecommunication Company	Confidential	Confidential	63.7%
	Telenor Bulgaria	Confidential		14.4%
	Mobiltel	Confidential		12.1%
	Blizoo Media and Broadband	Confidential		8.5%
	Other operators	Confidential		1.3%
CH	Swisscom	N/A	N/A	N/A
	Other operators	N/A	N/A	N/A
CY	CYTA	246,532	315,338	78.2%
	PRIMETEL	34,530		11.0%
	CABLENET	26,267		8.3%
	MTN FIXED	8,009		2.5%
CZ	O2 Czech Republic a.s.	Confidential	Confidential	48.2%
	UPC Česká republika s.r.o.	Confidential		8.6%
	T-Mobile Czech Republic a.s.	Confidential		7.6%
	Vodafone Czech Republic a.s.	Confidential		6.5%
	České radiokomunikace a.s.	Confidential		3.8%
	IPEX a.s.	Confidential		3.0%
	Other operators	Confidential		22.3%
DE	Telekom Deutschland GmbH	20,660,000	36,890,000	56.0%
	Other operators	16,230,000		44.00%
DK	TDC	677,067	866,936	78.1%
	Telenor	49,760		5.7%
	Telia	56,740		6.5%

	DLG Tele	56,683		6.5%
	Other operators	26,686		3.1%
EE	Telia Eesti	321,532	381,919	84.2%
	Starman	32,584		8.5%
	Elisa Eesti	14,056		3.7%
	STV	13,747		3.6%
EL	OTE	2,718,175	4,755,811	57.2%
	FORTHNET	Confidential		Confidential
	HOL	Confidential		Confidential
	WIND	Confidential		Confidential
	Other operators	Confidential		Confidential
ES	Telefónica de España	10,060,200	19,157,622	52.5%
	Oragne	2,126,939		11.1%
	Vodafone	2,077,609		10.8%
	Vodafone - Ono	2,048,457		10.7%
	Jazztel	1,710,030		8.9%
	Other operators	1,134,387618		5.9%
FI	DNA Oyj	N/A	N/A	15.0%
	Elisa Oyj			39.0%
	TeliaSonera Finland Oyj			23.0%
	Other operators			23.0%
FR	Orange	Confidential	36,674,098	Confidential
	Other operators			
HR	HT	886,730	1,291,196	68.7%
	OPTIMA	152,248		11.8%
	VIPnet	162,627		12.6%
	H1	89,591		6.9%
HU	Magyar Telekom	1,676,944	3,094,228	54.2%
	Invitel	388,257		12.5%
	UPC	513,876		16.6%
	Other operators	515,151		16.6%
IE	Eircom	884.916	NA	NA
IS	Siminn	89,014	126,745	70.20%
	Vodafone	37,731		29.80%

IT	Telecom Italia S.p.A.	11,906,651	20,275,568	58.7%
	Wind Telecomunicazioni S.p.A.	2,714,627		13.4%
	Fastweb S.p.A.	2,199,679		10.8%
	Vodafone Omnitel B.V. (including TeleTu S.p.A.)	2,114,530		10.4%
	Other operators	1,340,081		6.6%
LI	Telecom Liechtenstein AG	17,184	17,184	100.00%
LT	TEO LT AB	477,313	520,640	91.7%
	CSC Telecom	8,364		1.6%
	Lietuvos gelezinkeliai	5,442		1.0%
	Other operators	29,521		5.7%
LV	Lattelecom	270,894	353,691	76.6%
	Telefons	25,284		7.1%
	Megatel	23,994		6.8%
	Telekom Baltija	13,985		4.0%
	Other operators	19,534		5.5%
LU	EPT	205,000	273,400	75.0%
	Other operators	68,400		25.0%
ME	Crnogorski Telekom	162,471	168,360	96.5%
	Mtel	5,889		3.5%
FYROM	Makedonski Telekom AD	226,653	372,557	60.8%
	ONE Telecom services	55,723		15.0%
	Robi	25,308		6.8%
	Blizoo	44,944		12.1%
	Other operators	19,929		5.3%
MT	Go plc	150,214	229,880	65.3%
	Melita plc	78,101		34.0%
	Vodafone	531		0.2%
	Ozone	775		0.3%
	SIS	207		0.1%
	Vanilla	52		0.0%
NL	KPN	N/A	N/A	N/A
	Ziggo			
	UPC			
	Tele2			
NO	Telenor	625,726	1,029,545	60.8%
	NextGen Tel	86,598		8.4%
	Get	58,448		5.7%
	TeliaSonera	45,950		4.5%
	Phonero	36,753		3.6%

	Other operators	176,070		17.1%
PL	Orange Polska S.A.	Confidential	4,728,022	Confidential
	Netia	Confidential		Confidential
	Multimedia Polska S.A.	Confidential		Confidential
	Multimedia Polska Poludnie S.A.	Confidential		Confidential
PT	MEO	Confidential	4,682,997	50.1%
	NOS Group	Confidential		32.8%
	Vodafone	Confidential		12.4%
	ONI/Cabovisão	Confidential		4.3%
	Other operators	Confidential		0.3%
RO	Telekom RC S.A.	Confidential	4,300,000	Confidential
	RCS&RDS S.A.	Confidential		Confidential
	UPC Romania S.R.L.	Confidential		Confidential
	VODAFONE ROMANIA S.A.	Confidential		Confidential
	Other operators	Confidential		Confidential
RS	Telekom Srbija	Confidential	2,770,462	92.8%
	SBB	Confidential		5.5%
	Telenor	Confidential		0.7%
	Orion telekom	Confidential		0.3%
	Other operators	Confidential		0.7%
SE	TeliaSonera	2,708,600	3,779,000	71.7%
	Comhem	337,100		8.9%
	Telenor	250,100		6.6%
	Alltele	58,400		1.5%
	TelaVox	82,900		2.2%
	Other operators	341,900		9.0%
SI	Telekom Slovenije	Confidential	Confidential	56.3%
	Telemach	Confidential		20.3%
	T-2	Confidential		11.6%
	Amis	Confidential		6.0%
	Other operators	Confidential		5.9%
SK	Slovak Telekom	Confidential	1,233,626	Confidential
	Orange Slovensko	Confidential		Confidential
	UPC	Confidential		Confidential
	Swan	Confidential		Confidential
	Other operators	Confidential		Confidential
TR	Türk Telekom	N/A	N/A	N/A
	Other Operators	N/A		N/A
UK	BT	Confidential		Confidential

	TalkTalk	Confidential	33,601,843	Confidential
	Sky	Confidential		Confidential
	Virgin Media	Confidential		Confidential
	Vodafone	Confidential		Confidential
	Other operators	Confidential		Confidential

Notes to Table 6

BG: Number of fixed telephone lines as of 31.12.2015.
CY: Number of lines as at 30/9/2015.
CZ: The data provided is based on the total number of lines at the highest interconnection level. The number of lines is based on figures as of 30 June 2015 – data for the whole year 2015 are not yet available.
DE: The number of lines is based on figures from 2014. Source: BNetzA Annual Report 2014.
EL: Figures refer to active telephone access lines as at 30/6/2015. The wholesale line rental lines are included in the incumbent's (OTE) lines.
FR: Total number of lines by the end of 2015.
HR: Data from Q3 2015.
LT: Data as of Q3 2015.
LU: Data as of 01/07/2015.
MT: Data reflects position as at Q3 2015.
SK: The number of lines of Slovak Telekom includes the all type of accesses in fixed network with a geographic number.

Annex 5 Average MTR per operator as of 1 January 2016

Table 7

Country	Operator	Average effective prices (€cent)	Subscribers	Country total subscribers	Market Share %
AT	A1Telekom Austria	**0.8049**	5,300,000	13,113,000	**40.42%**
	T-Mobile Austria	**0.8049**	3,800,000		**28.98%**
	Hutchison Drei Austria	**0.8049**	3,700,000		**28.22%**
BE	Proximus	**1.1800**	*confidential*	14 404 825	***confidential***
	Mobistar	**1.1800**	*confidential*		***confidential***
	Base	**1.1800**	*confidential*		***confidential***
BG	Mobiltel	**0.9715**	*confidential*	*confidential*	**39.64%**
	Telenor Bulgaria	**0.9715**	*confidential*		**32.25%**
	BTC	**0.9715**	*confidential*		**27.93%**
CH	Swisscom	**5.4849**	6,625,000	10,881,594	**60.88%**
	Sunrise	**6.7754**	2,414,000		**22.18%**
	Salt	**6.7754**	1,842,594		**16.93%**
CY	Cyta	**0.9900**	703,495	1,123,955	**62.59%**
	Primetel	**1.3860**	53,711		**4.78%**
	MTN	**0.9900**	359,499		**31.99%**
CZ	T-Mobile Czech Republic a.s.	**0.9979**	*confidential*	*confidential*	**39.15%**
	O2 Czech Republic a.s.	**0.9979**	*confidential*		**31.41%**
	Vodafone Czech Republic a.s.	**0.9979**	*confidential*		**23.03%**
DE	T-Mobile	**1.6600**	39,892,000	113,397,000	**35.11%**
	Vodafone	**1.6600**	30,216,000		**26.97%**
	Telefónica Germany GmbH & Co. OHG	**1.6600**	43,289,000		**37.92%**
DK	TDC	**0.7252**	3,092,444	8,411,183	**36.77%**
	Telia	**0.7252**	1,482,272		**17.62%**
	Telenor	**0.7252**	1,989,097		**23.65%**
	Hi3G	**0.7252**	1,114,919		**13.26%**
EE	Telia Eesti AS	**1.0000**	752,765	1,903,545	**39.55%**
	Elisa Eesti AS	**1.0000**	643,194		**33.79%**
	Tele2 Eesti AS	**1.0000**	507,586		**26.67%**
EL	Cosmote	**1.0810**	*confidential*	12,681,641	***confidential***
	Vodafone	**1.0810**	*confidential*		***confidential***
	Wind	**1.0810**	*confidential*		***confidential***
ES	TME	**1.0900**	15,734,734	50,673,326	**31.05%**
	Vodafone	**1.0900**	12,689,870		**25.04%**
	Orange	**1.0900**	11,545,070		**22.78%**
	Xfera	**1.0900**	3,383,961		**6.68%**
FI	DNA	**1.2500**	n.a.	9,420,000	**25.0%**
	Elisa	**1.2500**	n.a.		**39.0%**

	TeliaSonera	**1.2500**	n.a.		**35.0%**
FR	Orange	**0.7600**	*confidential*	69,456,503	***confidential***
	SFR	**0.7600**	*confidential*		***confidential***
	Bouygues Telecom	**0.7600**	*confidential*		***confidential***
	Free Mobile	**0.7600**	*confidential*		***confidential***
HR	HT	**0.8265**	2,162,892	4,629,517	**46.72%**
	VIPnet	**0.8265**	1,599,357		**34.55%**
	Tele2	**0.8265**	867,268		**18.73%**
HU	T-Mobile	**0.5469**	*confidential*	*confidential*	***confidential***
	Telenor	**0.5469**	*confidential*		***confidential***
	Vodafone	**0.5469**	*confidential*		***confidential***
IE	Vodafone Ireland Limited	**2.6000**	1,879,410	4,902,909	**38.3%**
	Three Ireland Hutchison Limited (formerly Hutchison 3G Ireland Limited)	**2.6000**	1,568,633		**32.0%**
	Three Ireland Services (Hutchison) Limited (formerly Telefonica Ireland Limited)	**2.6000**			
	Meteor Mobile Communications Limited	**2.6000**	1,006,565		**20.5%**
	Tesco Mobile Ireland Limited	**2.6000**	332,129		**6.8%**
	Lycamobile Ireland Limited	**2.6000**	Confidential		**Confidential**
IS	Siminn	**0.9904**	149,588	423,544	**35.32%**
	Vodafone	**0.9904**	113,587		**26.82%**
	Nova	**0.9904**	141,594		**33.43%**
	365/Tal	**0.9904**	15,496		**3.66%**
IT	Telecom Italia S.p.A.	**0.9800**	30,022,754	93,072,439	**32.3%**
	Vodafone Omnitel N.V.	**0.9800**	24,670,249		**26.5%**
	Wind Telecomunicazioni S.p.A.	**0.9800**	21,344,634		**22.9%**
	H3G S.p.A.	**0.9800**	10,210,167		**11.0%**
	Poste Mobile	**0.9800**	3,551,000		**3.8%**
LI	Salt (Liechtenstein) AG	**6.8174**	*confidential*	11,054	***confidential***
	Swisscom (Schweiz) AG		*confidential*		***confidential***
	Telecom Liechtenstein AG		*confidential*		***confidential***
LT	Tele2	**1.0400**	1,817,305	4,235,577	**42.91%**
	Omnitel	**1.0400**	1,301,541		**30.73%**
	Bite Lietuva	**1.0400**	1,036,590		**24.47%**
LU	Post Télécom	**0.9700**	455,500	873,700	**52.13%**
	Tango	**0.9700**	286,600		**32.80%**
	Orange	**0.9700**	131,600		**15.06%**
LV	Tele2	**1.0500**	924,721	2,579,184	**35.85%**

	Latvijas Mobilais Telefons	**1.0500**	916,467		**35.53%**
	Bite Latvija	**1.0500**	490,249		**19.01%**
	Zetcom	**1.0500**	177,442		**6.88%**
ME	Telenor	**1.1800**	390,573	1,007,890	**38.75%**
	Crnogorski Telekom	**1.1800**	329,844		**32.73%**
	Mtel	**1.1800**	287,473		**28.52%**
FYROM	T Mobile Macedonia	**1.4612**	1,006,470	2,209,280	**46.86%**
	ONE Telecommunication services	**1.4612**	536,533		**26.03%**
	VIP Macedonia	**1.4612**	588,024		**27.11%**
MT	Go plc	**0.4045**	215,376	567,607	**37.94%**
	Melita plc	**0.4045**	88,355		**15.57%**
	Vodafone	**0.4045**	253,942		**44.74%**
	Redtouch fone	**0.4045**	9,896		**1.74%**
NL	KPN	**1.8610**	6,694,000	20,784,000	**31.72%**
	Vodafone	**1.8610**	5,068,000		**24.82%**
	T-Mobile	**1.8610**	3,677,000		**19.27%**
NO	Telenor	**0.8032**	2,973,155	5,841,088	**50.90%**
	TeliaSonera	**0.8032**	2,219,021		**37.99%**
	Phonero	**0.8032**	195,210		**3.34%**
	Lyca	**0.8032**	168,519		**2.89%**
PL	Orange Polska S.A.	**1.0062**	*confidential*	56,905,306	***confidential***
	Polkomtel sp. z o.o.	**1.0062**	*confidential*		***confidential***
	P4 sp. z o.o.	**1.0062**	*confidential*		***confidential***
	T-Mobile Polska S.A.	**1.0062**	*confidential*		***confidential***
PT	MEO	**0.8300**	*confidential*	16,790,405	**46.48%**
	VODAFONE	**0.8300**	*confidential*		**30.35%**
	NOS	**0.8300**	*confidential*		**21.65%**
RO	Vodafone Romania S.A.	**0.9600**	*confidential*	23,100,000	***confidential***
	Orange Romania S.A.	**0.9600**	*confidential*		***confidential***
	TELEKOM RMC S.A.	**0.9600**	*confidential*		***confidential***
	RCS & RDS S.A.	**0.9600**	*confidential*		***confidential***
RS	MTS (Telekom Srbija)	**2.8382**	*confidential*	9,344,977	***confidential***
	Telenor	**2.8382**	*confidential*		***confidential***
	Vip mobile	**2.8382**	*confidential*		***confidential***
SE	TeliaSonera	**0.8138**	5,352,600	14,413,700	**37.14%**
	Tele2	**0.8138**	3,960,100		**27.47%**
	Telenor	**0.8138**	2,479,900		**17.21%**
	Hi3G	**0.8138**	1,854,900		**12.87%**
SI	Telekom Slovenije	**1.1400**	*confidential*	5,998,155l	***confidential***
	Si.mobil	**1.1400**	*confidential*		***confidential***
	Telemach Mobil	**1.1400**	*confidential*		***confidential***
	T-2	**1.1400**	*confidential*		***confidential***

SK	Orange Slovensko, a.s.	**1.2260**	*confidential*	*confidential*	**38.07%**
	Slovak Telekom, a.s.	**1.2260**	*confidential*		**31.33%**
	O2 Slovakia, s.r.o.	**1.2260**	*confidential*		**29.08%**
	Swan a.s.	**1.2260**	*confidential*		**1.52%**
TR	Turkcell	**0.7847**	34,244,087	73,235,783	**46.76%**
	Vodafone	**0.8098**	22,012,851		**30.06%**
	Avea	**0.9291**	16,978,845		**23.18%**
UK	EE	**0.9418**	*confidential*	84,882,326	***confidential***
	O2	**0.9418**	*confidential*		***confidential***
	Vodafone	**0.9418**	*confidential*		***confidential***
	H3G	**0.9418**	*confidential*		***confidential***

Notes to Table 7

BE: Subscribers = number of active simcards as of the 1st of January 2016 - Prices are nominal prices
BG:
All data includes number of post-paid and prepaid active mobile subscribers. Number of post-paid active subscribers means number of subscribers with a valid contract. Number of prepaid active subscribers means numbers of subscribers that have made or received a call, sent an SMS or MMS or used data services at least once in the last three months. The number of the M2M SIMs is excluded.
CH: Subscriber base as of 31.12.2015
CZ: Regulated MTR is defined as a single price per minute. SIM cards filled in column "rest of operators" are MVNOs (Service Providers) with no MTR regulation - however, termination is carried out by their MNOs for regulated rates. Also we provide the total number of SIM cards as of 30th June 2015 - data for the whole year 2015 are not yet available.
DE: Current MTR are valid from 01.12.2015 until 30.11.2016. They are preliminary and still subject to phase II investigation.
Number of subscribers are as of 3th quarter 2015.
DK: Subscribers as of mid-2015
Subscribers for the operators Mundio and Lycamobile is not publish as the number of subscribers are below the discretion limit of 5 pct. of the total market share.
EL: Active subscribers as of 30/09/2015 (datacards, M2M not included)
FI: Market shares (%) in terms of subscriptions as of 30.6.2015. Altogether, the market share of the three biggest operators is 99 %. The amount of mobile subscription was 9 420 000 as of 30.6.2015.
FR: Contrary to the previous reports, the total number of mobile subscribers is now given excluding MtoM SIM cards, which explains the apparent drop of around 8 million subscribers between July 2015 and January 2016.
IE: Telefonica Ireland Limited subscriptions data is incorporated with Hutchison 3G Ireland Limited subscriptions data.
In December 2012 Vodafone issued appeal proceedings with respect to ComReg's MTR decision (http://www.comreg.ie/_fileupload/publications/ComReg12125.pdf (ComReg Document 12/125)). For information purposes, Vodafone and ComReg have reached an agreement in respect of these proceedings. Please see ComReg Decision D02/16 (with attached court order) of 16 February 2016.
IS: Subscriber data for 1.1.2016 not yet available – data as of 1.7.2015
LT: Subscribers at Q3 2015.
LU: data as of 07/2015
Règlement 15/191/ILR du 20 mars 2015 portant fixation du plafond tarifaire pour les prestations de la terminaison d'appel vocal sur les réseaux mobiles individuels (Marché 7/2007) , Price cap based on Pure-LRIC.
FYROM, HR, MT, TR: Data as of end Q3 2015

NO: Numbers of subscribers are provided as 30.06.2015. The total number of subscribers according to 1st of January 2016 will not be available before Q2 2016.
PL: Subscribers as of 31.12.2014.
RO: The number of subscribers refers to the number of active SIM cards.
RS: Termination rates are as of 01/01/2016. Provided numbers of subscribers are for 2014.

Annex 6 Regulatory model implemented to calculate MTRs

Table 8

Jan-16	COST ACCOUNTING MODEL			GLIDE PATH in €cent				
	Model	Rate status	When a tariff adopted by a final decision and meeting the standards of the TR Recommendation has been or will be firstly applied?	Period 1 - From 01/01/2016 until 30/06/2016	Period 2 - From 01/07/2016 until 31/12/2016	Period 3 - From 01/01/2017 until 30/06/2017	Period 4 - From 01/07/2017 until 31/12/2017	Period 5 - From 01/01/2018 until 30/06/2018
AT	BU-LRIC	adopted		0.8049	0.8049			
BE	BU-LRIC	adopted		1.1800				
BG	Pure BU LRIC	adopted	01/07/2013					
CH								
CY	Benchmark BU-LRIC			0.0099	0.0099			
CZ	pure BU-LRIC	adopted	01/07/2013					
DE	BU-LRAIC+			1.6600	1.6600			
DK	BU-LRIC	adopted		0.7252	0.7252			
EE	Benchmark BU-LRIC	adopted	01.01.2013	1.0000	0.9200	0.9200		
EL	BU LRIC	adopted	01/01/2013	1.0810	1.0810			

ES	BU LRIC		10/05/2012	1.0900	1.0900	1.0900	1.0900	1.0900
FI	Other (FDC)	adopted		1.2500	1.2500	1.2500	1.2500	1.2500
FR	BU LRIC	adopted	01/01/2013	0.7600	0.7600	0.7400	0.7400	
HR	Pure BU LRIC	adopted		0.8265				
HU	BU-LRIC	adopted	01.04.2015	0.5469	0.5469	0.5469	0.5469	Not yet decided
IE	other	adopted	01/09/2016	2.6000	0.8400	0.8200	0.8200	0.7900
IS	Benchmark BU-LRIC	notified		0.9904	0.9904			
IT	BU-LRIC	adopted		0.9800	0.9800	0.9800	0.9800	
LI	Benchmarking	adopted		3.5951	3.5951			
LT	Benchmarking BU-LRIC	adopted	01/08/2014	1.0400				
LU	Pure BU-LRIC	adopted	01/04/2015	0.9700	0.9700			
LV	Benchmark BU-LRIC	adopted	01/07/2014	1.0500	1.0500			
ME	CCA LRIC Top down	adopted		1.1800				
FYROM	BU LRAIC+							
MT	Pure BU-LRIC	adopted	01/04/2014	0.4045	0.4045			
NL								

NO	BU-LRIC	adopted	01/07/2015	0.8032	0.8032	0.6961	0.6961	
PL	Pure BU LRIC	adopted	01/07/2013	1.0062	1.0062	1.0062	1.0062	1.0062
PT	Pure BU LRIC	adopted	31/12/2012	0.8300	0.8100	0.8100		
RO	Pure BU LRIC	adopted	01/04/2014	0.9600				
RS	Benchmarking			2.8382	2.2755	1.7129		
SE	BU LRIC	adopted	01/07/2013	0.8138	0.6160	0.6160	0.5569	0.5569
SI	Pure BU LRIC	adopted	01/09/2014	1.1400	1.1400	1.1400	1.1400	1.1400
SK	Pure BU LRIC	adopted	01/08/2013	1.2260				
TR	BU LRAIC+							
UK	BU LRIC	adopted	01/04/2013	0.8189	0.6960	0.6922	0.6883	

Notes to Table 8

BE: 0,74c€/minute proposed in national consultation. Timing of the entry in force of the final decision still to be determined.
Besides, the proposed tariff of 0.74 will be most likely reviewed before adoption (work in progress).
On 1 January 2013, the last step of the MTR glide path set by the Belgian regulator (BIPT) in June 2010 for the 2010-2013 period entered into force. Since 1 January 2013, MTRs in Belgium have been fully symmetric at a rate of 1.18 euro cents/min (incl. inflation). At present the BIPT reviews the analysis of the mobile termination market and the MTR cost model.
BG: With Decision 135 from 14 February 2013 CRC approved cost-oriented mobile termination rates based on Pure Bu-LRIC model as follows:
from 01/07/2013 - 0.023 BGN/minute
from 01/01/2014 - 0.020 BGN/minute
from 01/01/2015 - 0.019 BGN/minute
No MTRs peak/off-peak differentiation
At the moment CRC is in process of updating the BULRIC model.
CH: MTRs are not regulated.
CY: Please note that from 1/1/2016 and until the results of our own BULRIC model (consistent with the TR Recommendation) are finalized, the national regulation imposes that from 1/1/2016 the applied MTRs are based on the average rate of all E.U. countries that have already imposed the results of a BULRIC (consistent with the TR Recommendation), 0.99c/minute. For MTN, Cablenet and Cyta the rate is symmetric (0.99c/minute), for the newly established MNO namely Primetel there is a glide path imposed, specifically a 40% above the regulated rate for 2016 and 20% above for 2017. The results of our own BULRIC are expected to be finalized by the end of 2016.
CZ: We do not apply any glide path mechanism for time period 01/01/2016 - 30/06/2018. According to the last price regulation level of MTR has been set up on 0.27 CZK per minute for all SMP-operators on relevant market no. 7. CTU is currently working on update of its pure BU-LRIC model so that it takes into account also LTE network and traffic. However, the upcoming updated level of MTR is still unknown. Regulated MTR is calculated in accordance with Recommendation 2009/369/ES.
DE: No glide path regulation. Current MTR (as indicated in Period 1 and Period II) are valid from 01.12.2015 until 30.11.2016. The decision is preliminary and still subject to phase II investigation.
EL: EETT is currently preparing the next market review. Until the adoption of the final measure (after the consultation and notification procedures) the price of 1.081eurocent/min will be applied.
ES: The final decision and meeting the standards of the TR Recommendation has been applied on 10th May 2012 but the MTR of the BULRIC model came into force on 1/7/2013.
FI: FICORA issued new decisions concerning significant market power in the mobile voice call termination markets on 10 August 2015. FICORA has, for the first time, set a cost-oriented maximum price for MTRs. The MTR 1.25 came into effect on 1th of December 2015. The cost-oriented maximum price for MTRs has been calculated based on FDC approach. Some of the operators have appealed to Supreme Administrative Court and the process is still going on.
FR: In period 4, the glide-path is only valid until 19/12/2017. Regulated MTRs after that date will be subject to next round of market analysis.
HR: HAKOM is currently in the process of updating MTR cost model. Please note that MRs are regulated only for the calls originated on A numbers belonging to the EU/EEA operators and terminated into the individual fixed networks in Croatia.
IE: • As previously advised:
• In December 2012, Vodafone issued appeal proceedings with respect to ComReg's MTR decision (http://www.comreg.ie/_fileupload/publications/ComReg12125.pdf (ComReg Document 12/125)).
• The appeal was heard in the high Court in May 2013. On 17 August the Order of the High Court included a provision for a maximum weighted average MTR of 2.60 cent per minute until the final determination of the Appeal or further order.
• On 21 November 2013, the High Court refused to grant any stay on its Order of 17 October 2013. The High Court also provided a further statement of reasons for its decision to postpone any ruling on

Vodafone's challenge to the validity of ComReg's choice of pure LRIC as the relevant cost standard for regulating MTRs. In addition, the High Court clarified that the maximum rate of 2.60 cent per minute referred to in its Order of 17 October 2013 applies from 1 July 2013.
a. Judgment of the Irish High Court dated 14 August 2013
http://www.courts.ie/judgments.nsf/6681dee4565ecf2c80256e7e0052005b/005d4340da18896480257bc7003cd090?OpenDocument&Highlight=0,vodafone
b. ComReg Information Notice 13/80: http://www.comreg.ie/_fileupload/publications/ComReg1380.pdf
c. ComReg Information Notice 13/97: http://www.comreg.ie/_fileupload/publications/ComReg1397.pdf
d. ComReg Information Notice 13/97a:
http://www.comreg.ie/_fileupload/publications/ComRegHCO1397a1.pdf
• Please also note that the High Court judgment is currently under appeal to the Supreme Court and note that the High Court refused to grant any stay on its Order of 17 October 2013 (i.e. refused to grant any stay on the application of the 2.60 cent MTR) pending the outcome of the Supreme Court appeal. In this regard, please refer to:
e. ComReg Information Notice 13/99 http://www.comreg.ie/_fileupload/publications/ComReg1399.pdf
f. ComReg Information Notice 13/108
http://www.comreg.ie/_fileupload/publications/ComReg13108.pdf
• Vodafone and ComReg have reached an agreement in respect of proceedings entitled Vodafone v. ComReg Record No. 2012 No. 465 MCA and Record No. 450/2013 whereby Vodafone has withdrawn its challenge to the choice of Pure LRIC as a methodology in Decision D12/12 and ComReg has agreed to withdraw its appeal against the judgment of the High Court of 14 August 2013 (and the Supplemental Ruling of 21 November 2013) in those proceedings. Such withdrawal is without prejudice to ComReg's contentions in that appeal.
See http://www.comreg.ie/_fileupload/publications/ComReg1614.pdf
.

IS: Benchmark against BU-LRIC to be made in sept 2016 for validity in 2017. Notified 1 October to ESA and ratified 1 November - Number of mobile subscribers is not confidential - PTA published this data on its website.
LI: Operator specific information on MTR and Market Share is confidential - no publication.
Market analysis M7 and MTR decisions are available on : http://www.llv.li/#/111026/m
Last step of glide path, effective since 1/1/2013: 0.0765 CHF/min (cap)
Benchmarking method: The weighted average of the termination rates in Switzerland, 0.0765 CHF per minute as of 1 January 2011, served as a reference value for setting the termination rates of the Liechtenstein mobile operators in the context of the M7 market analysis.
MTR as of May 1, 2016 is 3.9 CHF-cents per minute (Jan 1 until April 30, 2016: 7.65 CHF-cents)
LT: The rate was calculated and based on Benchmarking methodology in 2014. In the end of 2015 RRT finalized market research and calculated new rate, based on Benchmarking methodology, the rate will be applied from 01/04/2016.
LV: Latvian NRA doesn't apply any glide path
PT: In August 6, 2015 ANACOM approved a new decision establishing the new MTR also in accordance with the EC Recommendation on Termination rates - BU-LRIC.
From 01.07.2016 (and until June next year) and from 01.07.2017 (and until June next year) the MTR will correspond to the values of the pure LRIC cost model adjusted in accordance with the inflation rate. Maximum values to be applied since the 1st of July 2016 were set at 0.81 cents/minute.
RO: The number of subscribers refers to the number of active SIM cards.
RS: Current MTR will be valid until 1st of May 2016. From 1st May 2016 until 31/12/2016 price will be 2.75 in RSD. From 01/01/2017 MTR in national currency will be 2.07 RSD and will be valid until new RATEL`s decision.
SE: Glide path was applied for the period between 01/07/2011 and 30/06/2013
SK: RU has not applied any glide path.
TR: ICTA does not regulate MTRs via glide path, and the approvals don't occur periodically.
UK: Note that Ofcom uses financial year (APR to APR) glide paths for MTRs. Where the above periods cross an Ofcom glide path period, we have taken the average for the above period.

Forecasts values are calculated assuming a 2% inflation rate.

Annex 7 SMS TR per operator as of 1 January 2016

Table 9

Country	Operator	SMS TR (€cent)		Subscribers		Market share
		per operator	*WA per country*	*per operator*	*Total per country*	
AT	A1Telekom Austria	*n.a.*	**3.1200**	5,300,000	13,113,000	**40.42%**
	T-Mobile Austria	*n.a.*		3,800,000		**28.98%**
	Hutchison Drei Austria	*n.a.*		3,700,000		**28.22%**
BE	Belgacom	4.9600	**4.9600**	*confidential*	14 404 825	***confidential***
	Mobistar	4.9600		*confidential*		***confidential***
	KPN Belgium	4.9600		*confidential*		***confidential***
BG	Mobiltel	*confidential*	***confidential***	*confidential*	confidential	**39.64%**
	Telenor Bulgaria	*confidential*		*confidential*		**32.25%**
	BTC	*confidential*		*confidential*		**27.93%**
CH	Swisscom	*confidential*	**4.6704**	6,625,000	10,881,594	**60.88%**
	Sunrise	*confidential*		2,414,000		**22.18%**
	Salt	*confidential*		1,842,594		**16.93%**
CY	Cyta	0.5500	**0.6013**	703,495	1,123,955	**62.59%**
	Primetel	0.7300		53,711		**4.78%**
	MTN	0.6800		359,499		**31.99%**
CZ	T-Mobile Czech Republic a.s.	*confidential*	***confidential***	*confidential*	confidential	**39.15%**
	O2 Czech Republic a.s.	*confidential*		*confidential*		**31.41%**
	Vodafone Czech Republic a.s.	*confidential*		*confidential*		**23.03%**
DE	T-Mobile	**n.a.**	**n.a.**	39,892,000	113,397,000	**35.18%**
	Vodafone	**n.a.**		30,216,000		**26.65%**
	Telefónica Germany GmbH & Co. OHG	**n.a.**		43,289,000		**38.17%**

DK	TDC	0.1488	**0.1488**	3,092,444	8,411,183	**36.77%**
	Telenor	0.1488		1,989,097		**23.65%**
	Telia	0.1488		1,482,272		**17.62%**
	Hi3G	0.1488		1,114,919		**13.26%**
EE	Telia Eesti AS	2.6000	**2.2977**	752,765	1,903,545	**39.55%**
	Elisa Eesti AS	2.1000		643,194		**33.79%**
	Tele2 Eesti AS	2.1000		507,586		**26.67%**
EL	Cosmote	3.0000	**3.0000**	*confidential*	12,681,641	***confidential***
	Vodafone	3.0000		*confidential*		***confidential***
	Wind	3.0000		*confidential*		***confidential***
ES	Movistar	2.5623	**2.6333**	15,734,734	50,673,326	**31.05%**
	Vodafone	2.3684		12,689,870		**25.04%**
	Orange	3.0000		11,545,070		**22.78%**
	Yoigo	2.7051		3,383,961		**6.68%**
FI	TeliaSonera Finland Oyj	*confidential*	***confidential***	N.A.	9,420,000	**25.00%**
	Elisa Oyj			N.A.		**39.00%**
	DNA Oy			N.A.		**35.00%**
FR	Orange	1.0000	**1.0000**	*confidential*	69,456,503	***confidential***
	SFR	1.0000		*confidential*		***confidential***
	Bouygues Telecom	1.0000		*confidential*		***confidential***
	Free Mobile	1.0000		*confidential*		***confidential***
HR	HT	*n.a*	***n.a.***	2,162,892	4,629,517	**46,72%**
	VIPnet	*n.a.*		1,599,357		**34,55%**
	Tele2	*n.a.*		867,268		**18,73%**
HU	T-Mobile	4,4779	**4,4779**	*confidential*	*confidential*	**confidential**
	Telenor	4,4779		*confidential*		**confidential**
	Vodafone	4,4779		*confidential*		**confidential**
IE	Vodafone Ireland Limited	3.1700		1,879,410		**38.3%**

	Three Ireland Hutchison Limited (formerly Hutchison 3G Ireland Limited)	3.1700	**3.1700**	1,568,633	4,902,909	**32.0%**
	Three Ireland Services (Hutchison) Limited (formerly Telefonica Ireland Limited)	3.1700				
	Meteor Mobile Communications Limited	3.1700		1,006,565		**20.5%**
	Tesco Mobile Ireland Limited			332,129		**6.8%**
	Lycamobile Ireland Limited	3.1700		*confidential*		***confidential***
IS	Siminn	2.7235	**2.7235**	149,588	423,544	**35.32%**
	Vodafone	2.7235		113,587		**26.82%**
	Nova	2.7235		141,594		**33.43%**
	365/Tal	2.7235		15,496		**3.66%**
IT	Telecom Italia	*confidential*	**3.3109**	30,022,754	93,072,439	**32.3%**
	Vodafone Omnitel N.V.	*confidential*		24,670,249		**26.5%**
	Wind Telecomunicazioni	*confidential*		21,344,634		**22.9%**
	H3G S.p.A.	*confidential*		10,210,167		**11.0%**
	Poste Mobile	*confidential*		3,551,000		**3.8%**
LI	Salt (Liechtenstein) AG	*confidential*	**5,7909**	*confidential*	11,054	***confidential***
	Swisscom (Schweiz) AG	*confidential*		*confidential*		***confidential***
	Telecom Liechtenstein AG	*confidential*		*confidential*		***confidential***
LT	Tele2	0.7250	**0.9059**	1,301,541	4,235,577	**30.73%**
	Omnitel	0.7250		1,817,305		**42.91%**
	Bite Lietuva	1.4500		1,036,590		**24.47%**
LU	EPT	n.a.	**n.a.**	455,500	873,700	**53.00%**
	Tango	n.a.		286,600		**31.00%**
	Orange	n.a.		131,600		**16.00%**
LV	Tele2	2.1300	**2.1300**	924,721.00	2,579,184	**35.85%**
	Latvijas Mobilais Telefons	2.1300		916,467.00		**35.53%**

	Bite Latvija	2.1300		490,249.00		**19.01%**
ME	Telenor	2.2000	**2.2000**	390,573	1,007,890	**38.75%**
	Crnogorski Telekom	2.2000		329,844		**32.73%**
	Mtel	2.2000		287,473		**28.52%**
FYROM	T Mobile Macedonia	0.8118	**0.8118**	1,035,279	2,209,280	**46.86%**
	ONE Telecommunication services	0.8118		575,000		**26.03%**
	VIP Macedonia	0.8118		599,001		**27.11%**
MT	GoMobile	1.1824	**1.5347**	215,376	567,607	**37.94%**
	Melita Mobile	1.8507		88,355		**15.57%**
	Vodafone	1.7235		253,942		**44.74%**
NL	KPN	5.6000	**5.6000**	6,694,000	20,234,000	**31.72%**
	Vodafone	5.6000		5,068,000		**24.82%**
	T-Mobile	5.6000		3,677,000		**19.27%**
NO	Telenor	3.7481	**3.7481**	2,973,155	5,841,088	**50.90%**
	TeliaSonera	3.7481		2,219,021		**37.99%**
	Lyca	3.7481		195,210		**3.34%**
	Phonero	3.7481		168,519		**2.89%**
PL	Orange Polska S.A.	1.1727	**1.1727**	*confidential*	56,905,306	***confidential***
	Polkomtel sp. z o.o.	1.1727		*confidential*		***confidential***
	P4 sp. z o.o.	1.1727		*confidential*		***confidential***
	T-Mobile Polska S.A.	1.1727		*confidential*		***confidential***
PT	MEO	*confidential*	**1.2700**	*confidential*	16,790,405	**46,48%**
	VODAFONE	*confidential*		*confidential*		**30,35%**
	NOS	*confidential*		*confidential*		**21,65%**
RO	Vodafone Romania S.A.	*confidential*	**2.3000**	*confidential*	23,100,000	***confidential***
	Orange Romania S.A.	*confidential*		*confidential*		***confidential***
	TELEKOM RMC S.A.	*confidential*		*confidential*		***confidential***
	RCS & RDS S.A.	*confidential*		*confidential*		***confidential***
RS	Telekom Srbija	1.6549		*confidential*		***confidential***

	Telenor	1.6549	**1.6549**	*confidential*	9,344,977	***confidential***
	VIP mobile	1.6549		*confidential*		***confidential***
SE	TeliaSonera	**3.2250**	**3.2250**	5,352,600	14,413,700	**37.14%**
	Tele2	**3.2250**		3,960,100		**27.47%**
	Telenor	**3.2250**		2,479,900		**17.21%**
	Hi3G	**3.2250**		1,854,900		**12.87%**
SI	Telekom Slovenije	Bill & Keep	**Bill & Keep**	*confidential*	*confidential*	**52.50%**
	Si.mobil			*confidential*		**30.10%**
	Telemach Mobil			*confidential*		**14.07%**
	T-2			*confidential*		**3.33%**
SK	Orange Slovensko, a.s.	2.5000	**2.500**	*confidential*	5,998,155l	confidential
	Slovak Telekom, a.s.	2.5000		*confidential*		confidential
	O2 Slovakia, s.r.o.	2.5000		*confidential*		confidential
	Swan a.s.	2.5000		*confidential*		confidential
TR	Turkcell	0.1350	**0.1379**	34,244,087	73,235,783	**46.76%**
	Vodafone	0.1350		22,012,851		**30.06%**
	Avea	0.1475		16,978,845		**23.18%**
UK	EE	*confidential*	***2.2654***	*confidential*	84,882,326	***confidential***
	O2	*confidential*		*confidential*		***confidential***
	Vodafone	*confidential*		*confidential*		***confidential***
	H3G	*confidential*		*confidential*		***confidential***

Notes at Table 9

BE: National incoming SMS termination
Subcribers = number of active simcards as of the 1st of January 2016 - Prices are nominal prices
BG: All data includes number of post-paid and prepaid active mobile subscribers. Number of post-paid active subscribers means number of subscribers with a valid contract. Number of prepaid active subscribers means numbers of subscribers that have made or received a call, sent an SMS or MMS or used data services at least once in the last three months. The number of the M2M SIMs is excluded.

CZ: All Czech SMP-operators use the same level of SMS call termination rates all the time without any differences between peak time and off peak time.
DE: Number of subscribers are as of 3th quarter 2015.
SMS call termination rates are not regulated in Germany
DK: In 2015, DBA withdrew all SMP remedies on the wholesale SMS termination market effective as of 1 January 2016. The last regulated SMS termination rate that applied prior to this deregulation was 1.11 Danish øre/SMS. This price was still in effect as of 1 January 2016 but the operators have notified price increases to 10 Danish øre/SMS (1.34 eurocents) that will take effect as of 1 April 2016.
EL: Active subscribers as of 30/09/2015 (datacards, M2M not included)
FI: SMS termination rates are not regulated in Finland.
HR, TR: Data as of end Q3 2015.
HU: SMS termination rate in national currency has not changed. The HUF / Eur exchange rate has changed only.
IT: Estimated data.
LI: Salt (Liechtenstein) AG: "We do not charge MT-SMS and in all AA.19 contract the price is 0.0€ therefore we do not have a price list."
Telecom Liechtenstein AG: "SMS interworking fee is an average value and confidential."
LU: No data available as not regulated.
ME: SMS termination rates are valid only for termination of SMS's that originated from national operators
MT: Data reflects as up to Q3 2015 (January - September 2015)
NL: This is the last known commercially agreed SMS-termination rate. Rate is from 2012 and thus 3 years old.
Subscriber numbers from 01/2015
PL: Subscribers as of 31.12.2014.
RS: Provided numbers of subscribers are for 2014.
SE: PTS does not monitor the SMS wholesale termination rates. The current reference offers indicates a termination rate of SEK 0.30. However, statistics shows that the average retail revenue per sent SMS was SEK 0,18 in 2015 H1, clearly indicating that a wholesale level of SEK 0,30 is too high OR that the revenue from SMS termination has a net value of close to zero in the market, e.g. an SMS sent is often met by a reply from the receiver.
SI: SMS termination rates are not regulated. Operators apply "bill and keep" system.

Annex 8 Abbreviations and Exchange rates

Table 9 – Abbreviations

AT	Austria
BE	Belgium
BG	Bulgaria
CH	Switzerland
CY	Cyprus
CZ	Czech Republic
DK	Denmark
DE	Germany
EE	Estonia
EL	Greece
ES	Spain
FI	Finland
FR	France
HR	Croatia
HU	Hungary
IE	Ireland
IS	Iceland
IT	Italy
LI	Liechtenstein
LT	Lithuania
LV	Latvia
LU	Luxembourg
ME	Montenegro
FYROM	the former Yugoslav Republic of Macedonia
MT	Malta
NL	Netherlands
NO	Norway
PL	Poland
PT	Portugal
RO	Romania
RS	Serbia
SE	Sweden
SI	Slovenia
SK	Slovakia
TR	Turkey
UK	United Kingdom

Table 10 – Exchange Rates[12]

COUNTRY	1 EURO
BG	1.96
CH	1.08
CZ	27.06
DK	7.46
HR	7.62
HU	312,65
IS	141.36
LI	1.08
FYROM	61.59
NO	9.34
PL	4.26
RO	4.46
RS	120.85
SE	9.30
TR	3.19
UK	0.72

[12] ECB website: http://sdw.ecb.europa.eu/browseSelection.do?DATASET=0&FREQ=A&node=2018794
For IS at http://www.cb.is/exchange-rate/.

Annex 9 Glossary

A(s)	Simple average
A(w)	Weighted average
FTR	Fixed Termination Rate
MTR	Mobile terminate rate
NRA	National Regulatory Authority
SMS	Short Message Service
TR	Termination Rate
TD	Top Down
BU	Bottom Up
LRIC	Long Run Incremental Cost
LRAIC	Long Run Average Incremental Cost
FAC	Fully Allocated Cost
CCA	Current Cost Accounting
HCA	Historical Cost Accounting
FDC	Fully Distributed Cost

Body of European Regulators for Electronic Communications

BEREC

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Case Studies on IP-based Interconnection for Voice Services in the European Union

November 2015

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Executive Summary

In recent years several operators (fixed and mobile) in EU Member States started to migrate their networks to Next Generation Networks or all-IP networks. When networks are migrated to NGN or all-IP networks, it is “natural” and efficient that also the interconnection for voice services is based on IP (and no longer on TDM). In order to get a deeper insight into the IP-based interconnection for voice services (IPvIC) already in place and to foster the exchange of experiences, as well as to contribute to the harmonisation of regulatory instruments and technical solutions used in the European Union, this document has the following two objectives. Firstly, it aims to give an overview of the status of IPvIC in Europe on a general level based on information of 32 European countries. Secondly, it aims to give an overview of the IPvIC currently in place based on the experiences of ten countries (Bulgaria, Croatia, Denmark, Finland, France, Germany, Italy, Slovenia, Spain and Sweden). The latter covers IPvIC offered by fixed network incumbents (FNI, 8 countries), other fixed network operators (OFNO, 3 countries) and mobile network operators (MNO, 2 countries), i.e. in total thirteen cases. The analysis is descriptive and does not aim at being normative or recommend a best practice.

The high level analysis of the status of the IPvIC in Europe shows that the type of operator which most often offers IPvIC is the OFNO followed by the FNI and the MNO. NRAs imposed the obligation to offer IPvIC most frequently on FNI (13 countries) followed by OFNO (11) and MNO (5).

In the countries analysed the IPvIC have the following general characteristics:

- Obligation to offer IPvIC: All operators considered offer IPvIC based on an obligation except for the MNO in Finland.
- National specification(s): In order to support a common solution for several or all operators at the national level most countries analysed (7 of 10) have developed one (or more) national specification(s) defining the characteristics of the IPvIC in detail.
- Transitional period: The countries (9) which have imposed that the operators analysed have to offer IPvIC support the migration from TDM-based interconnection for voice services (TDMvIC) to IPvIC with the obligation that both types of voice IC have to be offered. In most of these countries (6 of 9) a transitional period is not (yet) defined, and therefore the operators are free to migrate to IPvIC when it is best for them. The other three countries have already defined the transitional period.
- Period of notice of phasing out TDMvIC: This period has already been defined in three countries. In the other countries this is not the case and in most of them the operators analysed have not made formal announcements to phase out TDMvIC so far.

In the cases analysed important technical characteristics of the IPvIC are as follows:

- Number of PoIs of the IPvIC: The minimum number of PoIs of the IPvIC which enable operators to handover voice traffic for national destinations based on the regulated termination rates (without additional charges) has been reduced to one or two (8 of 13 cases). This reflects the trend that the number of PoIs is usually reduced with the migration to NGN and all-IP networks.
- Signalling protocol: The signalling protocol to be used at the PoI is SIP (11 of 13). In most of these cases (7 of 11) the use of SIP is further defined with 3GPP specifications (related to IMS). In the two cases with MNO SIP-I (and not SIP) is used at the PoI which is also used within mobile networks.
- Number ranges, codecs and supplementary services supported by IPvIC: The IPvIC supports the same number ranges as the TDMvIC (10 of 13), the audio codec G.711 (all cases) which is typically used in fixed networks and also further audio codecs (9 of 13) as well as fax services (all cases) which all together facilitate the migration from TDMvIC to IPvIC. However, the same supplementary services as TDMvIC are only supported in about the half of the cases analysed.
- QoS: The IPvIC has a defined QoS with regard to certain QoS parameters (at least 11 of 13), whereby different QoS parameters are used in different cases.
- Redundancy and network security of the IPvIC: The networks are interconnected with the networks of the IC partners with direct physical IC links (12 of 13) or via (domestic) exchange points (1 case) and not over the public Internet which provides a significant protection against threats from the Internet. In order to increase the availability, redundancy is used at the level of the physical IC link (12 of 13) and at the level of the border gateway (8 of 13). The operators also apply further security measures (at least 12 of 13).

It can be concluded that from an overall perspective the IPvIC are rather similar. However in detail the characteristics may differ reflecting national circumstances.

1 Introduction and objective

In recent years several operators (fixed and mobile) in EU Member States started to migrate their networks to Next Generation Networks (NGN) or all-IP networks. A main driver for this is the fundamental change of the traffic from previously being dominated by voice traffic to meanwhile being dominated by data traffic. Previously the voice telephony networks were optimised for voice (i.e circuit switching and the use of TDM[1]) and to some extent also data was carried over these networks. Now the networks are optimised for data traffic (i.e. packet switching and IP) and voice is increasingly also transported over these networks. When networks are migrated to NGN or all-IP networks, it is "natural" and efficient that also the interconnection for voice services is based on IP (and no longer on TDM). Then no longer a conversion from IP to TDM is necessary and all voice traffic can stay completely on IP. Several operators therefore demand IP-based interconnection for voice services (IPvIC) instead of TDM-based interconnection for voice services (TDMvIC). If there is a mutual commercial interest, operators will migrate from TDMvIC to IPvIC on a voluntary basis. However, in other cases regulatory intervention may be necessary.

From a regulatory perspective, during the migration phase at least two crucial aspects have to be considered. Firstly, there are several different solutions which can be used for IPvIC. Therefore, all involved operators not only have to agree on which solution should be used but also on all details of the solution in order to guarantee full interoperability between their voice telephony networks. In the ideal case, all operators agree on the technical solution to be used for IPvIC. If, however, operators cannot agree to a common solution or if some operators refuse to offer IPvIC at all, there might be a need for regulatory intervention.

The second aspect of relevance is the time frame for the migration to IPvIC. Operators may migrate their voice telephony networks at a different time and with a different pace. This would mean that both IPvIC and TDMvIC need to be available in parallel for some time. If operators do not agree on a migration path, there might be a need for regulatory intervention to avoid that both technical solutions are offered over a long time while at the same time taking into account the migration plans of the operators involved.

Over the last years, several NRAs already imposed on operators, in most cases on the fixed network incumbent, the obligation to offer IPvIC, and some operators also started to offer IPvIC on a voluntary basis. In order to get a deeper insight into the IPvIC and foster the exchange of

[1] Time Division Multiplexing (TDM) divides a continues bitstream into equal time periods (called time slots) and assigns a communication channel (e.g. voice channel) to these time slots. The traditional voice switches (e.g. local exchange) connect dynamically such channels in order to set-up a connection for a call. Therefore TDM and circuit switching differ completely from packet switching and IP where information (e.g. voice) is transported and switched based on packets.

experiences, as well as to contribute to the harmonisation[2] of regulatory instruments and technical solutions used in the EU, this report has the following two objectives. Firstly, it aims to give an overview of the status of IPvIC in Europe on a general level based on information of 32 European countries. Secondly, it aims to give an overview of the IPvIC currently in place based on the experiences of ten countries (Bulgaria, Croatia, Denmark, Finalnd, France, Germany, Italy, Slovenia, Spain and Sweden). The latter covers IPvIC offered by fixed network incumbents (FNI, 8 countries), other fixed network operators (OFNO, 3 countries) and mobile network operators (MNO, 2 countries), i.e. in total thirteen cases. The analysis is descriptive and does not aim at being normative or recommend a best practice.

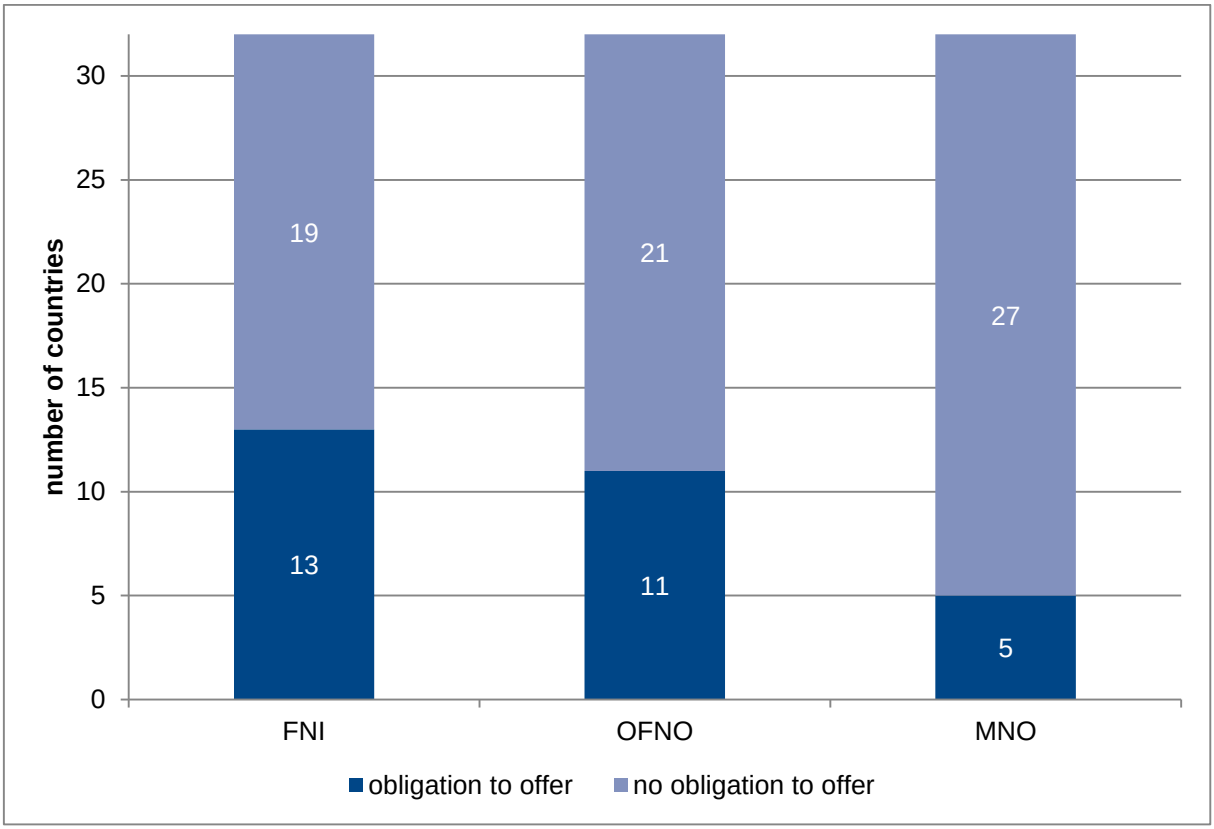
This document starts with an overview of the status of IPvIC in Europe on a general level (section 2). In the next step the IPvIC of the cases considered are analysed. This starts with an overview of the operators analysed (section 3.1) followed by the analysis of general characteristics (section 3.2) and important technical characteristics of the IPvIC (section 3.3). Finally, conclusions are drawn (section 4).

2 Status of IP-based in interconnection for voice services in Europe

This section gives an overview of the status of IPvIC in Europe as of April 2015. The information is based on the responses of 32 NRAs (of totally 37 BEREC members and BEREC observers).

Figure 1 shows the number of countries which have imposed obligations on the FNI, the OFNO and/or the MNO to offer IPvIC (the countries are listed in Table 1). 13 countries (41% of the 32 countries which responded) have imposed the obligation to offer IPvIC on the FNI. In most of these countries, also the OFNO has the obligation to offer IPvIC. Only two countries (CY, GR) imposed an obligation to offer IPvIC on the FNI but not on OFNO.

[2] By providing information and a reference to NRAs of countries where IPvIC has not yet been implemented, this report contributes to harmonisation. A further need for harmonisation has not been identified by BEREC.



Source: BEREC

Figure 1: Number of countries with an obligation on operators to offer IPvIC (Q1/2015)

Table 1: Obligation to offer IPvIC (Q1/2015)

	FNI	OFNO	MNO
Yes	AT*, BG, CH, CY*, DE, DK, ES, FR*, GR, HR, IT, SE*, SI	AT*, BG, CH, DE**, DK**, ES**, FR*, HR, IT, SE*, SI	AT*, CH, DK**, FR*, SE*
No	BE, CZ, EE, FI, FYROM, IE, LI, LT, LU, ME, NL, NO, PL, PT, RO, RS, TR, SK, UK	BE, CY, CZ, EE, FI, FYROM***, GR, IE, LI, LT, LU, ME, NL, NO, PL, PT, RO, RS, TR, SK, UK	BE, BG, CY, CZ, DE, EE, ES, FI, FYROM, GR, HR, IE, IT, LI, LT, LU, ME, NL, NO, PL, PT, RO, RS, SK, SI, TR, UK

* Only in case of (reasonable) request

** Only OFNO with customers directly connected to an NGN (DE) or with VoIP end users have the obligation to offer IPvIC (DK, ES). In Denmark, MNO have the obligation to offer IPvIC only under specific conditions.

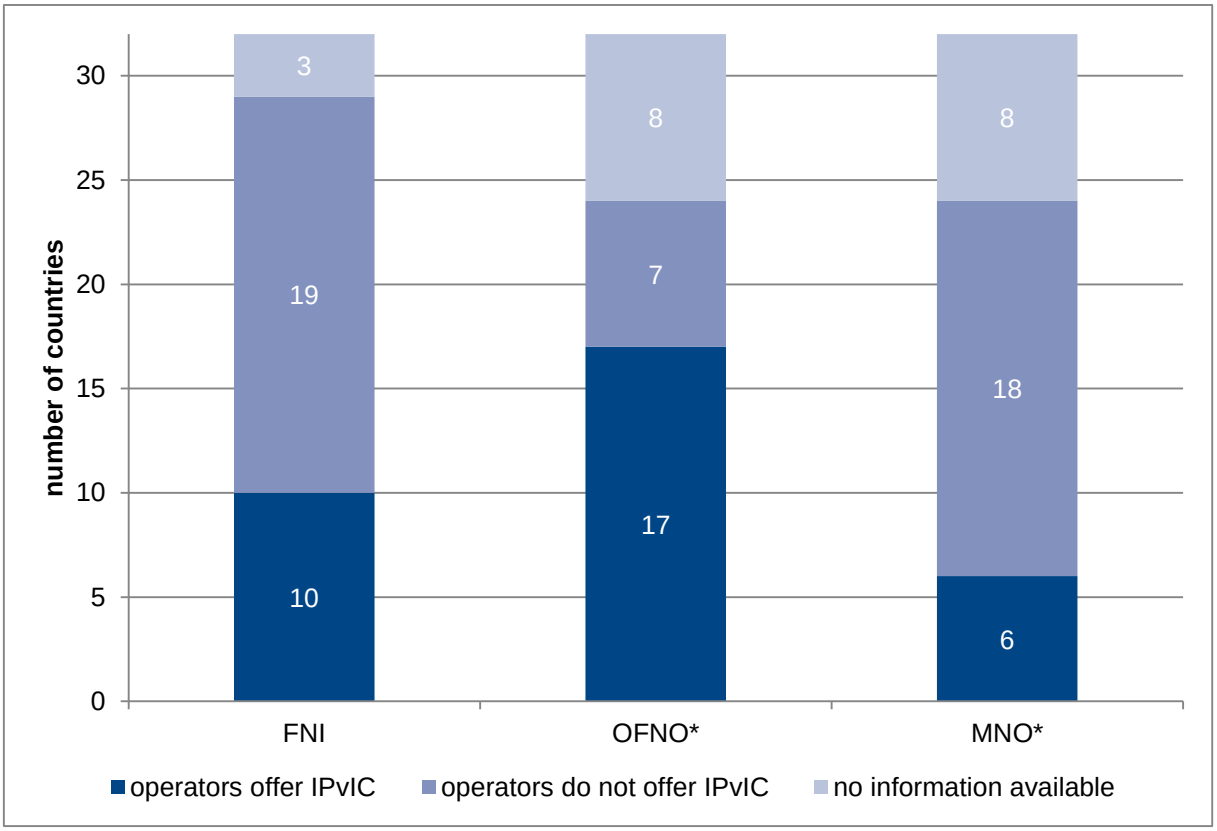
*** In FYROM, OFNO have the obligation to offer IPvIC from 01.01.2017.

Source: BEREC

The share of countries where MNO have the obligation to offer IPvIC is significantly lower (five countries, 16%). An explicit obligation might not be necessary in all cases since, for example, the operator(s) may offer IPvIC on a voluntary basis (and reach an agreement with other

operators with regard to the technical details) or there is (at least currently) no demand for IPvIC.

Figure 2 shows the number of countries where operators are already offering IPvIC (the countries are listed in Table 2).



* Also includes countries where some but not all OFNO or MNO are offering IPvIC

Source: BEREC

Figure 2: Number of countries where operators are offering IPvIC (Q1/2015)

Table 2: Countries where IPvIC is offered (Q1/2015)

	FNI	OFNO	MNO
Yes	DE, DK, FR, FYROM, IT, NL, SE, SK, SI, UK	AT*, BG, DE, ES*, FR, GR*, HR, IT, NL*, NO*, RO*, RS*, TR*, SE*, SI, SK*, UK*	AT*, FI, FR, RS*, TR*, UK*
No	AT, BE, BG, CZ, CY, EE, ES, FI, GR, HR, LI, LT, LU, ME, NO, PT, RO, RS, TR	CY, EE, FI, FYROM, LT, LU, ME	BE, BG, CY, DE, EE, FYROM, GR, HR, IT, LI, LT, LU, ME, NL, NO, PT, RO, SI
NIA**	CH, IE, PL	CH, BE, CZ, DK, IE, LI, PL, PT	CH, CZ, DK, ES, IE, PL, SE, SK

* Some but not all OFNO or MNO are offering IPvIC

** No information available

Grey: Countries where operators have an obligation to offer IPvIC

Source: BEREC

In ten countries, FNI are already offering IPvIC. This is less than the number of countries which have imposed on the FNI the obligation to offer IPvIC. The reason for this is that in some countries the process of defining the details of the reference interconnection offer (RIO) is still ongoing (BG, ES, GR) or has been finished only recently (HR). In other cases (AT, CY), the FNI has to provide IPvIC only if this is demanded by other operators, which has not been the case so far. On the other hand, there are cases where there is no regulatory obligation but the FNI is offering IPvIC on a voluntary basis (FYROM, NL, SK, UK).

The number of countries where OFNO are offering IPvIC is much higher (17 countries). However, this also includes cases where only some (and not all) OFNO are offering IPvIC (eleven countries). Many OFNO, in particular those who rolled-out their networks recently, already built pure IP networks and therefore also implemented IPvIC.

Compared to FNI and OFNO, there are only few countries where MNO are already offering IPvIC (six countries). This already includes four cases where only some MNO offer IPvIC. There is, however, also a significant number of countries where no information is available.

3 Analysis of IP-based interconnection for voice services

This section analyses the IPvIC used by thirteen operators or groups of operators in ten countries (BG, DE, DK, ES, FI, FR, HR, IT, SE, SI). It starts with an overview of the operators analysed (see section 3.1) followed by the analysis of the regulation with regard to IPvIC (see

section 3.2) and the technical characteristics of the IPvIC (see section 3.3). The data collected for the analysis in this section is shown in the tables of the Annex.

In two countries (DE, ES), the IPvIC of the FNI is based on information of the draft RIO of the FNI submitted to the NRA and the approval process is not yet finished. Therefore, the IPvIC of these FNI reflects the view of the FNI but not necessarily of the NRA.

3.1 Overview of the operators analysed

Table 3 gives an overview of the operators analysed in the report. These are the operators for which sufficient information on the IPvIC offer is available and easily accessible (e.g. based on a published reference offer) to make a detailed analysis and comparison of technical characteristics.

Table 3: Overview of the cases analysed

Country	Type of operator	Name of operator
Croatia (HR)	FNI	Hrvatski Telekom
Denmark (DK)	FNI	TDC
France (FR)	FNI	Orange
Germany (DE)	FNI	Deutsche Telekom (draft RIO)
Italy (IT)	FNI	Telecom Italia
Slovenia (SI)	FNI	Telekom Slovenije
Spain (ES)	FNI	Telefónica (draft RIO)
Sweden (SE)	FNI	TeliaSonera
Bulgaria (BG)	OFNO	all operators
Croatia (HR)	OFNO	all operators
France (FR)	OFNO	4 operators (SFR, Bouygues Telecom, Free, Colt)
Finland (FI)	MNO	3 operators (TeliaSonera, Elisa, DNA)
France (FR)	MNO	3 operators (Orange, SFR, Bouygues Telecom)

Source: BEREC

In the analysis, it is usually referred to the country and not to the operator, only for Croatia and France it is also referred to the type of operator if necessary.

The FNI analysed have already migrated their networks at least to some extent to an NGN or all-IP network and this migration process is still ongoing. The OFNO analysed have migrated their networks already completely to an NGN or all-IP network or have started from the beginning with such networks.

3.2 General characteristics of the IPvIC

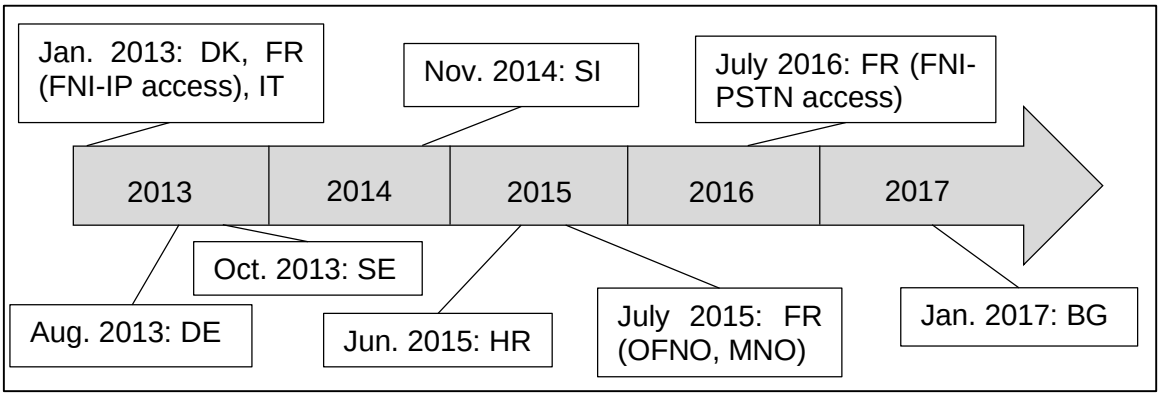
This section discusses general aspects of the obligation to offer IPvIC, the obligation to offer a RIO for IPvIC, whether a national specification for IPvIC exists and how it was developed, and certain aspects with regard to the transition from TDMvIC to IPvIC.

3.2.1 Obligation to offer IPvIC

If there is reasonable demand for IPvIC by some operators and other operators deny access to IPvIC, or the operators cannot reach an agreement on the terms and conditions, there might be a need to impose an obligation to offer IPvIC by the NRA.

As described in section 2, nine of the ten countries analysed have imposed regulatory obligations on operators to offer IPvIC (see also Table 11 to Table 13). These obligations have been imposed on the FNI and OFNO on the market for fixed network termination and on the MNO on the market for mobile network termination. Three countries (DE, HR, IT) have imposed this obligation on the FNI also on the market for fixed network origination.[3] The offers analysed from the MNO in Finland are not based on a regulatory obligation but are voluntary offers.

Figure 3 shows from which date the operators have (or had) to make IPvIC available to other operators. In Spain, no specific date is set, but the FNI has to make IPvIC available on reasonable request at any time. Once available, the operators have to offer IPvIC to all operators, fixed and mobile with the following exception: In Bulgaria, the MNO did not demand an IPvIC from the OFNO so far and hence the OFNO offer IPvIC only to fixed network operators.



Source: BEREC

Figure 3: Date from which operators have to offer IPvIC

[3] In Spain a proposal for such an obligation is currently under public consultation.

3.2.2 Obligation to offer a RIO for IPvIC

A reference interconnection offer (RIO) significantly increases transparency and reduces transaction costs. Therefore, large operators are usually obliged to publish a RIO which might or might not be approved by the NRA. For smaller operators, this obligation might be disproportionate and therefore may not be imposed by NRA.

Six FNI analysed (DK, FR, HR, IT, SE, SI) have already published a RIO for IPvIC (see Table 17 to Table 19). In Italy the RIO is approved by the NRA and in the other five countries the NRA does not formally approve the RIO.[4] Two FNI analysed (DE, ES) have submitted a draft RIO to the NRA and the approval process by the NRA is currently ongoing. The OFNO in Croatia and the MNO of France have also already published a RIO.[5] The OFNO in Bulgaria do not have the obligation to offer a RIO and the MNO in Finland do not have the obligation to offer IPvIC and therefore also do not have the obligation to offer a RIO for IPvIC.

For the analysis of the IPvIC it is important to know for which main categories of voice traffic the IPvIC can be used. The traffic types covered by the RIO are shown in Table 4. Termination in the own network is covered in all RIO due to the fact that the obligation to offer IPvIC is imposed on the markets for fixed or mobile network termination (see section 3.2.1) which regulate the termination in the own network. The RIO of the FNI of Germany, Croatia and Italy also include origination in their own networks since the NRA imposed IPvIC also on the market for fixed network origination (see section 3.2.1). The RIO of the FNI in Sweden also encompasses origination in their own network although this is not demanded by regulation. Transit in the own network is included in the RIO on a voluntary basis since transit is no longer regulated. The access to services in the own network is covered by RIO of five FNI (DE, HR, IT, SE, SI) and the OFNO of Croatia. The RIO of three FNI (DE, HR, SI) and the OFNO of Croatia also includes termination and access to services in the network of the IC partner.

[4] In Croatia, the NRA has the possibility to open a procedure and to investigate whether the RIO is compliant with regulatory obligations after RIO is published.
[5] With the exception of Colt which does not have the obligation to offer a RIO because in France a RIO does not have to be offered by operators with less than 1 million (fixed and mobile) subscribers.

Table 4: Traffic types covered by the RIO for IPvIC

	FNI								OFNO			MNO	
	DE	DK	ES	FR	HR	IT	SE	SI	BG	FR	HR	FI	FR
Traffic types in the network of the operator									No obligation to offer RIO			No obligation to offer RIO	
Termination	X	X	X	X	X	X	X	X		X	X		X
Origination	X				X	X	X						
Transit	X					X	X	X					
Access to services	X				X	X	X	X			X		
Other								X[6]					
Traffic types in the network of the IC partner													
Termination	X[7]				X			X			X		
Access to services	X[7]				X			X			X		
Other								X[6]					

Source: BEREC

3.2.3 National specification of IPvIC

The use of IPvIC is only possible if the operators agree on how to interconnect their networks based on IPvIC. Therefore a solution is necessary which in the ideal case fits for all operators which is especially important in case of the IPvIC offered by FNI which typically is used by most of the operators. Such specifications were elaborated in the following ways:

In three countries (BG, FI, HR), the NRA and in one country (IT) a ministry, defined technical characteristics either in a decision (BG[8], HR, IT) or recommendation (FI) or in a technical specification (IT[9]) which have to be fulfilled by the IPvIC of the operators analysed (see Table 20 to Table 28). In another country (ES), technical characteristics of the IPvIC were defined by an industry forum consisting of network operators hosted by the NRA. In further two countries (DE, FR), an industry body of network operators[10] defined technical characteristics of the IPvIC at a national level. Specifications of these industry bodies are referred to in the RIO (DE, FR (FNI, Orange mobile)), or operators comply with them although not included in the RIO (FR (OFNO, SFR mobile, Bouygues Telecom mobile)).

In all cases the relevant operators and stakeholders were involved in the process by which the national specifications were established. Consensus was achieved through discussions in the

[6] International services e.g. voice traffic from an OFNO over the FNI (Telekom Slovenije) to a foreign operator.
[7] optional
[8] A draft decision is already notified to the European Commission (BG/2015/1752), however, the final decision is not yet taken.
[9] The decision no. 128/11/CIR of the NRA (Agcom) provides the rules for the implementation of IPvIC and the technical specification ST 769 v.1 of the Ministry for Economic Development which builds upon the decision no. 128/11/CIR and defines the technical characteristics of the IPvIC which has to be fulfilled in detail.
[10] In Germany, the Working Group for Technical and Operational Numbering and Network Interconnection Issues (AKNN) and in France, the French Federation of Telecommunications (FFT)

specification process (BG, DE, ES, FR, HR), or because the national specification is based on implementations already used (FI) or by intervention of the NRA (IT). In Bulgaria, it was not possible to achieve consensus with regard to all aspects of IPvIC and the NRA had to decide on the other aspects of the national specification.

The technical topics covered by the national specifications are shown in Table 5.

Table 5: Technical topics covered by the national specification(s)

	FNI								OFNO			MNO	
	DE	DK	ES	FR	HR	IT	SE	SI	BG	FR	HR	FI	FR
Interconnection architecture	X	No national specification	X	X	X	X	No national specification	No national specification		X			X
Signalling protocol (at PoI)	X		X	X	X	X			X	X	X	X	X
Number ranges supported			X		X	X					X	X	X
Supplementary services supported	X		X	X	X	X			X	X	X	X	X
Codecs supported	X		X	X	X	X			X	X	X	X	X
Quality of service	X		X			X			X				
Physical interface				X	X	X			X	X	X		X
Redundancy				X	X	X			X	X	X	X	X
Security			X	X	X	X			X	X	X		X
Other major technical aspects	X[11]		X[12]		X[13]	X[11]					X[13]		

Source: BEREC

3.2.4 Migration to IPvIC

This section analyses the migration to IPvIC with regard to

- the transitional period for the migration to IPvIC,
- the periods of notice regarding the phasing out of TDMvIC,
- the delay of the migration to IPvIC compared with the migration plan and
- the current state of the migration to IPvIC.

Transitional period for the migration to IPvIC

Operators may have a different view on when the TDMvIC should be migrated to IPvIC. Operators which already have migrated their networks to an NGN or all-IP network may want to migrate the voice interconnection as soon as possible to IPvIC. Other operators which have not or only recently started to migrate their networks to an NGN or all-IP network may want to migrate to IPvIC at a later point in time which means that they will need the TDMvIC currently in place still for a certain time period. But operators may not want to offer both “old” TDMvIC

[11] Emergency calls
[12] Number portability information
[13] Emergency calls and number portability information

and “new” IPvIC in parallel over a long time in order to keep their costs low. Therefore, there may be a demand to regulate the migration to IPvIC in order to ensure a smooth transition.

All operators analysed currently have the obligation to offer both IPvIC and TDMvIC with the exception of the MNO in Finland which offer IPvIC on a voluntary basis (i.e., without any obligation to do so, see section 3.2.1 and Table 14 to Table 16). The FNI in five countries (DE, DK, ES, IT, SE) and the OFNO in Bulgaria have to offer IPvIC and TDMvIC over a time period which is currently not (yet) defined by the NRAs. Therefore the interconnection (IC) partners of these operators have the possibility to migrate to IPvIC when it best fits for them. On the other hand, this may cause costs for the operators who are offering both possibilities and will no longer be necessary after all or at least most of the operators migrated to IPvIC. Therefore, NRAs may define in the next round of market analysis the end of the transitional period.

In Croatia, the FNI and the OFNO have to offer TDMvIC at least until end 2017. In France, for FNI, OFNO and MNO the length of the transitional period is defined by the NRA with at least 18 months and in Slovenia, the FNI has the obligation to offer both TDMvIC and IPvIC at least for one year. Such solutions foster the migration to IPvIC but on the other hand leave operators less choice regarding when they migrate to IPvIC.

Periods of notice regarding the phasing out of TDMvIC

Operators need to know an appropriate time period in advance when the TDMvIC will no longer be available. Therefore, especially in countries where operators already announced to phase out TDMvIC there may be a demand to regulate periods of notice regarding the phasing out of TDMvIC in order to ensure that other operators will have sufficient time to prepare for the migration to IPvIC.

In France, three MNO and at least one OFNO already announced to phase out TDMvIC and the NRA (ARCEP) defined the minimum periods of notice for major steps of phasing out TDMvIC (see Figure 4). The minimum periods of notice are

- 12 months before commercial closure of TDMvIC (no new interconnections or capacity extension),
- 12 months before any increase in TDMvIC tariffs and
- 24 months before technical shutdown of TDMvIC

Source: ARCEP

Figure 4: Minimum period of notice for FNI, OFNO and MNO in France

In Denmark and Germany, it is envisaged that the FNI will phase out TDMvIC end of 2016 (DE) or over the years up to 2020 (DK). In other six countries (BG, ES, HR, IT, SE, SI), the operators analysed have not made any formal announcements to phase out TDMvIC. In these countries, there was no need for the NRA to regulate periods of notice regarding the phasing out of TDMvIC so far with the following two exceptions: The period of notice for no longer offering TDMvIC is already defined in Croatia with one year and in Slovenia with six months.

In Finland, the MNO analysed offer IPvIC on a voluntary basis (see section 3.2.1) and have already migrated the voice interconnections between them (not to fixed network operators) completely to IPvIC.

Delay of the actual migration to IPvIC compared with the migration plan

The delay of the actual migration to IPvIC compared with the migration plan may have a negative impact on operators. In Italy, the NRA uses an economic disincentive for the FNI in order to avoid such drawbacks for the IC partners of the FNI. According to rules defined by the NRA an IC partner has to pay the use of the TDM ports of the TDMvIC and the use of the IP ports of the IPvIC according to the migration plan agreed between him and the FNI and not according to the actual migration process, if the migration process is delayed for reasons objectively attributable to the FNI.

In the other countries analysed, no regulation with regard to the delay of the migration to IPvIC was necessary so far.

Current state of the migration to IPvIC

In nine countries (BG, DE, DK, FI, FR, HR, IT, SI, SE) the operators analysed (in HR the OFNO but not the FNI) already have implemented the IPvIC and the IPvIC is also already used by the IC partners. In Spain, the FNI only recently submitted the RIO to the NRA and in Croatia, the decision from the NRA (see section 3.2.3) only recently was made and therefore the FNI in both countries do not have implemented IPvIC yet.

In Finland, the IPvIC of the MNO analysed is already used for 80% of the voice IC traffic and the TDMvIC only for the remaining 20%.[14] As already mentioned the MNO have already migrated the voice interconnection between them completely to IPvIC and only IC traffic to fixed network operators is still based on TDMvIC. In Denmark, France and Italy, the IPvIC of the FNI is used for 30% (FR), 16% (IT), and less than 10% (DK) and the remaining IC traffic is still based on TDMvIC (data from end 2014 / begin of 2015). No information with regard to the use of IPvIC is available for the other operators analysed.

3.3 Technical characteristics of the IPvIC

This section covers several important technical characteristics of IPvIC and compares them across the cases analysed.

In two countries (DE, ES), the IPvIC of the FNI is based on information of the draft RIO of the FNI submitted to the NRA and the approval process is not yet finished. Therefore, the IPvIC of these FNI reflects the view of the FNI but not necessarily of the NRA.

3.3.1 Number of PoIs of the IPvIC

The number of points of interconnection (PoI) is an important characteristic of interconnections between networks. Interconnections for voice services based on traditional technology (TDMvIC) typically use different PoIs for subscribers in different areas. Since voice traffic only accounts for a small share of total traffic in all-IP networks, the migration to such networks usually also leads to a reduction of the number of PoIs.

In four countries (DK-TDM end user[15], ES[16], IT, SE), the IPvIC of the FNI is based on different PoIs for subscribers in different areas and the IC partner have either to connect to (at least) one PoI in each area or they have to pay unregulated transit rates in addition to the regulated termination rate (see Table 6, and Table 29 to Table 31).

[14] This is a rough estimate.
[15] The IPvIC for customers of the FNI which are still connected to the PSTN network of the FNI.
[16] According to the draft RIO

Table 6: Number of PoIs for IPvIC

	FNI								OFNO			MNO	
	DE	DK	ES	FR	HR	IT	SE	SI	BG	FR	HR	FI	FR
Minimum number for redundancy and local rates	2	2/6[17]	19	2	2	32[18]	4[18]	2	ND[19]	2	ND[19]	2	2
Total number	22[20]	6	19	10	4	32	4	2	1[21]	NIA	ND[19]	3	4/3[22]

Source: BEREC

In five countries (DE, DK-VoIP end user[23], FR, HR, SI), the FNI has reduced the minimum number of PoIs for the IPvIC to 1 or 2 in case of redundancy. The IC partner have the possibility to handover the traffic for the whole national territory on only one (or two in case of redundancy) PoI and have to pay only the regulated termination rate. In two countries (DE, DK), this has been imposed by the NRA. Reasons for that are to provide ANOs with more flexibility (DK) and that the FNI was not able to provide sufficient reasons for the use of more PoIs (DE). The IPvIC is offered by the FNI with more than 2 PoIs (4/6/10/22) in four countries (HR/DK/FR/DE) and the ANOs can choose one or two PoIs out of these PoIs.

In Bulgaria, the IPvIC of the OFNO is generally based on one PoI on a voluntary basis. In Croatia, the minimum and total number of PoIs of the IPvIC of the OFNO is not yet defined by the NRA. In France, the minimum number of PoIs of the IPvIC of the OFNO and the MNO is two. In Finland, the minimum number of PoIs of the IPvIC offered by the MNOs is two according to a recommendation of the NRA (FI[24]) and the total number of PoIs is three.

3.3.2 Signalling protocols at the PoI of the IPvIC

Signalling protocols are used e.g. for the set-up and ending of calls. With the move to NGN and IPvIC the traditional signalling protocol for voice (ISUP)[25] which is based on TDM has to be replaced by a signalling protocol based on IP.[26] Several different IP-based signalling protocols have been standardized and are available. In order to connect their networks operators have to agree on the signalling protocols used at the PoI.

[17] 2 PoIs for voice traffic to VoIP end users of the FNI and 6 PoIs for voice traffic to TDM end users of the FNI.
[18] In Italy and Sweden, the whole territory is divided in 16 (IT) or 2 (SE) (gateway) areas each with two PoIs. In order to avoid unregulated transit rates, it is sufficient to connect to one PoI of each area. However, if redundancy is required, it is necessary to connect to both PoIs of an area
[19] For OFNO the NRA has not yet defined the minimum or total number of PoIs.
[20] 22 PoIs on 12 locations
[21] Currently OFNO use generally 1 PoI
[22] Orange 4 PoIs, Bouygues Telecom 3 PoIs.
[23] The IPvIC for customers of the FNI which are already connected to the network of the FNI based on IP (VoIP).
[24] Ficoras`s regulation on redundancy (not Ficora`s recommendation regarding IPvIC described in section 3.2.3)
[25] ISDN User Part, which is part of the Signalling System No. 7 (SS7).
[26] Technically possible is also to keep the traditional signalling protocol for voice (ISUP) and transport it over IP (e.g. with SIGTRAN). However, the cases analysed in this report do not use such a solution.

Three FNI analysed (IT, SE, SI) offer IPvIC with two different signalling protocols at the PoI and the IC partners can choose between them (see Table 32 to Table 34). All other operators analysed provide IPvIC only with one signalling protocol at the PoI.

The following signalling protocols are used at the PoI in the cases considered:[27]

(i) SIP (IETF): The Session Initiation Protocol (SIP) defined by IETF standards (so-called RFCs) leaves room for network operators on how to use SIP. This provides, on the one hand, flexibility for the network operator but, on the other hand, further specifications may be needed in order to guarantee operability between different networks.

(ii) SIP (IETF+3GPP): SIP which also fulfils specifications of 3GPP[28] is based on the use of the so-called IP Multimedia Subsystem (IMS) defined by 3GPP. Such a solution is especially appropriate if an operator uses an IMS in its own network and defines the use of SIP in more detail.

(iii) SIP-I (ITU-T): SIP-I is a hybrid signalling protocol: It is SIP defined by IETF but used in a rather specific way defined by ITU-T where the traditional (TDM-based) signalling protocol (ISUP) is transported within the “new” signalling protocol SIP. Therefore, it can also be seen as an intermediate step between traditional signalling protocol (ISUP) and the “new” IP-based signalling protocol SIP. The standards of mobile networks already separated the call control from packet based transport for many years and suggest the use of SIP-I (or different signalling protocol[29]) within mobile networks. Therefore, it seems natural if MNOs use IPvIC based on SIP-I.[30]

All FNI and OFNO analysed offer IPvIC either with the Session Initiation Protocol (SIP) as defined by IETF (BG, DK, SE, SI) or with SIP defined by IETF including specifications of 3GPP (related to IMS) (DE, ES, FR (FNI, OFNO), HR (FNI, OFNO), IT). Three FNI (IT, SE, SI) offer in addition also SIP-I.[31] All MNO analysed (FI, FR (MNO)) offer IPvIC based on SIP-I.

[27] Other possible signaling protocols are e.g. SIP-T defined by IETF and BICC defined by ITU-T (primarily used in mobile networks, not fixed networks).
[28] 3GPP (3rd Generation Partnership Project) unites seven telecommunications standard development organizations, see http://www.3gpp.org/about-3gpp.
[29] Bearer Independant Call Control (BICC)
[30] With the introduction of voice over LTE (VoLTE) in mobile networks SIP may gain importance since VoLTE is based on SIP and IMS specified by 3GPP.
[31] In Croatia, the FNI and the OFNO are allowed to use SIP-I instead of SIP in case of IPvIC with mobile networks.

Table 7: Signalling protocols at the PoI of the IPvIC

	FNI								OFNO			MNO	
	DE	DK	ES	FR	HR	IT	SE	SI	BG	FR	HR	FI	FR
SIP (IETF)		X					X	X	X				
SIP (IETF+3GPP)	X		X	X	X	X				X	X		
SIP-I (ITU-T)						X	X	X				X	X[32]

Source: BEREC

The above mentioned IP-based signalling protocols used at the PoI by the operators analysed are not imposed by regulation except the signalling protocols used by the FNI of Croatia and Italy and the OFNO of Bulgaria[33] and Croatia.

The analysis shows that the signalling protocols used at the PoI are based on several international standards. SIP (IETF) is based on the main standard (RFC 3261) and usually also on other standards (RFCs) depending on which further aspects of SIP are used. SIP (IETF+3GPP) is also based on standards of 3GPP and the operators analysed are using four 3GPP specifications.[34] SIP-I (ITU-T) is defined in the ITU-T Rec. Q.1912.5 Profile C.

3.3.3 Number ranges supported by the IPvIC

For operators it is desirable that the "new" IPvIC supports the same number ranges as the TDMvIC. In such a case the voice IC traffic can be migrated completely from TDMvIC to IPvIC without any need of an additional solution for number ranges which are not supported by IPvIC.

In five countries (DE, HR, IT, SI, SE) the IPvIC of the FNI supports all number ranges including (see Table 35 to Table 37):

- geographical numbers,
- service numbers (e.g. free phone numbers, premium rate numbers),
- emergency numbers,
- harmonized European short codes (116xxx),
- public national short codes,
- location independent corporate numbers,
- mobile numbers, and
- international numbers.

[32] The target protocol is SIP but not yet implemented.
[33] In Bulgaria, the regulation demands at the PoI the use of SIP (IETF) or SIP-I (ITU-T). However, OFNO have (at least currently) implemented SIP (IETF).
[34] 3GPP TS 29.165 (ES, IT), 3GPP TS 24.229 (DE, FR (FNI, OFNO)), 3GPP TS 24.528 (ES) and 3GPP TS 24.628 (FR (FNI, OFNO)). In Germany, the IPvIC of the FNI is based on ETSI TS 124.503 which is an ETSI TISPAN endorsement of 3GPP TS 24.229.

In Denmark, the IPvIC of the FNI supports the same number ranges as the TDMvIC. In France, the IPvIC of the FNI is available for all interpersonal numbers (e.g. geographical numbers, mobile numbers, international numbers) but not yet for service numbers and short codes which currently still needs to be handed over based on TDMvIC.[35] In Spain, according to the draft RIO of the FNI the IPvIC will enable other operators to handover traffic to geographical and nomadic numbers but not to other numbers. The reason is that the obligation imposed on the FNI is only related to call termination.[36]

The IPvIC of the OFNO is available in Croatia for all number ranges, in Bulgaria for all number ranges assigned to the OFNO and in France for the same number ranges as the IPvIC of the FNI (see above). In Finland and in France, the IPvIC of all MNO analysed support all number ranges.[37]

3.3.4 Supplementary services supported by the IPvIC

Supplementary services such as Call Forwarding (CF) or Calling Line Identification Presentation (CLIP) modify or supplement a basic telephone service. For operators it is important which supplementary services are supported by the IPvIC. If the same supplementary services are supported as in case of TDMvIC then the migration to IPvIC will not lead to any change of the telephone service offered with regard to supplementary services.

In the following two aspects are considered. Firstly, which supplementary services are supported by the IPvIC and secondly, whether the IPvIC enables the operators to handover the same supplementary services as the (previous) TDMvIC.

The supplementary services supported by the IPvIC of the operators analysed are shown in Table 8 (see also Table 35 to Table 37).

With regard to the question whether the IPvIC enables the operators to handover the same supplementary services as the (previous) TDMvIC the results of the analyses are as follows: The IPvIC of four FNI (DE, DK, HR, SI), the OFNO of Croatia and the MNO of Finland provide (basically) the same supplementary services as the TDMvIC (DK, FI, HR, SI) or the supplementary services available based on TDMvIC are at least optionally supported by IPvIC (DE). The IPvIC of the FNI of three countries (ES, FR, IT) and the OFNO of France currently no longer support the following supplementary services which are available with TDMvIC:

- Subaddressing (SUB) (FNI: ES, IT)

[35] The French Federation of Telecommunications is currently working on a solution.
[36] However, it is likely that service numbers and short codes will be included in the RIO after the final decision on the market for fixed network origination.
[37] In France, based on SIP-I but not yet based on SIP.

- Dual Tone Multi Frequency (DTMF) (FNI: FR, OFNO: FR)
- Call Completion Busy Subscriber (CCBS) (FNI: IT)
- User-to-User signalling (UUS) (FNI: ES)

Table 8: Supplementary services supported by the IPvIC*

	FNI								OFNO			MNO	
	DE	DK	ES	FR	HR	IT	SE[38]	SI	BG	FR	HR	FI	FR
Calling Line Identification Presentation (CLIP)	X	X	X	X	X	X	X	X	X	X	X	Basically same as TDMvIC	X
Calling Line Identification Restriction (CLIR)	X	X	X	X	X	X	X	X	X	X	X		X
Call Forwarding (CF)		X	X	X	X	X	X		X	X	X		X
Call Hold (CH)			X	X	X	X	X			X	X		X
Connected Line Identification Presentation (COLP)			X		X	X[39]	X[39]				X		
Call Waiting (CW)			X		X	X	X[39]				X		X
Three Party Call (3PTY)			X		X	X	X[39]				X		
Connected Line Identification Restriction (COLR)			X			X[39]	X[39]						
Call Deflection (CD)						X[39]	X[39]						
User-to-User Signalling (UUS)						X[39]	X[39]						
Malicious Call Identification (MCID)						X	X[39]						

* The table only shows supplementary services that are each supported by at least two (groups of) operators. Several further supplementary services exist, each supported by one (group of) operator only.

Source: BEREC

3.3.5 Codecs supported by the IPvIC

The microphone in a telephone converts the speech of a speaker into an analogue signal and then a codec converts the analogue voice signal into a digital signal which is transmitted through telephony networks to the communication partner where a codec reconverts the digital signal into an analogue signal which is transformed into sounds with a loudspeaker. In order to enable a communication between calling and called subscriber the codecs at both ends need to be compatible.[40] The traditional signalling protocol for voice (ISUP) and therefore also

[38] The IPvIC supports the same supplementary services as the previous TDMvIC

[39] Only based on SIP-I (not SIP)

[40] Otherwise a so-called transcoding is necessary which converts the voice signal from one codec to another codec and vice versa which has a negative impact on the voice quality. Different codecs have been developed in order to increase the speech quality (MOS) and/or decrease the bandwidth demand for a phone call.

the TDMvIC support only the audio codec G.711 which is most commonly used in fixed telephony networks and no other codecs for voice calls. An advantage of IP-based signalling protocols and the IPvIC is that the codec used for the phone call can be negotiated between the parties of the call. This means phone calls are possible also with other audio codecs than G.711 without transcoding i.e. “translation” between different codecs which has a negative effect on the speech quality.

The IPvIC of all operators analysed supports the audio codec standard G.711 (A-law, see Table 38 to Table 40). The IPvIC of the FNI of six countries, the OFNO of two countries and the MNO of Finland also provide the possibility to handover voice traffic based on the codec standard G.729 (ES, FI, FR, IT) or G.729a[41] (DK, HR) or G.722[42] (HR) which are also used in fixed networks. The IPvIC of four FNI (ES, HR, IT, SI) and the OFNO of Croatia also supports the signalling of multi-tone signals (DTMF) based on RFC 2833 (IT, SI) or RFC 4733[43] (ES, HR). Codecs which are usually used in mobile networks are supported by the IPvIC of the MNO in Finland (EFR, AMR-NB) and the FNI and OFNO of France (AMR set 7). A summary is presented in Table 9.

Table 9: Audio codecs supported by IPvIC

	FNI								OFNO			MNO	
	DE[44]	DK	ES	FR	HR	IT	SE	SI	BG	FR	HR	FI	FR
G.711 A-law	X	X	X	X	X	X	X	X	X	X	X	X	X
G.729			X	X		X				X		X	
G.729a		X			X						X		
G.722					X						X		
DTMF			X		X	X		X			X		
EFR												X	
AMR-NB												X	
AMR set 7				X						X			

Source: BEREC

The IPvIC of all operators analysed support fax services. All FNI analysed and the OFNO of Croatia offer IPvIC with the possibility to handover fax services based on both the codec standard G.711 A-law and RFC T.38. The IPvIC of the OFNO of Bulgaria and France as well as the MNO of Finland and France support only one standard the RFC T.38.

[41] G.729a is a compatible extension of G.729. In comparison with the original G.729 codec the version G.729a is less complex and provides a slightly lower voice quality.
[42] G.722 is a 7 kHz wideband audio codec operating at 48, 56 and 64 kbit/s and provides improved speech quality due to a wider speech bandwidth compared to narrowband speech coders like G.711.
[43] RFC 4733 is the successor of RFC 2833
[44] Other codecs may be negotiated without guarantee

3.3.6 Quality of service of the IPvIC

The quality of a voice call is important and therefore also the quality of service (QoS) of network components (e.g. IC link) or networks (e.g. NER[45]) or the complete call (end-to-end) may be specified in interconnection agreements.

The IPvIC of the FNI of Croatia and Italy and the OFNO of Croatia have to have a QoS which is comparable with the QoS of the TDMvIC.

The QoS of the IPvIC analysed is defined with regard to several QoS parameters (see Table 10, and Table 41 to Table 43). The IPvIC of the FNI of three countries (DE[46], IT, SI) and the OFNO of Bulgaria have to fulfil a defined speech quality based on the following QoS parameters:

- One-way Delay (end-to-end) (G.114)
- MOS (LQO) (end-to-end): The Mean Opinion Score (MOS) is a measure for how satisfied a customer is with quality of a call with a value between 1 and 5 (1=bad quality, 5=excellent quality). Listener Quality Only (LQO) means that the customer is listening to what the other party says and rates this quality (not the quality of an interactive phone conversation).
- R-factor: The transmission rating factor R (R-factor) is a similar but different measure than the MOS and used in a tool for network planners (values: 0-100%, see G.107, G.109).
- Codecs that should be used
- Other QoS standards to which the IPvIC should comply with.

The end-to-end one way delay has to be less than 150 ms (BG, DE, SI), the MOS (LQO) higher than 4.0 (end-to-end) (DE), the R-factor higher than 70 (BG), the codecs G.711 (IT, SI) or G.729 (IT) should be used and the standards G.101 (DE) as well as G.107 (SI) and G.168 (SI) should be met.

In four countries analysed, the QoS of the IPvIC is also defined based on the following QoS parameters related to the call set-up:

- Call set-up time
- NER: The Network Effectiveness Ratio (NER) is the ratio of calls where the phone of the called party signals back to the calling party that the called party either takes the

[45] Network Effectiveness Ratio
[46] In Germany, the QoS of the IPvIC is defined with regard to several parameters but due to uncertainties of introductory phase of new technology and not yet finalised market consensus on quality parameters no service level guarantees (SLG) are available and no penalty have to be paid if the QoS targets are not achieved.

call or not although the phone is ringing or the phone is busy at this moment to the total number of calls (exact definition see E.425).

- ASR: The Answer Seizure Ratio (ASR) is the ratio of calls where the called party takes the call to the total number of calls (exact definition see E.425). Therefore, the ASR is lower than the NER and it depends, in contrast to the NER, also on the user behaviour.

Table 10: Quality of service of the IPvIC

	FNI								OFNO			MNO	
	DE[46]	DK	ES	FR	HR	IT	SE	SI	BG	FR	HR	FI	FR
QoS comparable with TDMvIC					X	X					X		
Speech quality				Not specified in RIO								Not specified in RIO	
One-way delay (end-to-end)	X							X	X				
MOS (LQO) (end-to-end)	X												
R-factor (G.107)									X				
Use of Codec G.711					X	X		X			X		
Use of Codec G.729					X	X					X		
Other standards[47]	X							X					
Call set-up													
Call set-up time	X												
Network Effectiveness Ratio	X								X	X[48]			X[49]
Answer Seizure Ratio									X	X[48]			X[49]
Transport of the IP traffic													
IP packet loss ratio			X				X		X				
IP packet transfer delay			X				X						
IP packet delay variation			X				X		X				
Expedited Forwarding (voice)		X	X										
Assured Forwarding (signalling)		X[50]	X[51]										
Availability of the interconnection													
Defined availability	X		X										

Source: BEREC

The call set-up time is defined with less than 3 sec. for the IPvIC of the German FNI. The IPvIC of the FNI in Germany, the OFNO in Bulgaria and the French OFNO and MNO Bouygues

[47] G.101, G.107, and G.168
[48] Only mentioned in Bouygues Telecom RIO
[49] Only mentioned in Bouygues Telecom RIO
[50] AFb
[51] AF31

Telecom have to have a Network Effectiveness Ratio (NER) higher or equal to 99.5% (DE) or higher than 99.3% (Bouygues Telecom) or 95% (BG) and an Answer Seizure Ratio (ASR) higher than 65% (Bouygues Telecom) or 50% (BG).

The IPvIC of the FNI in three countries (DK, ES, SE) and the OFNO of one country (BG) have to fulfil QoS parameters with regard to the transport of the IP traffic. The IP traffic have to be transported with a defined IP packet loss ratio (BG, ES, SE), IP packet transfer delay (ES, SE) and IP packet delay variation (BG, ES, SE) and the class of service (CoS) for forwarding the IP traffic has to be Expedited Forwarding (EF) for the voice traffic (DK, ES) and Assured Forwarding (AF)[52] for the signalling traffic (DK, ES).

The availability of the interconnection is defined for the IPvIC offered by the FNI of two countries (DE, ES) and has to be higher or equal 99.77% (ES) or 99.5%[53] (DE). In Germany the IPvIC of the FNI has also to fulfil QoS targets with regard to the probability of a dropped connection.[54]

A summary of the results is depicted in Table 10. It can be seen that different QoS parameters are used by the operators analysed and some have not defined any QoS parameter at all (at least not in the RIO).

3.3.7 Physical interconnection link and redundancy of the IPvIC

In order to connect two networks a physical link is necessary. The technical characteristics of the IC link are relevant for the IC partners. Furthermore, in order to achieve a high availability of the interconnection, redundancy may be important.

All operators analysed connect their networks with the network of the IC partner with a direct physical link with one exception (see Table 44 to Table 46). The MNO in Finland exchange their voice traffic via (domestic) exchange points to which their networks are connected to.

The physical IC link of the IPvIC of all operators[55] analysed can only be used to transport voice (and fax) traffic and not to exchange also other traffic (e.g. Internet traffic) between the interconnected networks except in Slovenia where additional services can be transported in the IC link of the IPvIC of the FNI if this is supported by the equipment.

The physical transport interface at the PoI of the IPvIC of all operators analysed is 1 GE with the following exceptions: In Bulgaria, the IPvIC of the OFNO has to be offered with a

[52] AFb in Denmark and AF31 in Spain
[53] per IC partner and excluding the leased line between the networks
[54] See footnote 46
[55] With regard to the FNI in Sweden at least in the RIO of the FNI it is not specified that other traffic than voice traffic can be carried in the IC link of the IPvIC.

standardised Ethernet interface and therefore other interfaces than 1 GE are possible and the IPvIC of the French MNO SFR is available with a transport interface that complies with standards of French Forum of Telecommunications. A 10 GE interface is available at the PoI of the IPvIC of the FNI in Germany and Sweden, two MNO in France and in the near future also at the PoI of the IPvIC of the MNO in Finland. In Germany the IPvIC of the FNI is also available with an SDH interface (155 Mbps).

The physical IC link of the IPvIC of all operators is redundant, however, in two countries (DK, SE) this is only an option and with the exception of the OFNO of Croatia where it is not yet defined whether the physical IC link has to be redundant.

The IPvIC of the FNI in six countries (DE, ES, FR, HR, SE, SI), the OFNO of two countries (FR, HR) and the French mobile network operator Bouygues Telecom has also a redundancy at the level of the border gateway (e.g. SBC). This redundancy is based on an n+1 model (DE, FR) or on load sharing (ES, HR, SI, Bouygues Telecom).

3.3.8 Network security of the IPvIC

For all operators it is of importance to ensure the security of their networks. Especially with regard to the “open” Internet security threats have significantly increased over the last years.

The operators analysed connect their networks with the networks of their IC partners with direct IC links[56] and not over the public Internet (see section 3.3.7) which provides already a substantial protection regarding threats from the Internet.

The IPvIC of all operators analysed are implemented with security measures in order to protect the networks with the following exception (see Table 47 to Table 49). In Finland, Ficora’s recommendation (see section 3.2.3) does not demand the use of security measures. However, the Finnish MNO may have implemented security measures in their own interests.

The following security measures of the IPvIC are used in several countries analysed:

- Use of a Session Border Controller (FNI: ES, FR, HR, SE, SI, OFNO: all, MNO: FR),
- IP addresses are not advertised to the Internet (FNI: DK, ES, FR, SE, OFNO: FR, MNO: FR),
- (E)BGP authentication (FNI: ES, HR, OFNO, HR)

In some countries also the features of the SBC are defined e.g. topology hiding (FNI: ES, SE, SI, OFNO: BG) or firewall (FNI: SE, OFNO: BG).

[56] The MNO in Finland connect their mobile networks over domestic exchange points for voice offered by a provider which is owned by them.

4 Conclusions

In recent years several operators (fixed and mobile) in European countries started to migrate their networks to Next Generation Networks or all-IP networks. When networks are migrated to NGN or all-IP networks, it is “natural” and efficient that also the interconnection for voice services is based on IP (and no longer on TDM).

This report analyses the status of IPvIC in Europe from a high-level perspective and provides details about general and important technical characteristics of IPvIC in ten countries.

The high level analysis of the status of the IPvIC in Europe, which comprises 32 countries, shows that the type of operator which most often offers IPvIC is the OFNO (17 countries where at least some OFNO are offering IPvIC) followed by the FNI (10 countries) and the MNO (6 countries where at least some MNO are offering IPvIC). NRAs imposed the obligation to offer IPvIC most frequently on FNI (13 countries) followed by OFNO (11) and MNO (5).

The general and important technical charcteristics of IPvIC have been analysed in detail for 13 cases in ten countries, for which sufficient information on the IPvIC offer was available. These cases cover FNI of eight countries as well as OFNO in three countries and MNO in two countries. In these countries the IPvIC have the following general characteristics (see section 3.2):

- Obligation to offer IPvIC: All operators considered offer IPvIC based on an obligation except for the MNO in Finland.
- National specification(s): In order to support a common solution for several or all operators at the national level most countries analysed (7 of 10) have developed one (or more) national specification(s) defining the characteristics of the IPvIC in detail.
- Transitional period: The countries (9) which have imposed that the operators analysed have to offer IPvIC support the migration from TDMvIC to IPvIC with the obligation that both types of voice IC have to be offered. In most of these countries (6 of 9) a transitional period is not (yet) defined, and therefore the operators are free to migrate to IPvIC when it is best for them. The other three countries have already defined the transitional period.
- Period of notice of phasing out TDMvIC: This period has already been defined in three countries. In the other countries this is not the case and in most of them the operators analysed have not made formal announcements to phase out TDMvIC so far.

The important technical characteristics of the IPvIC of the cases analysed are as follows (see section 3.3):

- Number of PoIs of the IPvIC: The minimum number of PoIs of the IPvIC which enable operators to handover voice traffic for national destinations based on the regulated termination rates (without additional charges) has been reduced to one or two (8 of 13 cases). This reflects the trend that the number of PoIs is usually reduced with the migration to NGN and all-IP networks.
- Signalling protocol: The signalling protocol to be used at the PoI is SIP (11 of 13). In most of these cases (7 of 11) the use of SIP is further defined with 3GPP specifications (related to IMS). In the two cases with MNO SIP-I (and not SIP) is used at the PoI which is also used within mobile networks.
- Number ranges, codecs and supplementary services supported by IPvIC: The IPvIC supports the same number ranges as the TDMvIC (10 of 13), the audio codec G.711 (all cases) which is typically used in fixed networks and also further audio codecs (9 of 13) as well as fax services (all cases) which all together facilitate the migration from TDMvIC to IPvIC. However, the same supplementary services as TDMvIC are only supported in about the half of the cases analysed.
- QoS: The IPvIC has a defined QoS with regard to certain QoS parameters (at least 11 of 13), whereby different QoS parameters are used in different cases.
- Redundancy and network security of the IPvIC: The networks are interconnected with the networks of the IC partners with direct physical IC links (12 of 13) or via (domestic) exchange points (1 case) and not over the public Internet which provides a significant protection against threats from the Internet. In order to increase the availability, redundancy is used at the level of the physical IC link (12 of 13) and at the level of the border gateway (8 of 13). The operators also apply further security measures (at least 12 of 13).

It can be concluded that from an overall perspective the IPvIC are rather similar. However in detail the characteristics may differ reflecting national circumstances.

5 Abbreviations for countries

Abbreviation	Country
AT	Austria
BE	Belgium
BG	Bulgaria
CH	Switzerland
CY	Cyprus
CZ	Czech Republic
DE	Germany
DK	Denmark
EE	Estonia
ES	Spain
FI	Finland
FR	France

Abbreviation	Country
FYROM	Former Yugoslavian Republic of Macedonia
GR	Greece
HR	Croatia
IE	Ireland
IT	Italy
LI	Liechtenstein
LT	Lithuania
LU	Luxembourg
ME	Montenegro
NL	Netherlands
NO	Norway

Abbreviation	Country
PL	Poland
PT	Portugal
RO	Romania
RS	Serbia
SE	Sweden
SI	Slovenia
SK	Slovakia
TR	Turkey
UK	United Kingdom

6 Further abbreviations

3GPP 3rd Generation Partnership Project

3PTY Three Party Call

ACL Access Control List

AF Assured Forwarding

AKNN Working Group for technical and operational Numbering and Network Interconnection Issues

ALG Application Level Gateway

AMR Adaptive Multi Rate

ANO Alternative Network Operator

ARCEP Regulatory Authority for Electronic Communications and Postal Services (France)

ASR Answer Seizure Ratio

BEREC	Body of European Regulators for Electronic Communications
BGP	Border Gateway Protocol
BU-LRIC	Bottom-Up Long Run Incremental Costs
CDIV	Call Diversion
CF	Call Forwarding
CH	Call Hold
CLIP	Calling Line Identification Presentation
CLIR	Calling Line Identification Restriction
COLP	Connected Line Identification Presentation
COLR	Connected Line Identification Restriction
CONF	Conference
CoS	Class of Service
CPS	Carrier Pre-Selection
CRC	Communications Regulation Commission (Bulgaria)
CS	Carrier Selection
CUG	Closed User Group
CW	Call Waiting
DOS	Denial of Service
DTAG	Deutsche Telekom AG
DTMF	Dual Tone Multi Frequency
EBGP	External BGP
EF	Expedited Forwarding
EFR	Enhanced Full Rate
ETSI	European Telecommunications Standards Institute
FFT	French Federation of Telecommunications

FICORA	Finnish Communication Regulatory Authority
FNI	Fixed Network Incumbent
FTR	Fixed Termination Rate
GE	Gigabit Ethernet
GSM	Global System for Mobile Communication
GSMA	Global System for Mobile Communications Association
HAKOM	Croatian Regulatory Authority for Network Industries
HT	Hrvatski Telekom (Croatian Telecom)
IC	Interconnection
IMS	IP Multimedia Subsystem
IETF	Internet Engineering Task Force
IP	Internet Protocol
IPvIC	IP-based interconnection for voice services
ISDN	Integrated Services Digital Network
ISUP	ISDN User Part
ITU-T	International Telecommunication Union – Telecommunication Standardisation Sector
LQO	Listening Quality Objective
MNO	Mobile network Operator(s)
MOS	Mean Opinion Score
MWI	Message Wait Indication
NB	Narrow Band
ND	Not defined
NGN	Next Generation Network
NIA	No Information Available

NRA	National Regulatory Authority
OAO	Other Authorised Operators
OFNO	Other Fixed Network Operator(s) (than FNI)
QoS	Quality of Service
PE	Provide Edge
PoI	Point of Interconnection
RFC	Request for Comments
RIO	Reference Interconnection Offer
SBC	Session Border Controller
SDH	Synchronous Digital Hierachy
SLG	Service Level Guarantees
SIP	Session Initiation Protocol
SIP-I	SIP with encapsulated ISUP
SSH	Secure Shell
TDM	Time Division Multiplexing
TDMvIC	TDM-based interconnection for voice services
TLS	Transport Layer Security
VPN	Virtual Private Network

7 Annex

Table 11: Regulatory context – part 1

Characteristic	Denmark	France	Germany	Italy	Slovenia
Operator which offers IPvIC	TDC (incumbent)	Orange (incumbent)	DTAG (incumbent)	Telecom Italia (incumbent)	Telekom Slovenije (incumbent)
Operator offers IPvIC with its (fixed and/or mobile network)	Fixed network	Fixed network	Fixed network	Fixed network	Fixed network
Operator has the obligation to offer IPvIC	Yes	Yes, if asked by another operator	Yes	Yes	Yes
According to the regulatory decision	Market 3 decision initially in Dec. 2012, continued in Dec. 2013	Market 3[57] decision in July 2011 and Market 1 (former market 3) decision in December 2014	Markets 2 and 3 decision in Aug. 2013	Markets 2 and 3 decision in Apr. 2010.[58] Decision no. 128/11/CIR	Market 3 decision in Sep. 2014
Operator has the obligation to make IPvIC available from	Jan. 2013	Jan. 2013 for calls towards IP accesses[59] July 2016 for calls towards PSTN access[59]	Aug. 2013	Jan. 2013	Nov. 2014
Operator has to offer IPvIC for which type of operators	Fixed and mobile	Fixed and mobile	Fixed and mobile	Fixed and mobile	Fixed and mobile

Source: BEREC

[57] Under relevant market list of 2007
[58] Next round market analysis to be started soon.
[59] if asked by another operator

Table 12: Regulatory context – part 2

Characteristic	Spain	Sweden	Croatia	Bulgaria	France
Operator which offers IPvIC	Telefónica (incumbent)	TeliaSonera (incumbent)	HT (incumbent)/Other fixed network operators	Other fixed network operators (OFNO)	Alternatives (SFR, Bouygues Telecom, Free, Colt)
Operator offers IPvIC with its (fixed and/or mobile network)	Fixed network	Fixed network	Fixed network	Fixed network	Fixed network
Operator has the obligation to offer IPvIC	Yes	Yes[60]	Yes	Yes	Yes, if asked by another operator
According to the regulatory decision	Market 3 decision in September 2014	Market 3 decision in Oct. 2013	Market 1 (former market 3) decision in March 2015	Market 3, Decision No 1361 of 31 May 2012	Market 1 (former market 3) decision in December 2014
Operator has the obligation to make IPvIC available from	Obligation to offer RIO for IPvIC and to offer IPvIC on reasonable request.	Oct. 2013.	July 2015	Jan. 2017	1st July 2015, if asked by another operator
Operator has to offer IPvIC for which type of operators	Fixed and mobile	Fixed and mobile	Fixed and mobile	Fixed[61]	Fixed and mobile

Source: BEREC

[60] According to Market 3 decision in Oct. 2013, TeliaSonera is obliged to meet any reasonable request to interconnect on a technology neutral basis, i.e. it includes IPvIC.
[61] IPvIC is not used by MNO because MNO do not demand IPvIC from OFNO.

Table 13: Regulatory context – part 3

Characteristic	Finland	France	France	France
Operator which offers IPvIC	TeliaSonera, Elisa, DNA	Orange	SFR	Bouygues Telecom
Operator offers IPvIC with its (fixed and/or mobile network)	Mobile network	Mobile network	Mobile network	Mobile network
Operator has the obligation to offer IPvIC	No (on voluntary basis)	Yes, if asked by another operator		
According to the regulatory decision	Not appl.	Market 2 (former market 7) decision of December 2014		
Operator has the obligation to make IPvIC available from	Not appl.	1st July 2015, if asked by another operator		
Operator has to offer IPvIC for which type of operators	Not appl. (IPvIC is offered for fixed and mobile operators on a voluntary basis)	Fixed and mobile		

Source: BEREC

Table 14: TDMvIC, network migration and use of IPvIC – part 1

Characteristic	Denmark	France	Germany	Italy	Slovenia
Operator which offers IPvIC	TDC (incumbent)	Orange (incumbent)	DTAG (incumbent)	Telecom Italia (incumbent)	Telekom Slovenije (incumbent)
Operator offers IPvIC with its (fixed and/or mobile network)	Fixed network	Fixed network	Fixed network	Fixed network	Fixed network
Operator is obliged to continue to offer TDM-based interconnection for voice services (TDMvIC) at least for a certain time	Yes. No defined deadline	18 months transitional period[62].	Yes. No defined deadline	Yes. Currently no defined deadline	Yes. For at least one year with a six month notice period.
Share of IC traffic handed over based on IPvIC and TDMvIC	< 10% IPvIC, >90% TDMvIC	For Orange, Q4 2014: 30%IPvIC / 70% TDMvIC	No information available	Q1 2015: 15.8% IPvIC / 84.2% TDMvIC	0% IPvIC/100% TDMvIC
Operator has announced to phase out TDMvIC	TDC: expected to be phased out over the years up to 2020	No	Yes, the date envisaged is 31.12.2016	No	No
Operator has migrated its fixed network already to NGN (all-IP network)	Partly	Partly	Partly	Partly (4.4%)	Partly (67%)
Operator has already implemented IPvIC	Yes	Yes	Yes	Yes	Yes
IPvIC is already used by other operators	Yes	Yes	Yes	Yes	No[63]

[62] According to Market 1 and 2 decision of Dec. 2014: IPvIC and TDMvIC should be offered both under regulated conditions during 18 months before the operator may start changing the terms of the TDMvIC offer. In addition, any price increase, commercial shutdown of TDMvIC should be announced with a 12 months' notice; any technical shutdown should be announced with a 24 months' notice

[63] FNI (Telekom Slovenije) has the obligation to make IPvIC available from November 2014. Currently IPvIC is in the testing phase. Probably first operator will use IPvIC soon.

Source: BEREC

Table 15: TDMvIC, network migration and use of IPvIC – part 2

Characteristic	Spain	Sweden	Croatia	Bulgaria	France
Operator which offers IPvIC	Telefónica (incumbent)	TeliaSonera (incumbent)	HT (incumbent)/Other fixed network operators	Other fixed network operators (OFNO)	Alternatives (SFR, Bouygues Telecom, Free, Colt)
Operator offers IPvIC with its (fixed and/or mobile network)	Fixed network	Fixed network	Fixed network	Fixed network	Fixed network
Operator is obliged to continue to offer TDM-based interconnection for voice services (TDMvIC) at least for a certain time	Yes. No defined deadline.	Yes. No defined deadline	Yes, for at least until 31 December 2017 with a one year notice period.	Yes. No defined deadline	18 months transitional period[62]
Share of IC traffic handed over based on IPvIC and TDMvIC	0% IPvIC/100% TDMvIC (IPvIC is not available yet)	No information available	No information available	No information available	No information available
Operator has announced to phase out TDMvIC	No	No formal announcement made	Yes, but without formal announcement	No	Bouygues Telecom: 01/01/2017 Others: No
Operator has migrated its fixed network already to NGN (all-IP network)	Partly	Partly	• OFNO: completely • Incumbent: partly (more than 70%[64])	Yes[65]	Yes
Operator has already implemented IPvIC	No[66]	Yes	OFNO Yes, Incumbent not yet	Yes	Yes
IPvIC is already used by other operators	No[67]	Yes	Yes between OFNO	Yes	Yes

Source: BEREC

[64] It will be finished by the end of 2015.
[65] OFNOs have fully migrated their networks to all-IP networks and their voice telephony services are entirely based on IP (mainly SIP) signaling and transport.
[66] No FNI (Telefonica España) does not have implemented IPvIC for national voice interconnections but for international interconnections (Telefonica Group)
[67] Not for national but for international voice interconnections (see footnote 66)

Table 16: TDMvIC, network migration and use of IPvIC – part 3

Characteristic	Finland	France	France	France
Operator which offers IPvIC	TeliaSonera, Elisa, DNA	Orange	SFR	Bouygues Telecom
Operator offers IPvIC with its (fixed and/or mobile network)	Mobile network	Mobile network	Mobile network	Mobile network
Operator is obliged to continue to offer TDM-based interconnection for voice services (TDMvIC) at least for a certain time	Not appl.	18 months transitional period[62].		
Share of IC traffic handed over based on IPvIC and TDMvIC	Rough estimate: 80% IPvIC / 20% TDMvIC	No information available		
Operator has announced to phase out TDMvIC	Only IPvIC (no TDMvIC) is used between mobile network operators[68]	TDMvIC tariff increase from January 2016.	TDMvIC tariff increase from October 2015	Yes[69]
Operator has migrated its fixed network already to NGN (all-IP network)	Not appl.	Not appl.		
Operator has already implemented IPvIC	Yes	Yes		
IPvIC is already used by other operators	Yes (between three MNOs)	Yes		

Source: BEREC

[68] About 20% of the voice traffic which terminates in mobile networks is handed over from fixed networks and abroad and is still based on TDMvIC.
[69] (i) Not possible to ask for new TDMvIC from January 2015 (ii) Not possible to ask for additional TDMvIC capacities from January 2016 (iii) TDMvIC tariff will increase by March 2016 (iv) Closing of TDMvIC by January 2017

Table 17: RIO on which the IPvIC is based on – part 1

Characteristic	Denmark	France	Germany	Italy	Slovenia
Operator which offers IPvIC	TDC (incumbent)	Orange (incumbent)	DTAG (incumbent)	Telecom Italia (incumbent)	Telekom Slovenije (incumbent)
Operator offers IPvIC with its (fixed and/or mobile network)	Fixed network	Fixed network	Fixed network	Fixed network	Fixed network
Operator already published a Reference Interconnection Offer (RIO) with IPvIC which is approved by NRA	Yes[70] DBA does not formally approve RIOs[71]	RIO published[72] ARCEP does not formally approve RIOs	No, approval procedure (BK3d-13/033) pending based on Draft RIO of Feb. 2013 with last update of June 2015[73]	Yes	Yes[74]. AKOS does not formally approve RIOs
RIO of the operator includes the following traffic types:					
In the network of the operator:					
• Termination	Yes	Yes	Yes	Yes	Yes
• Origination[75]	No	No[76]	Yes	Yes	No[77]
• Transit	No	No	Yes	Yes	Yes
• Access to services	No	No[78]	Yes	Yes	Yes
• Other	No	No	No	No	International services[79]
In the network of the IC partner:					
• Termination	No	No	Yes (optional)	No	Yes
• Access to services	No	No	Yes (optional)	No	Yes
• Other	No	No	No	No	International services[79]

Source: BEREC

[70] See https://wholesale.tdc.dk/wholesale/produkter/aftaler/Sider/standard.aspx (Termination via SIP)
[71] However. DBA supervises the RIO in order to ensure compliance with the relevant market decision and obligations.
[72] See http://www.orange.com/fr/content/download/22374/467149/version/1/file/ODR+Interco+nouvelle+modalit%C3%A9+IP+-+10+avril+2014.pdf
[73] See http://www.bundesnetzagentur.de/cln_1431/DE/Service-Funktionen/Beschlusskammern/1BK-Geschaeftszeichen-Datenbank/BK3-GZ/2013/2013_0001bis0999/2013_001bis099/BK3-13-033/BK3-13-033_Standardangebotsverfahren.html?nn=350652
[74] See http://www.telekom.si/operaterji/rio-mobilni/RIO%20IP_1_12_2014.pdf
[75] Traffic origination to indirect service providers based on carrier (pre) selection
[76] Call origination traffic from the fixed network is offered by Orange only based on TDMvIC not on IPvIC.
[77] FNI (Telekom Slovenije) does no longer have the obligation to provide carrier selection or carrier pre-selection (available based on TDMvIC on a commercial basis).
[78] Currently available only based on TDMvIC (not on IPvIC).
[79] International traffic e.g. OFNO – FNI (Telekom Slovenije) – foreign operator

Table 18: RIO on which the IPvIC is based on – part 2

Characteristic	Spain	Sweden	Croatia	Bulgaria	France
Operator which offers IPvIC	Telefónica (incumbent)	TeliaSonera (incumbent)	HT (incumbent)/Other fixed network operators	Other fixed network operators (OFNO)	Alternatives (SFR, Bouygues Telecom, Free, Colt)
Operator offers IPvIC with its (fixed and/or mobile network)	Fixed network	Fixed network	Fixed network	Fixed network	Fixed network
Operator already published a Reference Interconnection Offer (RIO) with IPvIC which is approved by NRA	No. Approval procedure pending based on draft RIO of Dec. 2014	Yes[80] PTS does not formally approve RIOs	Yes HAKOM does not formally approve RIOs[81]	OFNO do not have the obligation to publish a RIO	SFR, Bouygues Telecom[82], Free[83]: Yes Colt: No[84] ARCEP does not formally approve RIOs
RIO of the operator includes the following traffic types:					
In the network of the operator:					
• Termination	Yes	Yes	Yes	Not appl.	Yes
• Origination[75]	No[85]	Yes	Only incumbent	Not appl.	No
• Transit	No	Yes	No	Not appl.	No
• Access to services	No[85]	Yes	Yes	Not appl.	No[86]
• Other	No	No	No	Not appl.	No
In the network of the IC partner:					
• Termination	No[87]	No	Yes	Not appl.	No
• Access to services	No[88]	No	Yes	Not appl.	No
• Other	No	No	No	Not appl.	No

Source: BEREC

[80] See https://www.teliaoperator.se/ProdukterTjanster/Regleradeprodukter/Samtrafik/Dokument.html.
[81] Operators have to incorporate the conditions of HAKOM's decision on IP interconnection conditions in their RIO 15 days after it enters into force. Although HAKOM does not formally approve RIOs HAKOM has the possibility to intervene after RIO is published.
[82] See http://www.corporate.bouyguestelecom.fr/wp-content/uploads/2015/02/OFFRE-DE-REFERENCE-Janvier-20153.pdf
[83] See http://www.iliad.fr/documentation/Free_Interco_Contrat_Cadre_V15-01-01.pdf
[84] No obligation to publish RIO if operator has less than 1,000,000 subscribers (sum of fixed and mobile).
[85] Currently the RIO only includes termination traffic but not origination traffic, because the origination market (Market 2/2007) is not yet approved.
[86] Currently available only based on TDMvIC (not on IPvIC).
[87] The RIO only includes termination services of Telefonica. The same PoI and procedures are used for the termination of voice traffic in the network of the IC partner (even if the IC partner is not obliged to offer a RIO).
[88] The RIO only includes services of Telefonica.

Table 19: RIO on which the IPvIC is based on – part 3

Characteristic	Finland	France	France	France
Operator which offers IPvIC	TeliaSonera, Elisa, DNA	Orange	SFR	Bouygues Telecom
Operator offers IPvIC with its (fixed and/or mobile network)	Mobile network	Mobile network	Mobile network	Mobile network
Operator already published a Reference Interconnection Offer (RIO) with IPvIC which is approved by NRA	No	RIO published ARCEP does not formally approve RIOs	RIO published ARCEP does not formally approve RIOs	RIO published ARCEP does not formally approve RIOs
RIO of the operator includes the following traffic types:				
In the network of the operator:				
• Termination	Not appl.	Yes	Yes	Yes
• Origination[75]	Not appl.	No	No	No
• Transit	Not appl.	No	No	No
• Access to services	Not appl.	No	No	No
• Other	Not appl.	No	No	No
In the network of the IC partner:				
• Termination	Not appl.	No	No	No
• Access to services	Not appl.	No	No	No
• Other	Not appl.	No	No	No

Source: BEREC

Table 20: National specifications to which the RIO refers to – part 1

Characteristic	Denmark	France	Germany	Italy	Slovenia
Operator which offers IPvIC	TDC (incumbent)	Orange (incumbent)	DTAG (incumbent)	Telecom Italia (incumbent)	Telekom Slovenije (incumbent)
Operator offers IPvIC with its (fixed and/or mobile network)	Fixed network	Fixed network	Fixed network	Fixed network	Fixed network
RIO refers to further national specifications (Yes/No)	No	Yes	Yes	Yes	No
List of national specifications to which the RIO refers to	Not appl.	Specifications by FFT[89]: • FFT Doc 10.001 (5/2014)[90] • FFT Doc 09.002 (July 2009)[91]	Specifications by AKNN[92]: • Concept for Interconnection of NGN[93] • NGN Ic Interface[94] • Examination QoS in NGN[95]	• Agcom decision n. 128/11/CIR[96] (general framework of IP-IC technical specifications). • Specification by the Ministry for Economic Development: Technical specification ST 769[97]	Not appl.

Source: BEREC

[89] French Federation of Telecommunications
[90] http://www.fftelecoms.org/sites/fftelecoms.org/files/contenus_lies/sip_profile_v1.2.1.pdf
[91] http://www.fftelecoms.org/sites/default/files/contenus_lies/architecture_principes_et_recommandations_-_version_anglaise.pdf
[92] Working group for technical and operational numbering and network interconnection issues (see http://www.aknn.de/index.php/1731/0/)
[93] http://www.aknn.de/fileadmin/uploads/oeffentlich/Konzept_Next_Generation_Network_V_2_0_0.pdf
[94] http://www.aknn.de/fileadmin/uploads/oeffentlich/Spec_UAKS_NGN_Ic_Interface_V1_0_0.pdf
[95] Not formally adopted by AKNN but referred to in the RIO
[96] http://www.agcom.it/documentazione/documento?p_p_auth=fLw7zRht&p_p_id=101_INSTANCE_kidx9GUnIodu&p_p_lifecycle=0&p_p_col_id=column-1&p_p_col_count=1&_101_INSTANCE_kidx9GUnIodu_struts_action=%2Fasset_publisher%2Fview_content&_101_INSTANCE_kidx9GUnIodu_assetEntryId=643110&_101_INSTANCE_kidx9GUnIodu_type=document
[97] Main document: http://www.isticom.it/documenti/normazione/pdf/ST%20769%20versione%201.pdf
Part A: http://www.isticom.it/documenti/normazione/pdf/ST%20769%20Parte%20A%20versione%201.pdf
Part B: http://www.isticom.it/documenti/normazione/pdf/ST%20769%20Parte%20B%20versione%201.pdf

Table 21: National specifications to which the RIO refers to – part 2

Characteristic	Spain	Sweden	Croatia	Bulgaria	France
Operator which offers IPvIC	Telefónica (incumbent)	TeliaSonera (incumbent)	HT (incumbent)/Other fixed network operators/	Other fixed network operators (OFNO)	Alternatives (SFR, Bouygues Telecom, Free, Colt)
Operator offers IPvIC with its (fixed and/or mobile network)	Fixed network	Fixed network	Fixed network	Fixed network	Fixed network
RIO refers to further national specifications (Yes/No)	Yes	No[98]	Yes	Not appl.	No
List of national specifications to which the RIO refers to	Specification by Telefónica (SIP interface definition) which in 2013 was agreed between operators at "Forum for IPvIC" hosted by CNMC[99]	Not appl. RIO refers to the following interconnect specifications by TeliaSonera: • No 8211-A 357[100] • No 8211-A 353[101] • No 8211-A 354[102] • No 8211-A 355[103] • No 8211-A 356[104]	RIO refers to the HAKOM's decision on IP interconnection conditions**Error! Bookmark not defined.**	Not appl. CRC currently develops a decision which lists specifications which have to be met by OFNO (a draft decision is already available[105])	Not appl.

Source: BEREC

[98] RIO does not refer to national specifications. Specifications below are those of TeliaSonera.
[99] At this forum operators also agreed on a specification by ASTEL (group of alternative operators) which specifies SIP-I and to which the RIO of Telefónica does not refer to.
[100] https://www.teliaoperator.se/dms/teliaoperator/Dokument/ReglProdukt/Samtrafik/8211_A357_SIP_rev_3_0.pdf
[101] https://www.teliaoperator.se/dms/teliaoperator/Dokument/ReglProdukt/Samtrafik/8211_A353_SIP_I__rev_4_0.pdf
[102] https://www.teliaoperator.se/dms/teliaoperator/Dokument/ReglProdukt/Samtrafik/8211_A354_Media_rev_3_0.pdf
[103] https://www.teliaoperator.se/dms/teliaoperator/Dokument/ReglProdukt/Samtrafik/8211_A355__IP_network_rev_3_0.pdf
[104] https://www.teliaoperator.se/dms/teliaoperator/Dokument/ReglProdukt/Samtrafik/8211_A356_Address_formats_for_Swedish_national_SIP_and_SIP_I_ver_1__0.pdf
[105] http://www.crc.bg/files/_bg/resh_798-18_12_2014-IP_interconnect-prilojenie.pdf

Table 22: National specifications to which the RIO refers to – part 3

Characteristic	Finland	France	France	France
Operator which offers IPvIC	TeliaSonera, Elisa, DNA	Orange	SFR	Bouygues Telecom
Operator offers IPvIC with its (fixed and/or mobile network)	Mobile network	Mobile network	Mobile network	Mobile network
RIO refers to further national specifications (Yes/No)	Not appl.	Yes	No	No
List of national specifications to which the RIO refers to	Not appl. However, interconnection profiles are agreed by the operators and described in Ficora's recommendations[106, 107] These profiles should be complied with by operators that use IPvIC.	Refers to the SIP-I specifications by FFT. The latest is FFT Doc 11.001 v1.2 (5/2014)[108]	Not appl.	Not appl.

Source: BEREC

[106] https://www.viestintavirasto.fi/attachments/suositukset/Suositus_201-2014_S_-_Finnish_profile_for_SIP-I_interworking.pdf
[107] https://www.viestintavirasto.fi/attachments/suositukset/Suositus_202-2014_S_-_Finnish_profile_for_SIP_interworking.pdf
[108] http://www.fftelecoms.org/sites/fftelecoms.org/files/contenus_lies/fft_interco_ip_-_sip-i_profile_v1_2_.pdf

Table 23: Technical aspects defined in the national specification(s) – part 1

Characteristic	Denmark	France	Germany	Italy	Slovenia
Operator which offers IPvIC	TDC (incumbent)	Orange (incumbent)	DTAG (incumbent)	Telecom Italia (incumbent)	Telekom Slovenije (incumbent)
Operator offers IPvIC with its (fixed and/or mobile network)	Fixed network	Fixed network	Fixed network	Fixed network	Fixed network
The following major technical aspects are further specified in the national specification(s):					
• IC architecture	Not appl.	Yes	Yes	Yes	Not appl.
• Signalling protocol (at PoI)	Not appl.	Yes	Yes	Yes	Not appl.
• Number ranges supported	Not appl.	No	No	Yes	Not appl.
• Supplementary services supported	Not appl.	Yes	Yes	Yes	Not appl.
• Codecs supported	Not appl.	Yes	Yes	Yes	Not appl.
• QoS	Not appl.	Yes, but no QoS objectives	Yes	Yes	Not appl.
• Physical interface	Not appl.	Yes	No	Yes	Not appl.
• Redundancy	Not appl.	Yes	No	Yes	Not appl.
• Security	Not appl.	Yes (high level principles)	No	Yes	Not appl.
• Other major technical aspects (which?)	Not appl.	No	Yes, emergency calls	Yes, emergency calls	Not appl.

Source: BEREC

Table 24: Technical aspects defined in the national specification(s) – part 2

Characteristic	Spain	Sweden	Croatia	Bulgaria	France
Operator which offers IPvIC	Telefónica (incumbent)	TeliaSonera (incumbent)	HT (incumbent)/Other fixed network operators)	Other fixed network operators (OFNO)	Alternatives (SFR, Bouygues Telecom, Free, Colt)
Operator offers IPvIC with its (fixed and/or mobile network)	Fixed network	Fixed network	Fixed network	Fixed network	Fixed network
The following major technical aspects are further specified in the national specification(s):				Below information is provided for the draft decision of CRC (see Table 21)	Alternatives comply to national specifications on a voluntary basis[109]
• IC architecture	Yes	Not appl.	FNI: Yes, OFNO: No (specified in RIO)	No	Yes
• Signalling protocol (at PoI)	Yes[110]	Not appl.	Yes	Yes	Yes
• Number ranges supported	Yes	Not appl.	Yes	No	No
• Supplementary services supported	Yes	Not appl.	Yes	Yes	Yes
• Codecs supported	Yes	Not appl.	Yes	Yes	Yes
• QoS	Yes, but no QoS objectives	Not appl.	Yes, but no QoS objectives	Yes	Yes, but no QoS objectives
• Physical interface	No	Not appl.	Yes	Yes	Yes
• Redundancy	No	Not appl.	Yes	Yes	Yes
• Security	Yes (high level principles)	Not appl.	Yes	Yes	Yes (high level principles)
• Other major technical aspects (which?)	Yes, number portability information	Not appl.	Yes, emergency call, number portability	No	No

Source: BEREC

[109] Alternatives (SFR, Bouygues Telecom, Colt) participated in the FFT task force which developed FFT national specifications (see Table 27).
[110] Both SIP and SIP-I are defined in national specifications (see Table 21). However, the RIO of Telefónica's only proposes SIP.

Table 25: Technical aspects defined in the national specification(s) – part 3

Characteristic	Finland	France	France	France
Operator which offers IPvIC	TeliaSonera, Elisa, DNA	Orange	SFR	Bouygues Telecom
Operator offers IPvIC with its (fixed and/or mobile network)	Mobile network	Mobile network	Mobile network	Mobile network
The following major technical aspects are further specified in the national specification(s):			SFR and Bouygues Telecom comply to national specifications on a voluntary basis[111]	
• IC architecture	No	Yes	Yes	
• Signalling protocol (at PoI)	Yes	Yes	Yes	
• Number ranges supported	Yes	Yes	Yes	
• Supplementary services supported	Yes	Yes	Yes	
• Codecs supported	Yes	Yes	Yes	
• QoS	No	Yes, but no QoS objectives	Yes, but no QoS objectives	
• Physical interface	No	Yes	Yes	
• Redundancy	Yes	Yes	Yes	
• Security	No	Yes	Yes	
• Other major technical aspects (which?)	No	No	No	

Source: BEREC

[111] They participated in the FFT task force which developed FFT national specifications (see Table 28).

Table 26: Process by which the national specification(s) was (were) defined – part 1

Characteristic	Denmark	France	Germany	Italy	Slovenia
Operator which offers IPvIC	TDC (incumbent)	Orange (incumbent)	DTAG (incumbent)	Telecom Italia (incumbent)	Telekom Slovenije (incumbent)
Operator offers IPvIC with its (fixed and/or mobile network)	Fixed network	Fixed network	Fixed network	Fixed network	Fixed network
Short description of the process how the further national specification(s) was(were) defined	Not appl.	National dialogue between major operators, in compliance with international standards.	AKNN, an industry body of network operators has produced specifications, which were used in drafting the reference offer.	See footnote 112	Not appl.
Operators and other stakeholders which were involved	Not appl.	Task force composed of: FFT board, Orange, SFR, Bouygues Telecom, Colt	AKNN membership, i.e. German operators and manufacturers.[113]	Telecom Italia, OAO, AGCOM	Not appl.
Was it possible to achieve consensus between all stake-holders involved? (Yes/No)	Not appl.	Yes[114]	Yes	Yes	Not appl.
If consensus was achieved, how was it possible, by which process?	Not appl.	Standardization task force within FFT, which gathers all involved operators worked on a common standard.	Within the AKNN specifications have to be approved unanimously by network operators. Consensus between all stakeholders is achieved by discussions within the working groups of AKNN.	See footnote 115	Not appl.
If consensus was not achieved, reasons why NRA accepted the reference to the national specification(s) in the RIO	Not appl.	Not appl.	Not appl. (approval process is still ongoing)	Not appl.	Not appl.

Source: BEREC

[112] Following the publication of AGCOM resolution n. 128/11/CIR (December 2011) the Interconnection Commission of the Ministry for Economic Development (MiSE) has started the drafting, discussion and convergence processes among operators of the technical specification of IP interconnection. A process of revision of the technical specification of IP interconnection will be carried out after the migration to IP of main OAO.

[113] A membership list is available at http://www.aknn.de/index.php/615/0/

[114] However, Free chose to not take part in the discussions of the FFT task force and then, as regard to fixed interconnection, complied with the recommendations issued by the task force.

[115] Consensus has been reached thanks to AGCOM intervention who held a technical committee with OAO and Telecom Italia to discuss and solve several open issues that arose during the definition process of technical specification by the Ministry for Economic Development.

Table 27: Process by which the national specification(s) was (were) defined – part 2

Characteristic	Spain	Sweden	Croatia	Bulgaria	France
Operator which offers IPvIC	Telefónica (incumbent)	TeliaSonera (incumbent)	HT (incumbent)/Other fixed network operators	Other fixed network operators (OFNO)	Alternatives (SFR, Bouygues Telecom, Free, Colt)
Operator offers IPvIC with its (fixed and/or mobile network)	Fixed network	Fixed network	Fixed network	Fixed network	Fixed network
Short description of the process how the further national specification(s) was(were) defined	CNMC (former CMT) started a forum with all operators, for the definition of technical specifications for IPvIC in May 2012. As a result, two signalling protocol specifications were approved in 2013: SIP and SIP-I	Not appl.	End of 2014 HAKOM started a forum with all operators, for the definition of technical specifications for IPvIC in compliance with international standards.	An advisory body consisting of representatives of CRC and interested fixed network operators was established. This advisory body adopted a common position on which the draft CRC decision is based on.	National dialogue between major operators, in compliance with international standards.
Operators and other stakeholders which were involved	All relevant fixed network operators and mobile operators were involved.	Not appl.	All relevant fixed network operators and mobile operators were involved.	BTC (incumbent) and other fixed network operators[116]	Task force composed of: FFT board, Orange, SFR, Bouygues Telecom, Colt
Was it possible to achieve consensus between all stakeholders involved? (Yes/No)	Yes, although two specifications (SIP and SIP-I) were approved because there was no consensus about the mandatory protocol to be used. (Telefonica's RIO only proposes SIP)	Not appl.	Consensus was achieved between all operators involved in the standardization process	Yes, partially on some issues	Consensus was achieved between all operators involved in the standardization process engaged at the FFT task force.[114]
If consensus was achieved, how was it possible, by which process?	By the collaboration of CNMC (former CMT) in the process, throughout meetings with stakeholders. The process lasted one year.	Not appl.	By the collaboration of HAKOM in the process, throughout meetings with stakeholders.	With discussions and mediation of CRC the advisory body aimed to achieve the maximum consensus between the stakeholders possible.	Standardization task force within FFT, which gathers all involved operators worked on a common standard.
If consensus was not achieved, reasons why NRA accepted the reference to the national specification(s) in the RIO	Not appl.	Not appl.	Not appl.	Not appl.	Not appl.

Source: BEREC

[116] ITD, Blizoo, Varna Net, Mobiltel, Telenor, GCN, Goldtelecom, Vestitel, NetIsSat, Netfinity, Telecom1, ETC, Interroute, Nexcom

Table 28: Process by which the national specification(s) was (were) defined – part 3

Characteristic	Finland	France	France	France
Operator which offers IPvIC	TeliaSonera, Elisa, DNA	Orange	SFR	Bouygues Telecom
Operator offers IPvIC with its (fixed and/or mobile network)	Mobile network	Mobile network	Mobile network	Mobile network
Short description of the process how the further national specification(s) was(were) defined	Ficora's recommendation was drafted in a working group consisted of network operators and NRA (& national hearing).	National dialogue between major operators, in compliance with international standards.		
Operators and other stakeholders which were involved	Network operators (mobile, fixed, VoIP, company operating the number portability infrastructure (Numpac Ltd))	Task force composed of: FFT board, Orange, SFR, Bouygues Telecom, Colt		
Was it possible to achieve consensus between all stake-holders involved? (Yes/No)	Yes	Consensus was achieved between all operators involved in the standardization process engaged at the FFT task force.[114]		
If consensus was achieved, how was it possible, by which process?	Specification was defined based on practical implementation experience.	Standardization task force within FFT, which gathers all involved operators worked on a common standard.		
If consensus was not achieved, reasons why NRA accepted the reference to the national specification(s) in the RIO	Not appl.	Not appl.		

Source: BEREC

Table 29: Number of PoIs of the IPvIC – part 1

Characteristic	Denmark	France	Germany	Italy	Slovenia
Operator which offers IPvIC	TDC (incumbent)	Orange (incumbent)	DTAG (incumbent)	Telecom Italia (incumbent)	Telekom Slovenije (incumbent)
Operator offers IPvIC with its (fixed and/or mobile network)	Fixed network	Fixed network	Fixed network	Fixed network	Fixed network
Total number of points of interconnection (PoIs) for IPvIC nationwide	6 PoIs (each available for IPvIC and TDMvIC) No/3 areas (no areas for VoIP end users, 3 areas for TDM end users with 2 PoIs in each area)	10 PoIs[117]	22 PoIs on 12 locations No areas	32 PoIs 16 Gateway areas 2 PoIs per gateway area	2 PoIs
Minimum number of PoIs mandated by RIO (to allow for redundancy and local rates)	1/6 (for VoIP end users: 1 or 2 in case of redundancy, for TDM end users: 6, optional with redundancy)	2[118]	2 on 2 different locatons for redundancy, 1 for small local operators, 1 for local rates[119]	32[18]	1 PoI
The minimum number of PoIs mandated by RIO has been imposed by NRA? (Yes/No)	Yes	No	Yes	No	No
If imposed by NRA, reasons for demanding this minimum number of PoIs (and not more/less)	To support flexibility. For VoIP end users alternative operators can choose to interconnect at only one PoI (of any of the 6 PoIs), for redundancy reason also at more PoIs	Not appl.	For small operators 1 PoI is sufficient and 2 PoIs seem not to be proportionate	Not appl.	Not appl.
Total number of points of interconnection (PoIs) for previous TDMvIC nationwide	6 (the same 6 PoIs that are available for IPvIC)	360	474	660	44 PoIs (2 IX, 11 SX and 31 PX)[120]

Source: BEREC

[117] 5 PoP locations each with 2 PoIs
[118] According to national specifications of FFT the PoI has to be redundant. Therefore, the minimum number of PoI is two. The operators can handover traffic for all destinations in France at each of the two PoIs and have to pay (only) the regulated local rates (no unregulated transit charges).
[119] ANOs have to select two out of 22 PoIs (not less and not more). Two PoIs are needed for redundancy, not for local rates. Small local operators may interconnect at just 1 PoI. Any traffic can be handed over at any PoI for the same price.
[120] IX - International Exchange, SX - Secondary Exchange, PX - Primary Exchange

Table 30: Number of PoIs of the IPvIC – part 2

Characteristic	Spain	Sweden	Croatia	Bulgaria	France
Operator which offers IPvIC	Telefónica (incumbent)	TeliaSonera (incumbent)	HT (incumbent)/Other fixed network operators	Other fixed network operators (OFNO)	Alternatives (SFR, Bouygues Telecom, Free, Colt)
Operator offers IPvIC with its (fixed and/or mobile network)	Fixed network	Fixed network	Fixed network	Fixed network	Fixed network
Total number of points of interconnection (PoIs) for IPvIC nationwide	19 areas / 19 PoI Each PoI with redundancy	4 PoIs 2 areas 2 PoIs per area	FNI: 4 PoIs OFNO: not defined yet	Currently OFNO use generally 1 PoI	No information available
Minimum number of PoIs mandated by RIO (to allow for redundancy and local rates)	19 PoIs (each PoI with redundancy)	4[18]	FNI: 2[121] OFNO: not defined yet	Not appl.[122]	2[118]
The minimum number of PoIs mandated by RIO has been imposed by NRA? (Yes/No)	No	No	Yes	Not appl.	No
If imposed by NRA, reasons for demanding this minimum number of PoIs (and not more/less)	Not appl.	Not appl.	For redundancy reason[123]	Not appl.	Not appl.
Total number of points of interconnection (PoIs) for previous TDMvIC nationwide	21, corresponding to the 21 geographical transit areas of Telefonica, since last market 3 analysis (586 local exchanges in the past).[124]	26 PoIs 13 areas 2 PoIs per area	2 international, 9 regional and 26 local exchanges	Not appl.[125]	No information available

Source: BEREC

[121] In transition period as long as operator has TDMvIC with incumbent 1 PoI is enough.
[122] OFNO do not have the obligation to publish a RIO (see Table 18) and to offer at least a certain number of PoIs.
[123] Number of PoIs was proposed by incumbent. During the negotiation process HAKOM only insisted on redundancy which is ensured by 2 PoI.
[124] In the last market 3 decision (September 2014) it was decided to impose to incumbent Telefonica the BU-LRIC FTR with a minimum number of 21 PoI (no longer different levels of interconnection, no longer the obligation to interconnect to 586 exchanges as before)
[125] From the very beginning the OFNO use IPvIC based on H.323 or SIP

Table 31: Number of PoIs of the IPvIC – part 3

Characteristic	Finland	France	France	France
Operator which offers IPvIC	TeliaSonera, Elisa, DNA	Orange	SFR	Bouygues Telecom
Operator offers IPvIC with its (fixed and/or mobile network)	Mobile network	Mobile network	Mobile network	Mobile network
Total number of points of interconnection (PoIs) for IPvIC nationwide	3 PoIs	4	NIA	3
Minimum number of PoIs mandated by RIO (to allow for redundancy and local rates)	2[126]	2[118]		
The minimum number of PoIs mandated by RIO has been imposed by NRA? (Yes/No)	Not appl.	No		
If imposed by NRA, reasons for demanding this minimum number of PoIs (and not more/less)	Not appl.	Not appl.		
Total number of points of interconnection (PoIs) for previous TDMvIC nationwide	2 PoIs for each MNO	6	6	3

Source: BEREC

[126] Two PoIs is the minimum based on Ficora's regulation on redundancy (not Ficora's recommendation mentioned in Table 22).

Table 32: Signalling protocol(s) supported by the IPvIC – part 1

Characteristic	Denmark	France	Germany	Italy	Slovenia
Operator which offers IPvIC	TDC (incumbent)	Orange (incumbent)	DTAG (incumbent)	Telecom Italia (incumbent)	Telekom Slovenije (incumbent)
Operator offers IPvIC with its (fixed and/or mobile network)	Fixed network	Fixed network	Fixed network	Fixed network	Fixed network
Operator has the obligation to use a certain signalling protocol (Yes(which?)/No)	No	No	No	Yes (section 5 of ST 769): • SIP (IETF) • SIP-I (ITU-T)	No
Signalling protocol(s) used by the operator at the PoI of the IPvIC	SIP (IETF)	SIP (IETF) including specifications of 3GPP (IMS)	SIP (IETF) including specifications of 3GPP (IMS)	• SIP (IETF) including specifications of 3GPP (IMS) • SIP-I (ITU-T)	• SIP (IETF)[127] • SIP-I (ITU-T)
Signalling protocol(s) is(are) specified by reference to the following international standards	• SIP: RFC 3261, RFC 3262, RFC 3325, RFC 2327 (SDP) • Interworking ISUP-SIP: RFC 3398, RFC 3578 • Fax: T.38	• List of 16 RFC e.g. RFC 3261, RFC 3262, RFC 3264, RFC 3311, RFC 3312, RFC 4566 • 3GPP TS 24.628, 3GPP TS 24.229	• ETSI TS 124 503 V8.3.0 (2009-01)	SIP: • List of RFCs e.g. RFC 3261, RFC 2327, RFC 2833, RFC 3262, RFC 3264 RFC 3311 etc • ETSI TS 129 165 V8.4.0 SIP-I: • ITU-T Q.1912.5 Profil C	• SIP: RFC 3261, mapping SIP/ISUP: ITU-T Q.1912.5, Profile B, Q.850 release code • SIP-I: ITU-T Q.1912.5, Profile C

Source: BEREC

[127] For mapping SIP/ISUP ITU-T Q.1912.5 Profile B is used

Table 33: Signalling protocol(s) supported by the IPvIC – part 2

Characteristic	Spain	Sweden	Croatia	Bulgaria	France
Operator which offers IPvIC	Telefónica (incumbent)	TeliaSonera (incumbent)	HT (incumbent)/Other fixed network operators	Other fixed network operators (OFNO)	Alternatives (SFR, Bouygues Telecom, Free, Colt)
Operator offers IPvIC with its (fixed and/or mobile network)	Fixed network	Fixed network	Fixed network	Fixed network	Fixed network
Operator has the obligation to use a certain signalling protocol (Yes(which?)/No)	No	No	SIP (IETF) (optional for mobile networks SIP-I)[128]	SIP (IETF) or SIP-I (ITU-T)	No
Signalling protocol(s) used by the operator at the PoI of the IPvIC	• SIP (IETF) including specifications of 3GPP (IMS)	• SIP (IETF) • SIP-I (ITU-T)	SIP (IETF) including specifications of 3GPP (IMS)	• SIP (IETF)	SIP (IETF) including specifications of 3GPP (IMS)
Signalling protocol(s) is(are) specified by reference to the following international standards	• List of RFC, e.g. RFC 3261, RFC 3262, RFC 3264, RFC 3311, RFC 4566 etc • 3GPP TS 24.528, 29.165	SIP:[129] • List of RFCs related to SIP and SDP SIP-I:[130] • ITU-T Q.1912.5 Profil C • List of RFCs related to SIP and SDP	• List of 17 RFC, e.g. RFC 3261, RFC 3262, RFC 3264, RFC 3311, RFC 3312, RFC 3323, RFC 3325, RFC 3326, RFC 3407, RFC3556 • 3GPP TS 24.628, 3GPP TS 24.229 • Fax: T.38	• SIP RFC 3261 • ITU-T Q.1912.5 Profile C	• List of 16 RFC e.g. RFC 3261, RFC 3262, RFC 3264, RFC 3311, RFC 3312, RFC 3323, RFC 3325, RFC 3326, RFC 3407, RFC3506, RFC 3966, RFC 4028, RFC 4566, RFC 5009, RFC 5806 • 3GPP TS 24.628, 3GPP TS 24.229

Source: BEREC

[128] The IPvIC between fixed network operators is only allowed to be based on SIP. However, if MNO demand an IPvIC based on SIP-I this is also allowed.
[129] See TeliaSonera Interconnect Specification No 8211-A353 (section 4)
[130] See TeliaSonera Interconnect Specification No 8211-A357 (section 4)

Table 34: Signalling protocol(s) supported by the IPvIC – part 3

Characteristic	Finland	France	France	France
Operator which offers IPvIC	TeliaSonera, Elisa, DNA	Orange	SFR	Bouygues Telecom
Operator offers IPvIC with its (fixed and/or mobile network)	Mobile network	Mobile network	Mobile network	Mobile network
Operator has the obligation to use a certain signalling protocol (Yes(which?)/No)	No	No		
Signalling protocol(s) used by the operator at the PoI of the IPvIC	SIP-I (national)	SIP-I[131]		
Signalling protocol(s) is(are) specified by reference to the following international standards	• SIP-I: ITU-T Q.1912.5; & national ISUP3 (SFS5869) • GSMA & 3GPP specifications	- List of 18 IETF RFC (2046, 2976, 3204, 3261, 3262, 3264, 3311, 3312, 3323, 3325, 3326, 3407, 3556, 3966, 4028, 4040, 4566, 4733) - List of 4 3GPP TS (24.528, 29.231, 26.071, 26.171) - List of 5 ITU-T recommendations (Q.1912.5, G.711, G.729, G.729 Annex A, G.722)		

Source: BEREC

[131] The target protocol is SIP but not implemented yet for mobile networks.

Table 35: Number ranges and supplementary services supported by the IPvIC – part 1

Characteristic	Denmark	France	Germany	Italy	Slovenia
Operator which offers IPvIC	TDC (incumbent)	Orange (incumbent)	DTAG (incumbent)	Telecom Italia (incumbent)	Telekom Slovenije (incumbent)
Operator offers IPvIC with its (fixed and/or mobile network)	Fixed network	Fixed network	Fixed network	Fixed network	Fixed network
List of number ranges supported by IPvIC	Same as for TDMvIC	All interpersonal numbers ((non-) geographical numbers, mobile numbers, international numbers)	All number ranges	SIP, SIP-I: a, b, c, d, e, f, g, h (ECS nomadic numbers, +55)[132]	SIP, SIP-I: All number ranges
Number ranges supported by previous TDM-based interconnection but no longer by IPvIC	None	Not yet: service numbers and short codes[133]	None	None	SIP, SIP-I: None
List of supported supplementary services	CLIP, CLIR, Call forwarding	CLIP, CLIR, Call forwarding, Call Hold[134]	OIP, OIR (optional e.g. CDIV, HOLD, CONF, CUG)	SIP, SIP-I: • CLIP/CLIR, MCID, CFB/CFNR/CFU, CH, CW, 3PTY SIP-I only: • COLP, COLR, CD, UUS (type 1)	SIP, SIP-I: CLIP and CLIR (other services are subject to agreement)
Supplementary services supported by previous TDM-based interconnection but no longer by IPvIC	The main supplementary services are the same	DTMF	CDIV, HOLD, CONF, CUG are optional in IPvIC	CCBS, Sub Addressing	SIP, SIP-I: None

Source: BEREC

[132] (a) geographical numbers, (b) service numbers (e.g. free phone numbers, premium rate numbers), (c) emergency numbers, (d) harmonized European short codes (116xxx), (e) public national short codes, (f) location independent corporate numbers, (g) mobile numbers, (h) international numbers

[133] Currently FFT works on that.

[134] According to FFT Doc 10.001 (May 2014), sections 1.1 and 13

Table 36: Number ranges and supplementary services supported by the IPvIC – part 2

Characteristic	Spain	Sweden	Croatia	Bulgaria	France
Operator which offers IPvIC	Telefónica (incumbent)	TeliaSonera (incumbent)	HT (incumbent)/Other fixed network operators	All fixed operators Other fixed network operators (OFNO)	Alternatives (SFR, Bouygues Telecom, Free, Colt)
Operator offers IPvIC with its (fixed and/or mobile network)	Fixed network	Fixed network	Fixed network	Fixed network	Fixed network
List of number ranges supported by IPvIC	Geographical numbers and nomadic numbers (RIO only covers termination services).[135]	a, b, c, d, e, f, g, h, i – M2M[136]	All number ranges	All number ranges assigned to OFNO	All interpersonal numbers ((non-) geographical numbers, mobile numbers, international numbers)
Number ranges supported by previous TDM-based interconnection but no longer by IPvIC	None	None	None	Not appl.[125]	Not yet: service numbers and short codes[133]
List of supported supplementary services	CLIP, CLIR, COLP, COLR, Call Forwarding, Call Hold, Call Waiting, Call Transfer, 3PTY	SIP, SIP-I:[137] • CLIP, CLIR, DDI, HOLD, Call Forwarding (CFNR, CFB, CFU) SIP-I only:[138] • COLP. COLR, MCID, SUB, CD, CW, ECT, CCBS, CCNR, CONF, 3PTY, CUG, UUS, MWI	CLIP, CLIR, CNIP, CNIR, CONP, COLP, CLIPRO, Call Hold, Call Waiting, Call Forwarding, Call Transfer, ACR, 3-way conference	CLIP, CLIR, Call forwarding, DTMF	CLIP, CLIR, Call forwarding, Call Hold[139]
Supplementary services supported by previous TDM-based interconnection but no longer by IPvIC	Sub Addressing, User to User signaling[140]	Not specified in RIO	None	Not appl.[125]	DTMF

Source: BEREC

[135] However, other number ranges are expected to be included in the future, when on the market for call origination also the obligation to offer IPvIC will be imposed. The national specification includes any type of number ranges.
[136] (a) geographical numbers, (b) service numbers (e.g. free phone numbers, premium rate numbers), (c) emergency numbers, (d) harmonized European short codes (116xxx), (e) public national short codes, (f) location independent corporate numbers, (g) mobile numbers, (h) international numbers, (i) other numbers
[137] See TeliaSonera Interconnect Specification No 8211-A357 (section 4.1) and No 8211-A353 (section 4.1)
[138] See TeliaSonera Interconnect Specification No 8211-A353 (section 4.1)
[139] According to FFT Doc 10.001 (May 2014), sections 1.1 and 13
[140] All supplementary services not mandatory can be used on bilateral agreement.

Table 37: Number ranges and supplementary services supported by the IPvIC – part 3

Characteristic	Finland	France	France	France
Operator which offers IPvIC	TeliaSonera, Elisa, DNA	Orange	SFR	Bouygues Telecom
Operator offers IPvIC with its (fixed and/or mobile network)	Mobile network	Mobile network	Mobile network	Mobile network
List of number ranges supported by IPvIC	All number ranges	All number ranges	At least mobile numbers	At least mobile numbers
Number ranges supported by previous TDM-based interconnection but no longer by IPvIC	None	All number ranges supported by TDMvIC are supported by SIP-I		
List of supported supplementary services	Basically all supplementary services that are used in TDMvIC are also implemented in IPvIC (national GFI9803)	The specifications following supplementary services: - Calling Line Identification Presentation (CLIP), - Calling Line Identification Restriction (CLIR), - Call Forwarding, - Call Hold, - Call Waiting, - User to user information, - Terminal portability		
Supplementary services supported by previous TDM-based interconnection but no longer by IPvIC	Not appl.	No information is available		

Source: BEREC

Table 38: Codecs supported by the IPvIC – part 1

Characteristic	Denmark	France	Germany	Italy	Slovenia
Operator which offers IPvIC	TDC (incumbent)	Orange (incumbent)	DTAG (incumbent)	Telecom Italia (incumbent)	Telekom Slovenije (incumbent)
Operator offers IPvIC with its (fixed and/or mobile network)	Fixed network	Fixed network	Fixed network	Fixed network	Fixed network
List of audio codecs supported by IPvIC	• G.711A-law • G.729a	G.711 A-law (default)[141] Otherwise AMR set 7 or G.729	G.711 A-law[142]	SIP, SIP-I: • G.711 A-law • G.729 (no Annex B) • RFC 2833 (DTMF)[143]	SIP, SIP-I: • G.711 A-law (recommended) • RFC 2833 (DTMF)
Fax services are supported by IPvIC? (Yes/No)	Yes	Yes[144]	Yes	Yes	SIP, SIP-I: Yes
List of fax codecs supported by IPvIC	• T.38 • G.711 A-law	• G.711 A-law • T.38 if bilaterally agreed • V.152 optional[145]	• G.711 A-law • AKNN recommended T.38	• G.711 A-law (media type “audio”) • T.38 (media type “image”)[143]	SIP, SIP-I: • G.711 • T.38

Source: BEREC

[141] According to FFT Doc. 09.002 (July 2009), section 4.2.2
[142] Other codecs may be negotiated without guarantee
[143] See Draft RIO of Oct. 2012, section 7, p. 19
[144] But fax traffic is not included in QoS commitments
[145] According to FFT Doc 10.001 (May 2014), section 11

Table 39: Codecs supported by the IPvIC – part 2

Characteristic	Spain	Sweden	Croatia	Bulgaria	France
Operator which offers IPvIC	Telefónica (incumbent)	TeliaSonera (incumbent)	HT (incumbent)/Other fixed network operators	Other fixed network operators (OFNO)	Alternatives (SFR, Bouygues Telecom, Free, Colt)
Operator offers IPvIC with its (fixed and/or mobile network)	Fixed network	Fixed network	Fixed network	Fixed network	Fixed network
List of audio codecs supported by IPvIC	• G.711 A-law (10 and 20 msec packet) • G.729 (20 and 30 msec packet) • RFC 4733 (DTMF)	SIP, SIP-I: G.711 A-law	• G.711 A-law (20 ms) • ITU-T G.729a (20ms) • ITU-T G.722 (Wide Band) • RFC 4733 (DTMF)	G.711 A-law	G.711A-law (default)[146] Otherwise AMR set 7 or G.729
Fax services are supported by IPvIC? (Yes/No)	Yes	SIP, SIP-I: Yes	Yes	Yes	Yes[147]
List of fax codecs supported by IPvIC	• T.38 (media type "image") • G.711, pass-through optionally.	SIP, SIP-I: G.711 A-law	• G.711 • T.38	• G.711 A-law • Required: T.38	• G.711 A-law (default) • T.38 if bilaterally agreed • V.152 optional[148]

Source: BEREC

[146] According to FFT Doc. 09.002 (July 2009), section 4.2.2
[147] But no commitment of interoperability because it depends on the costumers equipement.
[148] According to FFT Doc 10.001 (May 2014), section 11

Table 40: Codecs supported by the IPvIC – part 3

Characteristic	Finland	France	France	France
Operator which offers IPvIC	TeliaSonera, Elisa, DNA	Orange	SFR	Bouygues Telecom
Operator offers IPvIC with its (fixed and/or mobile network)	Mobile network	Mobile network	Mobile network	Mobile network
List of audio codecs supported by IPvIC	• G.711 A-law • G.729 • NB-AMR • GSM EFR	G.711A-law (default)		
Fax services are supported by IPvIC? (Yes/No)	Yes	Yes, but there is no guaranty of end to end interoperability		
List of fax codecs supported by IPvIC	T.38	• G.711 A-law • T.38 if bilaterally agreed • V.152 optional		

Source: BEREC

Table 41: QoS of the IPvIC – part 1

Characteristic	Denmark	France	Germany	Italy	Slovenia
Operator which offers IPvIC	TDC (incumbent)	Orange (incumbent)	DTAG (incumbent)	Telecom Italia (incumbent)	Telekom Slovenije (incumbent)
Operator offers IPvIC with its (fixed and/or mobile network)	Fixed network	Fixed network	Fixed network	Fixed network	Fixed network
Speech quality (objective/not defined)	Not specified in RIO	Defined indicator but no objective.	• Requirements of G.101 / ETSI EG 202 086 have to be fulfilled • MOS (LQO) >4.0 (end-to-end) • Delay < 150 ms (end-to-end)(G.114)	The codecs to be used are: G.711, G.729 In any case the speech quality has to be comparable with TDMvIC	• G.711[149] • G.114 • G.107[150] • G.168[151]
Call set-up time (objective/not defined)	Not specified in RIO	Not specified in RIO	Max. 3 s	Comparable with TDMvIC	Not specified in RIO
Network Effectiveness Ratio (NER) (objective/not defined)	Not specified in RIO	Not specified in RIO	Within network of DTAG and within network of IC partner: >= 99.5%	Comparable with TDMvIC	Not specified in RIO
Probability of a dropped connection (objective/not defined)	Not specified in RIO	Not specified in RIO	<0.01%	Comparable with TDMvIC	Not specified in RIO
Availability of the IC link per PoI (objective/not defined)	Not specified in RIO	Not specified in RIO	• >= 99.5% (per IC partner and excluding the leased line bet-ween the networks) • Availability of leased line between the networks >= 98.5%	Comparable with TDMvIC	Not specified in RIO
Other QoS parameters (parameter and objective)	CoS of IP transport: - Media: Expedited Forwarding (EF) - Signalling: Assured Forwarding, burstable (AFb)	Not specified in RIO	Not specified in the draft RIO	Comparable with TDMvIC	CoS of IP transport: - Media: Expedited Forwarding (EF) - Signalling: Assured Forwarding (AF31)

Source: BEREC

[149] Packetization time 20 ms, jitter-buffer >= 10 ms
[150] Minimum voice quality – delay <= 300 ms
[151] Echo cancellation: echo return loss > 30 dB, tail length > 128 ms. However, FNI (Telekom Slovenije) does not require this method and values can be agreed upon with operator.

Table 42: QoS of the IPvIC – part 2

Characteristic	Spain	Sweden	Croatia	Bulgaria	France
Operator which offers IPvIC	Telefónica (incumbent)	TeliaSonera (incumbent)	HT (incumbent)/Other fixed network operators	Other fixed network operators (OFNO)	Alternatives (SFR, Bouygues Telecom, Free, Colt)
Operator offers IPvIC with its (fixed and/or mobile network)	Fixed network	Fixed network	Fixed network	Fixed network	Fixed network
Speech quality (objective/not defined)	Not defined.	Not specified in RIO	Comparable with TDMvIC	Required:[152] • R-factor>70 (G.107,G.109) • One way Delay < 150 ms (G.114)	Defined indicator but no objective.
Call set-up time (objective/not defined)	Not defined	Not specified in RIO	Comparable with TDMvIC	Not defined in CRC's draft decision[153]	Not specified in RIO
Network Effectiveness Ratio (NER) (objective/not defined)	Not defined	Not specified in RIO	Comparable with TDMvIC	Required:[152] NER>95% (E.425)	Bouygues Telecom: NER>99,3%
Probability of a dropped connection (objective/not defined)	Not defined	Not specified in RIO	Comparable with TDMvIC	Not defined in CRC's draft decision[153]	Not specified in RIO
Availability of the IC link per PoI (objective/not defined)	>= 99.77%	Not specified in RIO	Comparable with TDMvIC	Not defined in CRC's draft decision[153]	Not specified in RIO
Other QoS parameters (parameter and objective)	IC GbE link QoS: IPLR < 10^{-7}, IPTD < 3 ms, IPDV < 20 µs E2E QoS: IPLR < 1%, IPTD < 150 ms, IPDV < 100 ms In IP network, TOS/DiffServ values defined for voice ("5/EF") and signalling ("3/AF31")	Guidelines for each IP network: • IPLR < 0.02%. • IPTD < 50ms (one-way delay). • IPDV < 4ms	Comparable with TDMvIC	Required:[152] • ASR>50% (E.425) • Packet delay variation< 50ms • IPLR<0.1%	Bouygues Telecom: Answer Seizure Ratio of at least 65% for calls to the operator's clients, 55% for calls to roamers (computed for a 3 months period)

Source: BEREC

[152] By CRC's draft decision (see Table 21)
[153] See Table 21

Table 43: QoS of the IPvIC – part 3

Characteristic	Finland	France	France	France
Operator which offers IPvIC	TeliaSonera, Elisa, DNA	Orange	SFR	Bouygues Telecom
Operator offers IPvIC with its (fixed and/or mobile network)	Mobile network	Mobile network	Mobile network	Mobile network
Speech quality (objective/not defined)	Not specified in Ficora's recommendation.	Defined indicator but no objective.		
Call set-up time (objective/not defined)	Not specified in Ficora's recommendation	Not specified in RIO		
Network Effectiveness Ratio (NER) (objective/not defined)	Not specified in Ficora's recommendation	Not specified in RIO	Not specified in RIO	NER>99,3%
Probability of a dropped connection (objective/not defined)	Not specified in Ficora's recommendation	Not specified in RIO		
Availability of the IC link per PoI (objective/not defined)	Not specified in Ficora's recommendation	Not specified in RIO		
Other QoS parameters (parameter and objective)	Not specified in Ficora's recommendation	Not specified in RIO	Not specified in RIO	Answer Seizure Ratio of at least 65% for calls to the operator's clients, 55% for calls to roamers (computed for a 3 months period)

Source: BEREC

Table 44: Physical IC link and redundancy of the IPvIC – part 1

Characteristic	Denmark	France	Germany	Italy	Slovenia
Operator which offers IPvIC	TDC (incumbent)	Orange (incumbent)	DTAG (incumbent)	Telecom Italia (incumbent)	Telekom Slovenije (incumbent)
Operator offers IPvIC with its (fixed and/or mobile network)	Fixed network	Fixed network	Fixed network	Fixed network	Fixed network
Networks are connected with each other with (direct IC link and/or via other networks)	Direct IC link	Direct IC link between major operators [154]	Direct IC link (used IP addresses are not publicly routed)	Direct IC link	Direct IC link
IC link of the IPvIC is used for (voice services only / also for additional services (e.g. Internet access))	Voice only	For voice services only. Separate PoI for Internet traffic.	Voice services only	Voice service only	Can be used also for additional services if supported by equipment
Physical transport interface and bandwidth options at the PoI	Typically 1 GE	Minimal 1 GE	• SDH: 155 Mbps, • 1 GE: 150/300/600/ 1,000 Mbps, • 10 GE: 2 to 10 Gbps in steps of 1 Gbps	SDH: 155 Mbps, 1 GE: 1,000 Mbps	1 GE (or other supported by both parties)
Redundancy of the physical connection at the network level (Yes/No)	Yes (option, not an obligation)[155]	Yes, minimum 1 IC link, redundant, each with different equipment	Yes, 2 IC links, each IC link can carry total voice IC traffic	Yes, 2 IC links, each IC link can carry 70% of voice IC traffic (peak traffic)	Yes (option)
Redundancy at the level of the border gateway (e.g. SBC) (Yes/No)	Not specified in RIO	Yes, N+1 model (N nominal SBCs / 1 back-up SBC) or load sharing between I-SBC equipment[156]	Yes, 2 or more SBCs, if 1 SBC is no longer available the other SBC(s) can take over the traffic of this SBC	No	Yes, georedundant SBC based on load sharing principle

Source: BEREC

[154] Major operators typically connect their networks based on a direct link. Small operators connect their networks indirectly by transit through the network of a major operator.
[155] The degree of redundancy (e.g. 100% or only 50%) is an option for the OFNO to decide.
[156] See FFT Doc 09.002 (July 2009), p. 8, section 4.2.4.3

Table 45: Physical IC link and redundancy of the IPvIC – part 2

Characteristic	Spain	Sweden	Croatia	Bulgaria	France
Operator which offers IPvIC	Telefónica (incumbent)	TeliaSonera (incumbent)	HT (incumbent)/Other fixed network operators	Other fixed network operators (OFNO)	Alternatives (SFR, Bouygues Telecom, Free, Colt)
Operator offers IPvIC with its (fixed and/or mobile network)	Fixed network	Fixed network	Fixed network	Fixed network	Fixed network
Networks are connected with each other with (direct IC link and/or via other networks)	Direct IC link	Direct link	Direct IC link	Direct link	Direct IC link between major operators[154]
IC link of the IPvIC is used for (voice services only / also for additional services (e.g. Internet access))	Voice and fax[157]	Not specified in RIO	For voice and fax services only. Separate PoI for Internet traffic.	Voice and fax	For voice services only. Separate PoI for Internet traffic.
Physical transport interface and bandwidth options at the PoI	1 GE[158]	1 GE, 10 GE	Minimal 1 GE	Required:[152] Ethernet interface and minimum bandwidth of 10 Mbps	Minimal 1 GE
Redundancy of the physical connection at the network level (Yes/No)	Yes. 2 IC links with different equipments. Each IC link should be able to carry the total voice IC traffic.	Geographical redundant links are preferred (option)	Geographical redundant links are mandatory for incumbent, for OFNO not defined yet	Yes	Yes, minimum 1 IC link, redundant, each with different equipment
Redundancy at the level of the border gateway (e.g. SBC) (Yes/No)	Yes. For each serving area, 2 SBC share the traffic.	Yes, “High availability SBC”	Yes, load sharing between I-SBC equipment is available	No information available	Yes, N+1 model (N nominal SBCs / 1 back-up SBC) or load sharing between I-SBC equipment[159]

Source: BEREC

[157] However, existing PoIs of TDMvIC or ULL can also be used for IPvIC based on a dedicated fibre for IPvIC.
[158] Proposed in draft RIO of Telefonica but ANOs request also 10 GE
[159] See FFT Doc 09.002 (July 2009), p. 8, section 4.2.4.3

Table 46: Physical IC link and redundancy of the IPvIC – part 3

Characteristic	Finland	France	France	France
Operator which offers IPvIC	TeliaSonera, Elisa, DNA	Orange	SFR	Bouygues Telecom
Operator offers IPvIC with its (fixed and/or mobile network)	Mobile network	Mobile network	Mobile network	Mobile network
Networks are connected with each other with (direct IC link and/or via other networks)	Via interconnection exchange points	Direct IC link between major operators		
IC link of the IPvIC is used for (voice services only / also for additional services (e.g. Internet access))	Voice only	For voice services only. Separate PoI for Internet traffic.		
Physical transport interface and bandwidth options at the PoI	1 GE, 10 GE (coming) Bandwidth options: 10 Mbps, 100 Mbps, 1Gbps[160]	1 or 10 Gigabits/s	Not specified in RIO[161]	1 or 10 Gigabits/s
Redundancy of the physical connection at the network level (Yes/No)	Geographical redundant links to two different interconnection exchange points (1 IC link to each)	Yes, minimum 1 IC link, redundant, each with different equipment		
Redundancy at the level of the border gateway (e.g. SBC) (Yes/No)	Not specified in Ficora's recommendation	Not specified in RIO[162]	Not specified in RIO[162]	At least 2 I-SBC

Source: BEREC

[160] Physical interface is specified by the company (Numpac) that runs the interconnection points.
[161] The physical transport interface complies with the standards of FFT.
[162] Redundancy at the level of the border gateway complies with standards of FFT.

Table 47: Network security of the IPvIC – part 1

Characteristic	Denmark	France	Germany	Italy	Slovenia
Operator which offers IPvIC	TDC (incumbent)	Orange (incumbent)	DTAG (incumbent)	Telecom Italia (incumbent)	Telekom Slovenije (incumbent)
Operator offers IPvIC with its (fixed and/or mobile network)	Fixed network	Fixed network	Fixed network	Fixed network	Fixed network
Security measures to protect the network	• In TDCs MPLS network closed VPN connections are used • SBC protection: IP addresses of SBCs are not advertised to the public Internet and only exchanged between TDC and IC partner	Each operator is responsible for securing the traffic from its side. FFT recommends the following:[163] • Possibility to block ports based on a list of authorized addresses, ports and protocols • Use of public IPv4 addresses within each interconnection without announce-ment on the Internet • Make flow IP-tight (e.g. VPN) • Different SBCs secure signalling and media (e.g. distributed SBC) • At the router level: access control to a list of well-defined source addresses	• Detailed rules on security of collocation rooms • Some general obligations to cooperate in security issues, to not use PoIs for types of traffic not covered by the agreement etc.	• Border gateway functionality with firewall • Use of public IP addresses • Geographical redundancy of IP point-to-point physical or logical connections (signalling and media)	SBC with the security measures: Layer 3 and Layer 4: • Detects and drops malformed or malicious TCP/IP packets • Access Control Lists • Dynamic pinholes for media • Traffic policing • Topology hiding for media Application Security: • Detects and drops malformed or malicious SIP/H.323 messages (ALG) • Topology hiding for SIP/H.323 sessions • Authentication, Integrity, Confidentiality measures (TLS, SSH) • Session constraints • Dynamic blacklisting

Source: BEREC

[163] See FFT Doc 09.002 (July 2009), section 4.2.4.2

Table 48: Network security of the IPvIC – part 2

Characteristic	Spain	Sweden	Croatia	Bulgaria	France
Operator which offers IPvIC	Telefónica (incumbent)	TeliaSonera (incumbent)	Other fixed network operators/Incumbent (HT)	Other fixed network operators (OFNO)	Alternatives (SFR, Bouygues Telecom, Free, Colt)
Operator offers IPvIC with its (fixed and/or mobile network)	Fixed network	Fixed network	Fixed network	Fixed network	Fixed network
Security measures to protect the network	At NNI: • BGP authentication • IPsec with Authentication Header without encryption • Avoid progress of Ping commands and traceroute. • IP address will be specific for each IC operator and geographical area.[164] At SBC: The use of SBC with the following features is foreseen: • Control of access of signalling and media packets, adapting the content. • All the signalling and media flows must be handled by SBC • Packet inspection • Topology hiding, traffic policy etc	SIP and SIP-I:[165] SBC of TeliaSonera • prevent unauthorised SIP or IP messages • provide topology hiding • provide session limiting • prevent DOS attacks • SIP ALG function • SIP header manipulation • act as a dynamic Firewall SIP-I only:[166] • Call servers have SIP-I based screening mask IP transport:[167] • IP addresses are not advertised to the public Internet • ACL filters (PE, SBC) only allow agreed traffic • Encryption of signalling or media is not allowed	• SBC • EBGP authentication	Required:[152] Session Border Controller integrating security functions (provide topology hiding, traffic filtering, firewall, authentication, authorization) and Point-to-Point physical connection	Each operator is responsible for securing the traffic from its side. FFT recommends the following:[163] • Possibility to block ports based on a list of authorized addresses, ports and protocols • Use of public IPv4 addresses within each interconnection without announcement on the Internet • Make flow IP-tight (e.g. VPN) • Different SBCs secure signalling and media (e.g. distributed SBC) • At the router level: access control to a list of well-defined source addresses

Source: BEREC

[164] IP address will be public and not visible on the Internet
[165] See TeliaSonera Interconnect Specification No 8211-A357 (section 4.9) and No 8211-A353 (section 4.9)
[166] See TeliaSonera Interconnect Specification No 8211-A353 (section 4.9)
[167] See TeliaSonera Interconnect Specification No 8211-A355 (section 4.6)

Table 49: Network security of the IPvIC – part 3

Characteristic	Finland	France	France	France
Operator which offers IPvIC	TeliaSonera, Elisa, DNA	Orange	SFR	Bouygues Telecom
Operator offers IPvIC with its (fixed and/or mobile network)	Mobile network	Mobile network	Mobile network	Mobile network
Security measures to protect the network	Not specified in national specifications	Each operator is responsible for securing the traffic from its side. FFT recommends the following:[163] • Possibility to block ports based on a list of authorized addresses, ports and protocols • Use of public IPv4 addresses within each interconnection without announcement on the Internet • Make flow IP-tight (e.g. VPN) • Different SBCs secure signalling and media (e.g. distributed SBC) • At the router level: access control to a list of well-defined source addresses		

Source: BEREC