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Award of the new mobile radio frequencies in Switzerland

1 Background

In June and July 2017, on behalf the Federal Communications Commission ComCom, the Federal Office of Communications OFCOM conducted a public consultation on the necessity for an award of new frequencies within the 700 MHz, 1400 MHz, 2.6 GHz and 3.5 GHz ranges. The feedback received indicated that there is great interest in the use of these new frequencies. On the one hand use of some of these frequencies will enable quality bottlenecks in today's 4G mobile radio networks to be overcome. On the other hand, these frequencies are needed so that the promising 5G mobile radio technology can be introduced. The comments received and a summary of the results have been published on the OFCOM website (www.bakom.ch).

In view of the great interest in the new frequencies, it can be assumed that the demand for this scarce resource exceeds the supply. In accordance with the statutory provisions, ComCom therefore decided to carry out a tender procedure and award the frequencies within the framework of an auction.

In early November 2017, the Federal Council took two decisions which paved the way for the award of the mobile radio frequencies by ComCom: in the National Frequency Allocation Plan (NFAP) for the year 2018 it released the frequencies for use in mobile radio networks. In the Ordinance on Fees in the Telecommunications Sector, it also reduced the licence fees for mobile radio frequencies in the range above 3 GHz to a level which is customary internationally.

Interested companies were able to comment on a draft of the tender documents from January to April 2018. Together with OFCOM, ComCom carefully analysed all the comments submitted within the framework of the consultation. Many suggestions and points of criticism were taken into consideration in the tender documents, which have now been published. For example, the maximum price increment in a clock round has been reduced from 50% to 15%.

2 Objectives of the award procedure

With regard to the implementation of the award of frequencies, ComCom is pursuing the following objectives within the framework of the statutory provisions:

- Consumers benefit from the latest technologies: all three Swiss mobile radio operators have already publicly presented their first 5G tests. With the possibility of using the 5G frequencies from 2019, Switzerland is among the leading countries in Europe. Furthermore, the Swiss population and economy will benefit from the most up-to-date mobile radio networks with high bandwidths and from technological innovation, which also promotes competition.
- Investment security for operators: the timely introduction of 5G is of great importance for digitalisation and innovation in Switzerland. To enable the mobile networks to meet the future needs of customers, the operators must be able to decide in good time on the technologies in which they wish to invest. The frequencies will be awarded for 15 years, offering operators planning and investment security.
- A clearly comprehensible auction format of minimum complexity: for reasons of transparency and comprehensibility for bidders, an auction format which is as easy as possible to understand is being chosen - in accordance with the industry's wishes: The clock auction

(CA) permits simultaneous bidding on all desired frequencies, is easy to understand and reduces complexity for bidders.

- Optimal allocation of frequencies: by awarding small blocks of frequencies, the participants in the auction will be able to exercise flexibility and acquire a range of frequencies which best corresponds to their needs and business models. Bidding restrictions in certain frequency ranges will ensure that individual auction participants cannot purchase an excessive amount of frequency blocks thereby leaving other participants with none.
- An open award of frequencies: the auction of the available spectrum is open to all interested parties under the same conditions – not just the existing operators in Switzerland. Regarding the 5G technology of the future, there is a possibility that companies with new business ideas can acquire frequencies and will wish to enter the market. There are legal restrictions on foreign companies from countries which do not grant Switzerland reciprocity (e.g. within the framework of applicable WTO agreements).
- A reasonable return (cf. Art. 23 KVF): frequencies are a scarce public resource for which a reasonable fee has to be charged, in accordance with the legal provisions. For Switzerland's future, enabling the rapid introduction of modern and efficient communications technologies and the efficient use of frequencies is, however, more important than maximising revenue.

3 Award procedure

Interested companies can download the tender documents from the OFCOM website and can submit written questions concerning the procedure and the envisaged rules. Answers to questions will also be published in an anonymised form on the OFCOM website and will be visible to all.

Candidature dossiers must be submitted by 05 October 2018 and will be analysed by OFCOM. All the companies which have submitted a complete dossier and which meet the conditions of the tender documents will receive authorisation to take part in the auction (see next section) and will receive the final rules for this sale.

Authorised companies will then be able to participate in training on the auction system and in a mock auction in order to familiarise themselves with the system and the rules of the sale.

It is expected that the auction will begin at the beginning of 2019, subject to unforeseen circumstances, and may extend over a few days or a few weeks. The winning companies will receive the licences on conclusion of the procedure.

Authorisation

ComCom will authorise to take part in the auction those candidates who can demonstrate that they can meet the licensing requirements (in accordance with Article 23 of the Telecommunications Act, TCA) and that the award of a radiocommunications licence to them will neither eliminate nor substantially adversely affect effective competition.

For financial security, a bank guarantee must be submitted together with the candidature documents, fully covering the lowest bid for the respective frequencies applied for.

4 Frequencies, configuration of blocks and minimum prices

4.1 Frequencies

Newly available frequencies which are being put out to tender

Frequency band	Configuration	Maximum useable bandwidth	Current and foreseeable uses
700 MHz	703–733 MHz / 758–788 MHz: <ul style="list-style-type: none"> 2 x 30 MHz FDD 738–753 MHz: <ul style="list-style-type: none"> 1 x 15 MHz downlink only SDL 	60 MHz FDD 15 MHz SDL	Current: digital terrestrial television (DVB-T) Future: 4G, 5G
1400 MHz	Downlink only SDL <ul style="list-style-type: none"> 1427–1452 MHz, 1 x 25 MHz 1452–1492 MHz, 1 x 40 MHz 1492–1517 MHz, 1 x 25 MHz 	90 MHz SDL	Current: digital broadcasting (DAB) Future: 4G, 5G
2600 MHz	2565–2570 MHz / 2685–2690 MHz: <ul style="list-style-type: none"> 2 x 5 MHz FDD 	10 MHz FDD	Current: 4G Future: 4G, 5G
3500–3600 MHz 3600–3800 MHz	3500–3600 MHz: <ul style="list-style-type: none"> 1 x 100 MHz TDD 3600–3800 MHz: <ul style="list-style-type: none"> 1 x 200 MHz TDD 	300 MHz TDD	Current: wireless broadband connections (BWA), wireless cameras (PMSE), satellite services Future: 5G, satellite services

FDD: Frequency Division Duplex => Two radio channels are used for a connection

TDD: Time Division Duplex => Only one radio channel is used for a connection

SDL: Supplemental Downlink => Three radio channels are used for a connection

Term of use of the individual frequencies

700 MHz: useable until 31.12.2033

1400 MHz: useable until 31.12.2033

2600 MHz: useable until 31.12.2028¹

3500-3600 MHz: useable until 31.12.2033

3600-3800 MHz: useable until 31.12.2033

¹ The term of use corresponds to the frequencies allocated in the 2600 Hz band in 2012.

Current allocation of frequencies to mobile operators in Switzerland

Frequency band	Salt	Sunrise	Swisscom
800 MHz FDD (currently LTE)	20 MHz	20 MHz	20 MHz
900 MHz FDD (currently GSM, UMTS, LTE)	10 MHz	30 MHz	30 MHz
1800 MHz FDD (currently GSM, UMTS, LTE)	50 MHz	40 MHz	60 MHz
2100 MHz FDD (currently UMTS, LTE)	40 MHz	20 MHz	60 MHz
2600 MHz FDD (currently UMTS, LTE)	40 MHz	50 MHz	40 MHz
2600 MHz TDD (currently UMTS, LTE)	0 MHz	0 MHz	45 MHz
Total bandwidth	160 MHz	160 MHz	255 MHz

FDD: Frequency Division Duplex => Two radio channels are used for a connection

TDD: Time Division Duplex => Only one radio channel is used for a connection

4.2 Frequency categories and block sizes: the market determines the scope of the licence

For the continuing expansion of the existing 4G networks and the construction of the future 5G networks, bidders are to be given an opportunity to acquire frequencies which meet their needs and business plans. Consequently the available frequencies are being put out to tender in small blocks, which gives bidders the greatest possible flexibility in the auction.

The frequencies are divided into blocks of 2 x 5 MHz FDD and 1 x 5 MHz SDL. The frequencies in the 3.5-3.8 GHz band are divided into blocks of 1 x 20 MHz TDD.

For the auction, the available frequencies are being split into a total of 7 categories. The categories differ in terms of frequency range, block size, term of use, conditions of use (cf. 0) and minimum price (cf. table).

Category	Term	Number of blocks	Block size	Minimum price per block
A: 700 MHz FDD	31.12.2033	6	2x5 MHz	CHF 16.8 million
B: 700 MHz SDL	31.12.2033	3	1x5 MHz	CHF 4.2 million
C1: 1400 MHz SDL	31.12.2033	5	1x5 MHz	CHF 4.2 million
C2: 1400 MHz SDL	31.12.2033	8	1x5 MHz	CHF 4.2 million
C3: 1400 MHz SDL	31.12.2033	5	1x5 MHz	CHF 4.2 million
D: 2.6 GHz FDD	31.12.2028	1	2x5 MHz	CHF 5.8 million
E: 3.5-3.8 GHz TDD	31.12.2033	15	1x20 MHz	CHF 1.68 million

FDD: Frequency Division Duplex => Two radio channels are used for a connection

TDD: Time Division Duplex => Only one radio channel is used for a connection

SDL: Supplemental Downlink => Three radio channels are used for a connection

4.3 Description of the individual frequency bands

700 MHz

Of all the frequency bands, this band features the best propagation characteristics for area coverage and penetration of buildings. The characteristics are comparable with the 800 MHz and 900 MHz frequency bands currently used for mobile radio applications. These frequencies are suitable on the one hand for coverage of fairly large and less populated areas and on the other hand for penetrating to the interior of buildings.

2 x 30 MHz are being put out to tender for use with the so-called Frequency Duplex Division method (FDD), as well as a total of 15 MHz for use as additional downlink channels (so-called Supplemental Downlink SDL).

SDL serves to increase the speed and data capacity (the downlink²) of an established terminal connection in the currently used 800 MHz frequency band³. This means that a mobile radio operator must already dispose of assigned frequency resources in the 800 MHz in order to be able to utilise the SDL frequencies in the 700 MHz and 1400 MHz band (see below). All three Swiss mobile network carriers already have the necessary allocations in the 800 MHz band for the use of SDL frequencies.

SDL is a new method to be introduced, which bundles together multiple frequencies (carrier aggregation) to a terminal connection. With SDL, unlike with today's conventional carrier aggregation (FDD and TDD), data communication capacity is increased on the downlink, but not on the uplink⁴. Carrier aggregation of FDD and TDD frequencies is already being used by all network carriers and will also be used with the new frequencies which are being put out to tender.

The 700 MHz frequencies are partly used in neighbouring countries (provisionally until 2022) for digital television. Because of the interference range of these television transmitters, there may be restrictions on use for the Swiss mobile networks. At present, 700 MHz SDL is not yet possible with existing terminals.

1400 MHz

This frequency band - because of the low frequency range - also exhibits very good propagation characteristics.

For the award, a total of 90 MHz is being put out to tender for utilisation by Supplemental Downlink (SDL) in order to increase the download speed and capacity of an established terminal connection (similar to SDL frequency resources in the 700 MHz band - see above).

The frequencies are divided into three sub-categories, since different conditions of use exist. In particular the use of the outer bands may be restricted at the national borders because of the operation of other systems in neighbouring countries. In addition, certain satellite applications must be protected from possible interference due to mobile radio applications. Some new terminal device models can receive signals in this frequency band.

² Data communication from the base station to the terminal

³ At present the use of the SDL frequencies is restricted in the LTE mobile radio standard of ETSI 3GPP in combination with the FDD 800 MHz band. It is expected that in future it will be possible to use the SDL frequencies with combinations featuring other frequencies.

⁴ Data communication from the terminal to the basis station

2600 MHz

These frequencies - because of the higher frequency range - have comparatively worse propagation characteristics in terms of coverage and building penetration. They are, however, suitable for local coverage of areas with higher user densities with the necessary data communication capacities.

One block of 2 x 5 MHz is being put out to tender for use with frequency division duplex (FDD). There was no demand for this block in the last auction in 2012. The remaining 2600 MHz frequencies are currently already in use in the mobile radio networks.

3.5-3.8 GHz

The frequencies in this range were previously available for broadband wireless access (BWA) and for wireless cameras for television production. 90 MHz in the 3.41 - 3.5 GHz frequency range continues to be available for wireless cameras. It is expected that these 90 MHz will be made available to mobile radio in the medium term (presumably in three years).

It is expected that the fifth generation of mobile radio (5G) will initially be launched in this frequency range. Together with the 700 MHz frequencies they represent ideal resources for the introduction of 5G.

These frequencies, because of the even higher frequency position, have worse propagation characteristics in terms of coverage and building penetration than the other frequencies now being put out to tender. However, they are highly suitable for local coverage of areas with high user densities with very high data communication speeds, because of the large total bandwidth of 300 MHz.

Owing to the use of parts of the frequency band by satellite services with equal entitlements, the utilisation of some of these frequencies for mobile radio is limited, in Valais and partly in Geneva for example.

Other frequencies that will become available in the foreseeable future:

Further frequency bands for use with mobile radio, especially in the range above 6 GHz, will be decided at the World Radiocommunication Conference in November 2019 (WRC-19). Subsequently, the internationally harmonised introduction of the corresponding frequency use will be carried out.

4.4 Minimum prices

When radiocommunication licences are awarded by auction, ComCom, as the licensing authority, must set a minimum bid pursuant to Article 39 para. 4 TCA. Moreover, Article 23, para. 1 of the Ordinance on Frequency Management and Radiocommunications Licences (OFMRL) states in this regard that in the case of award of licences by auction, **adequate licence revenue** should be achieved and that the licensing authority may set a minimum bid for this purpose.

The statutory lower limit of this minimum bid is equal to the sum:

- a. *of the licence fees discounted by the industry-standard interest rate congruent with the term, for the full term of the licence; and*
- b. *the administrative fees for the tender process and the award of the licence.*

The ordinance lays only down the amount at which the lower limit of the minimum bid is to be calculated. An upward revision of this may be made when defining a minimum bid.

For frequencies above 1 GHz, ComCom has specified a minimum bid equal to the legally prescribed lower limit. For the frequencies below 1 GHz which are technically advantageous with regard to propagation (700 MHz), a minimum bid which is two times higher than the legally pre-

scribed lower limit has been laid down, in light of the expected high level of interest and the legal requirement for an appropriate return from the auction. In particular, this was also intended to guarantee an efficient auction process.

4.5 Bidding restrictions (spectrum caps)

In order to ensure that there is competition in the mobile telephony market, ComCom has imposed bidding restrictions (spectrum caps) in individual frequency categories. These specify the maximum extent of the frequencies which one bidder can acquire in the corresponding frequency band. The spectrum caps restrict competition in the auction between bidders in order to enable all bidders to acquire adequate spectrum.

The following spectrum caps were set:

- a maximum of three blocks in category A (i.e. a maximum of 2x15 MHz FDD spectrum in the 700 MHz band);
- a maximum of five blocks in categories B and C2 (i.e. a maximum of 25 MHz SDL spectrum in the 700 MHz band and in the 1400 MHz core band); and
- a maximum of six blocks in category E (i.e. a maximum of 120 MHz TDD spectrum).
- furthermore, a cumulative bidding restriction applies which ensures that two bidders together cannot acquire more than five blocks in category A (i.e. a maximum of 2x25 MHz FDD spectrum in the 700 MHz band), as long as there is at least one other bidder who is interested in a block in this band.

These restrictions were imposed so that a financially strong bidder can acquire at most half of the frequencies. Assuming there are three bidders, this means that each operator, given a corresponding willingness to pay, has the possibility of acquiring frequencies for a 5G rollout.

5 The auction

In an analysis, different auction formats which might have been considered for the upcoming award were assessed. The format which could best achieve ComCom's goals was determined to be the simple clock auction (CA) which has now been chosen. This ensures that bidders have the opportunity to configure frequency packages which best suit their business model. In this way, bidders are not exposed to the risk that, at the end of the auction, they will be encumbered with a frequency spectrum in a configuration which they did not wish to acquire, or which does not correspond to their needs. This auction design also permits bidders to switch flexibly between different frequency categories in the course of the auction. In addition, the CA is a transparent, easily understandable auction format.

An experienced auctioneer

DotEcon Ltd, a company which specialises in spectrum auctions, was commissioned to help choose the auction format and to hold the auction. The auction platform on which the sale by auction will be conducted has already been used successfully in more than 25 auctions in countries such as Denmark, Great Britain, Ireland, the Netherlands, Norway, Sweden, Slovenia, Spain and Hong Kong and is being adapted for the Swiss auction. This system allows secure bidding over the internet and has the advantage that the auction can be conducted remotely - i.e. bidders can bid from their company headquarters and develop an infrastructure appropriate to the implementation of their bidding strategy.

To prevent possible collusion and arrangements between bidders, ComCom will only reveal the names of the bidders at the end of the auction, together with the names of the winners, the acquired frequencies and the auction price.

5.1 Simple Clock Auction CA

The CA is a multi-stage auction, which is composed of a clock phase and an assignment phase.

In the clock phase it is determined which (abstract) frequency range a bidder can bid for, taking into account the bidding restrictions. On completion of the clock phase it is therefore clear how many blocks of frequencies the individual participants in the auction have acquired in the different frequency categories and at what base price.

For any blocks which have not been awarded during the clock phase, ComCom may conduct an additional bidding phase if it is of the opinion that this would promote efficient frequency assignment.

The assignment phase takes place after the clock phase and serves to assign the auctioned abstract frequency blocks to a specific location in the frequency band. ComCom's aim is to award frequency blocks which are as contiguous as possible.

6 Provisional timetable

Opening of the tender procedure	6 July 2018
Submission of candidature dossiers	5 October 2018
Authorisation of bidders	Expected in November 2018
Commencement of the auction	Expected in January 2019
Granting of the radio licences	Expected in the 2 nd quarter of 2019

7 Technological development

The continued strong growth in demand for mobile broadband services requires additional frequencies for IMT systems⁵. The reasons for this are the increasing market penetration of smartphones and the growing consumption of data. In addition, an increase in devices and objects with wireless connections to the internet (the "Internet of Things"; IoT) is expected.

At the ITU's World Radio Conference (WRC)⁶ in November 2015, additional frequency ranges for IMT systems were therefore identified. In many countries these frequencies are or will shortly become available for use. The ComCom tender covers a range of 475 MHz in total. For comparison the current assigned bandwidth is 575 MHz.

In order to provide the population with mobile telecommunication services (e.g. mobile internet access), the mobile radio operators in Switzerland use GSM transmission technologies (EDGE enhanced data), UMTS/HSPA⁷ and LTE.

In view of the expected increase in mobile data traffic worldwide, the desire for improved user experience and the opening-up of new business sectors (e.g. time-critical applications, the Internet of Things and eHealth) the industry is developing new high-performance, economical and spectrum-efficient mobile radio standards.

⁵ International mobile telecommunications (IMT), the GSM (2G), UMTS (3G), LTE (4G), etc. family of mobile radio system standards.

⁶ International Telecommunication Union

⁷ HSPA (High Speed Packet Access) is an evolution of UMTS for the provision of higher data rates from the network to a mobile terminal and vice versa.

The next development stages are:

1. LTE-Advanced (LTE-A, LTE-A Pro)

Devices which support this standard are already available today.

The version of the standard (3GPP⁸ Release 13) enables:

- an increase in data capacity and data transfer rates on the existing LTE networks as a result of further developments in
 - multi-antenna technology (MIMO⁹)
 - bundling of multiple radio channels (carrier aggregation) into one data connection
 - a reduction in the transmission time (latency = duration for the transmission of a signal between a terminal and the mobile radio antenna)
- Wi-Fi linking (Licensed Assisted Access) of mobile network and fixed network connections (e.g. to relieve mobile radio networks by shifting traffic onto fixed networks or Wi-Fi)
- improved device connectivity (IoT/MTC/M2M¹⁰)

2. 5G (5G New Radio)

5G designates a further evolutionary development phase in mobile radio networks and has an enhanced air interface (5G NR¹¹). Standardisation of the first phase of 5G will be concluded from mid-2018 (3GPP Release 15), and the second phase (3GPP Release 16) will provisionally be concluded by 2020. The 3.5 GHz and 700 MHz frequency bands are envisaged for the introduction of 5G in the initial phase. Later 5G will be introduced in currently used and additional frequency bands above 20 GHz. For the rapid introduction of 5G, the standard envisages the possibility of connecting 5G base stations to 4G networks (the first phase of 5G: Non-Standalone Solution). Expansion into a service-based architecture of the core networks is essential for the second phase of 5G (Standalone Solution) at the latest.

Essential innovations of the 5G air interface compared to 4G (LTE):

- a significant increase in capacity and data transmission rates (≥ 1 Gbit/s).
- a further reduction in transmission time (latency) by a factor of 30 to 50 compared to LTE plus an increase in the reliability of the connection.
- the maximum number of terminals connected to an antenna is increased substantially. In particular this will meet future requirements in relation to the "Internet of Things" (IoT).

8 The licence

8.1 Term of the licence

The term of the licences has been specified as the end of 2033 for all frequencies. This is intended to give licensees sufficient certainty so that they can recoup the high investment in new technologies. One exception is the block in the 2.6 GHz band which was not awarded in the 2012 auction: for this block the term of the licence is the same as the blocks assigned at the last auction, i.e. to the end of 2028.

⁸ 3rd Generation Partnership Project

⁹ Multiple Input Multiple Output

¹⁰ Internet of Things / Machine Type Communications / Machine to Machine

¹¹ 5G New Radio, the current designation in 3GPP of the enhanced air interface

8.2 Technology-neutral licences

The licences are being awarded essentially in a technology-neutral manner. The licensees are free, within the assigned frequency ranges, to use those mobile radio technologies which they consider most appropriate to the implementation of their business models. The general technical conditions will be laid down in the annexes to the licence.

8.3 Conditions of use

The licences guarantee use of the assigned frequencies for the provision of mobile telecommunications services. Additionally, conditions for population coverage with mobile radio services will be imposed:

- If the licensed utilisation rights include 700 MHz FDD frequencies (category A), the licensee is obliged to cover at least 50% of the population of Switzerland with mobile radio services via its own infrastructure by 31 December 2024 at the latest.
- If the licensed utilisation rights do not include any 700 MHz FDD frequencies, the licensee is obliged to cover at least 25% of the population of Switzerland with mobile radio services via its own infrastructure by 31 December 2024 at the latest.

The aim of these requirements is to ensure that the assigned frequencies are actually used. Any violations would be punished within the framework of a supervisory procedure. However, more extensive provision of the population with high-quality mobile services which exceed the minimum requirements will be achieved within the framework of competition between the mobile operators, as is currently already the case.

8.4 Protection from immissions and spatial planning

As with the current licences, the new licences will also include provisions regarding compliance with the Ordinance on Protection from Non-Ionising Radiation (ONIR). The licences include an obligation which specifies that a location outside the building zone must be used jointly by the licensees if there is sufficient capacity.

The licensee must inform the cantons in advance of their network planning.

With regard to non-ionising radiation, it should be noted that the frequencies which are now being assigned may continue to be used in future for mobile radio. For all these frequencies, many years of experience concerning non-ionising radiation has already been acquired throughout the world.

For example, the 700 MHz frequencies have been used for some time on the mobile radio networks in the USA, the Asia-Pacific region and throughout the world for digital terrestrial television (DVB-T). The new 1400 MHz and 2600 MHz spectrum is located within the range of the frequencies currently used in mobile radio networks. The frequencies in the 3.5-3.8 GHz range are used worldwide for broadband wireless access (BWA and WiMAX) or also with wireless cameras and at sports events. In addition, the 2.4 GHz and 5 GHz frequency ranges, which are used everywhere in countless private WLANs, are located above or below 3.5 GHz and are thus comparable in terms of the radiation effect.