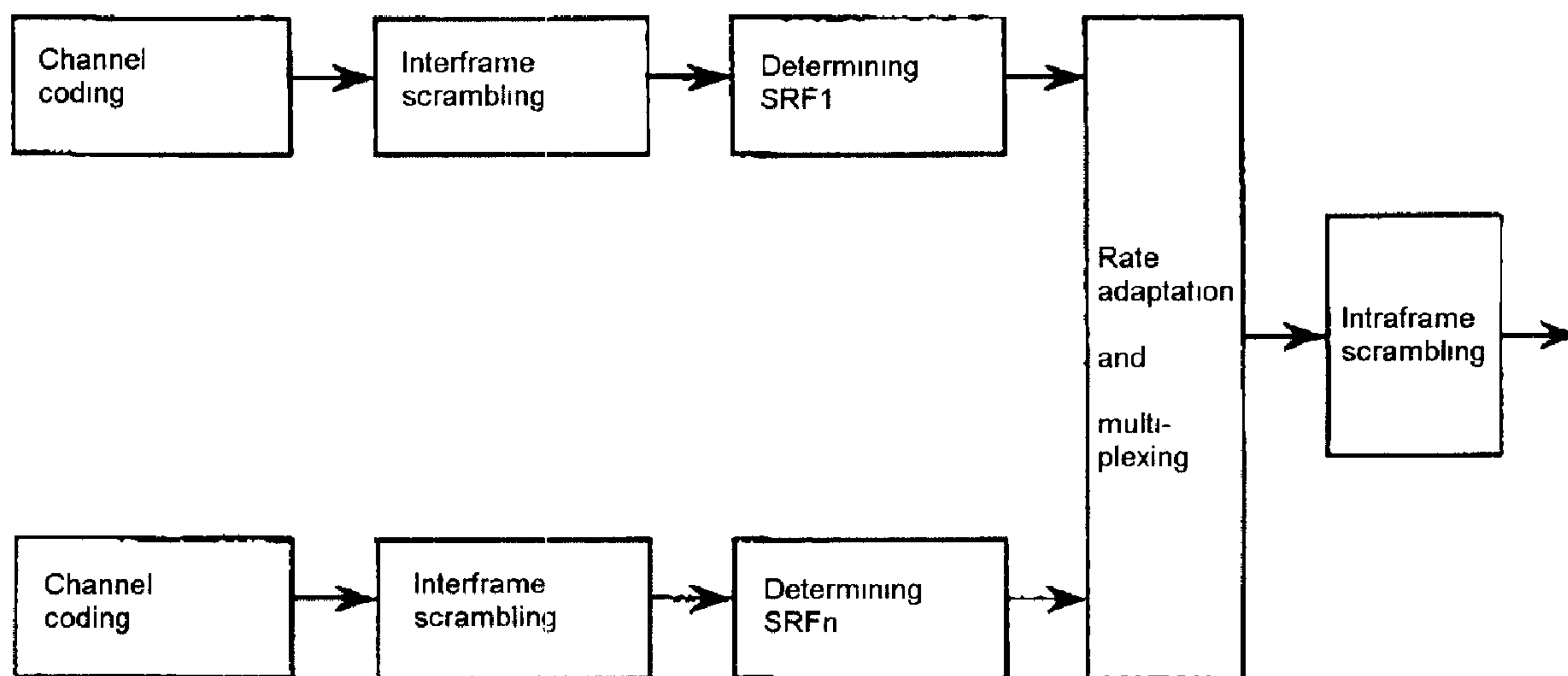




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 (54) Title: METHOD FOR MATCHING DATA RATES



(57) **Abrégé/Abstract:**

According to the invention, a service-specific static rate adaptation factor that controls a service-specific quality of service is determined in a manner already known per se. A dynamic rate-oriented rate adaptation factor is determined for a link, whereby said factor adapts the hypothetical volume of data to a volume of data that is available in the next frame while taking into account the adaptation of the service-specific data rate that is yet to be performed. It is possible to pass through several optimization loops if said data volume is not rigidly predetermined as a result of a sufficient number of transmission channels and spread factors. A service-specific rate adaptation factor is determined by combining the static rate adaptation factor and the dynamic link-oriented rate adaptation factor, whereupon one single and therefore one-step adaptation of the data rate is carried out. Service data is thus compressed or expanded only once with said service-specific rate adaptation factors and inputted into a frame for transmission. The method is suitable for CDMA transmission methods within a UMTS.



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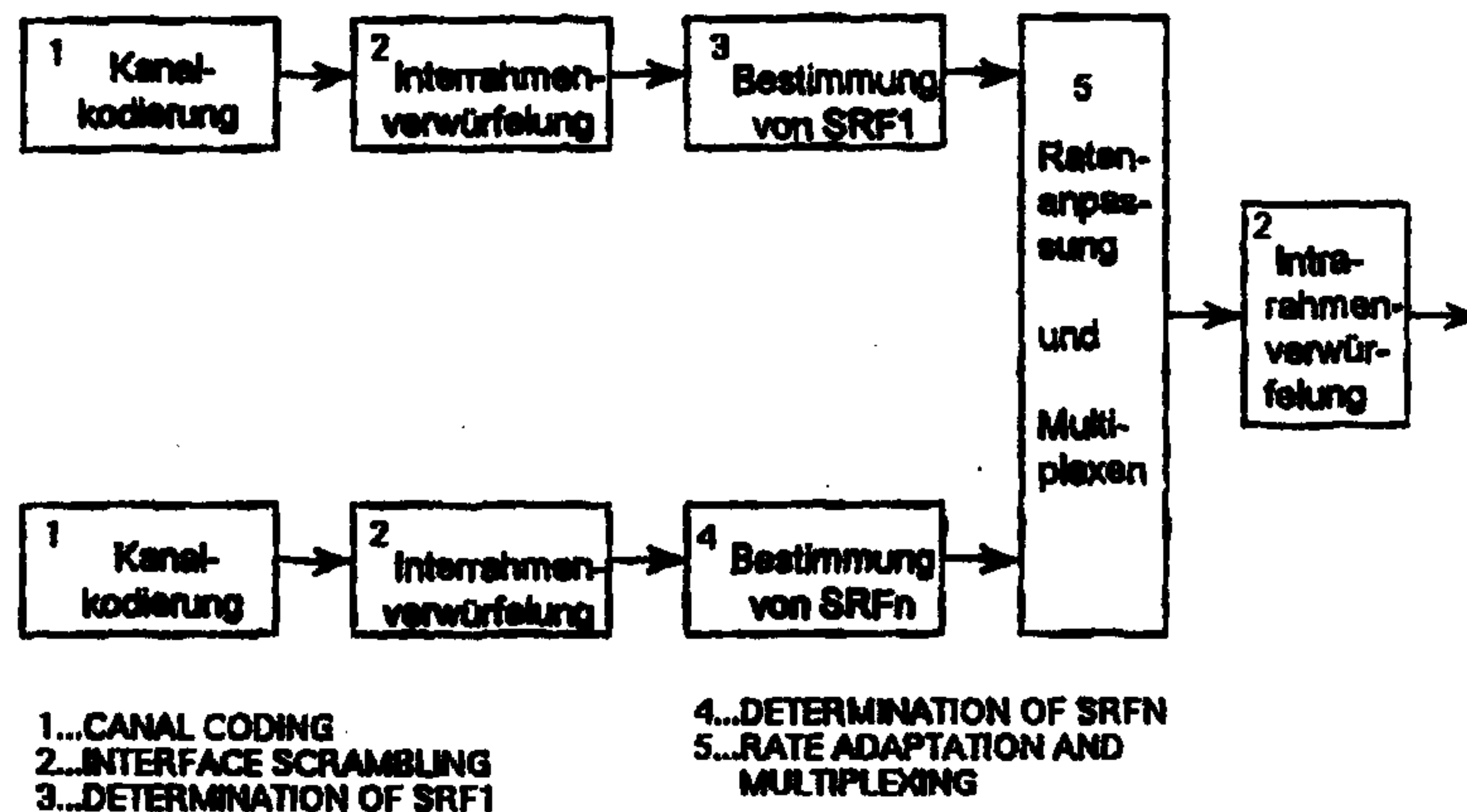
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(54) Title: METHOD FOR ADAPTING DATA RATES IN UNIVERSAL MOBILE TELEPHONE SYSTEMS (UMTS)

(54) Bezeichnung: VERFAHREN ZUR DATENRATENANPASSUNG IN UNIVERSALEM MOBILTELEFONSYSTEM (UMTS)

(57) Abstract

According to the invention, a service-specific static rate adaptation factor that controls a service-specific quality of service is determined in a manner already known per se. A dynamic rate-oriented rate adaptation factor is determined for a link, whereby said factor adapts the hypothetical volume of data to a volume of data that is available in the next frame while taking into account the adaptation of the service-specific data rate that is yet to be performed. It is possible to pass through several optimization loops if said data volume is not rigidly predetermined as a result of a sufficient number of transmission channels and spread factors. A service-specific rate adaptation factor is determined by combining the static rate adaptation factor and the dynamic link-oriented rate adaptation factor, whereupon one single and therefore one-step adaptation of the data rate is carried out. Service data is thus compressed or expanded only once with said service-specific rate adaptation factors and inputted into a frame for transmission. The method is suitable for CDMA transmission methods within a UMTS.



(57) Zusammenfassung

Erfindungsgemäss wird, wie bereits bekannt, ein dienstspezifischer statischer Ratenanpassungsfaktor bestimmt, der eine dienstspezifische Dienstqualität einstellt. Für die Verbindung wird ein dynamischer verbindungsorientierter Ratenanpassungsfaktor bestimmt, der unter Berücksichtigung der noch nicht durchgeführten dienstspezifischen Datenratenanpassung die hypothetische Datenmenge an eine im nächsten Rahmen verfügbare Datenmenge anpasst. Dabei können auch mehrere Optimierungsschleifen durchlaufen werden, wenn diese Datenmenge aufgrund einer ausreichenden Anzahl von Übertragungskanälen und Spreizfaktoren nicht fest vorgegeben ist. Ein dienstspezifischer Ratenanpassungsfaktor wird durch Kombination des statischen Ratenanpassungsfaktors und des dynamischen verbindungsorientierten Ratenanpassungsfaktors bestimmt und erst dann die einzige und damit einstufige Datenratenanpassung durchgeführt. Die Daten der Dienste werden also mit diesen dienstspezifischen Ratenanpassungsfaktoren nur einmal gestaucht bzw. gedehnt und in einen Rahmen zur Übertragung eingetragen. Das Verfahren eignet sich für CDMA-Übertragungsverfahren innerhalb UMTS.

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Description

Method for matching data rates

5 The invention relates to a method for matching data rates for transmitting data via a radio interface between a base station and a subscriber station, especially via broadband radio interfaces which use a CDMA subscriber separation method and simultaneously
10 provide a number of services per call.

 In radio communication systems, messages (for example voice, image information or other data) are transmitted via a radio interface with the aid of electromagnetic waves. The radio interface relates to a
15 connection between a base station and subscriber stations where the subscriber stations can be mobile stations or stationary radio stations. The electromagnetic waves are radiated at carrier frequencies in the frequency band intended for the
20 respective system. For future radio communication systems, for example the UMTS (Universal Mobile Telecommunication System) or other third-generation systems, frequencies are provided in the frequency band of approx. 2 000 MHz.

25 For the third generation of mobile radios, broadband ($B = 5$ MHz) radio interfaces are provided which use a CDMA (Code Division Multiple Access) subscriber separation method for distinguishing between different transmission channels and can simultaneously
30 provide a number of services per call. The problem is how the data of different services of a call are to be time-division multiplexed, i.e. inserted into a frame. The transmission capacity of the radio interface must be utilized in the best possible way, especially taking
35 into consideration a highly dynamic variance in the data rates of the individual services.

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From ETSI STC SMG2 UMTS-L1, Tdoc SMG2 UMTS-L1 221/98 of August 25, 1998, especially pages 15-20, it is known to perform a two-stage data rate matching. First data rate matching is performed after channel coding and is intended to guarantee the service-specific qualities of service since the joint transmission of the data of a number of services makes a common signal/noise ratio mandatory. A second data rate matching after the multiplexing guarantees continuous transmission. The disadvantage of this solution can be seen in the fact that it is not possible to minimize the number of required transmission channels or at least, by spreading, the required transmitting power in the transmission channels. The code efficiency also drops since, in part, an expansion followed by a compression or conversely is performed on the same data. The code efficiency specifies the ratio between the change in the bit error rate (BER) and change in the redundancy of the data, the signal/noise ratio being considered as constant.

According to the invention, a service-specific steady-state rate matching factor which sets a service-specific quality of service is determined as already known. However, the rate matching is not performed using this factor. Instead, a dynamic call-oriented rate matching factor is determined for the call which matches the hypothetical volume of data to a volume of data available in the next frame, taking into consideration the service-specific data rate matching yet to be performed. It is also possible in this case to pass through a number of optimization loops if this volume of data is not permanently predetermined due to there being an adequate number of transmission channels and spread factors.

It is thus possible to optimize the total transmission capacity needed.

In a next step, a service-specific rate matching factor is determined by combining the steady-state rate matching factor and the dynamic call-oriented rate matching factor and only then performing the single and thus single-stage data rate matching. Thus, the data of the services are compressed or expanded by means of these service-specific rate matching factors and are inserted into a frame for transmission.

The steady-state and dynamic rate matching is performed at the same time in one step in which it is only possible to perform the calculation of the factors but not the matching itself in an optimization loop so that the code efficiency increases and conflicting rate matching for the same data is prevented.

If certain frame intervals must be shortened in order to perform measurements (slotted mode), this can already be taken into consideration in the available volume of data.

According to an advantageous further development of the invention, the dynamic call-oriented rate matching factor is set to a minimum value related to the service to be compressed most severely and for this purpose, a number of transmission channels and of spread factors to be used during the transmission is determined in accordance with a predetermined coding rule. Once this has been done, the dynamic call-oriented rate matching factor is then determined as a quotient of the maximum volume of data available for the call and the sum of the volume of data of all services of the call, taking into consideration the respective service-specific steady-state rate matching factors. The minimum value is established so that the code efficiency is not impaired too much. This

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further development of the invention needs minimum resources.

If the dynamic call-oriented rate matching factor is greater than a maximum value related to the service to be expanded most severely, it is advantageous to accept
5 additional data into the frame and to redetermine the dynamic call-oriented rate matching factor. Thus, transmission capacity is not unnecessarily given away.

Before the dynamic call-oriented rate matching factor is determined, the steady-state rate matching factors
10 are advantageously referred to their geometric mean in such a manner that the product of all steady-state rate matching factors of a call is equal to one. Thus, only the lowest possible rate matching is necessary for optimizing the code efficiency when the data rates of the services are similar.

15 A mapping rule for multiplexing the data of the services into a frame to be transmitted is advantageously specified in such a manner that it is simultaneously known to the transmitting and receiving end so that only the volume of data per service is signaled and the arrangement
20 of the data in the frame can be unambiguously duplicated. The rate matching can also be reconstructed from the signaled volume of data.

In accordance with one aspect of this invention, there is provided a method for matching the data rate of a
25 simultaneous radio transmission of data of a number of services of a connection between a base station and a subscriber station, in which data of the services to be transmitted in a frame are compressed and, respectively, expanded using service-specific resultant rate matching
30 factors, wherein the resultant rate matching factor of each service is dependent on a service-specific steady-state rate matching factor which sets a service-specific quality of

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service and wherein the resultant rate matching factor of each service is additionally dependent on a connection-oriented dynamic rate matching factor which matches the sum of the volume of data of all services of the connective to the transmission capacity available in the frame, taking into consideration the respective service-specific steady-state rate matching factors.

In accordance with another aspect of this invention, there is provided apparatus for matching a data rate of a simultaneous transmission of data of a number of services of a connection between a base station and a subscriber station, comprising means for compressing and, respectively, expanding data of each service to be transmitted in a frame with a service-specific resultant rate matching factor, wherein the resultant rate matching factor of each service is dependent on a service-specific steady-state rate matching factor which sets a service-specific quality of service and wherein the resultant rate matching factor of each service is additionally dependent on a connection-oriented dynamic rate matching factor which matches the sum of the volume of data of all services of the connection to the transmission capacity available in the frame, taking into consideration the respective service-specific steady-state rate matching factors.

Exemplary embodiments of the invention will be explained in greater detail with reference to the attached drawings, in which:

Figure 1 shows a diagrammatic representation of a radio communication system,

Figure 2 shows a diagrammatic representation of requirements for three services to be transmitted simultaneously,

Figure 3 shows a block diagram of a rate matching method, and

Figure 4 shows a representation of an optimization loop in the rate matching.

5 The mobile radio system shown in figure 1 as an example of a radio communication system consists of a multiplicity of mobile switching centers MSC which are networked together and set up the access to a landline network PSTN. Furthermore, these mobile switching
10 centers MSC are connected to in each case at least one facility RNM for allocating radio resources. Each of these facilities RNM, in turn, provides for a connection to at least one base station BS. Such a base station BS can set up a call to subscriber stations,
15 e.g. mobile stations MS or other mobile and stationary terminals via a radio interface. Each base station BS forms at least one radio cell.

 Figure 1 shows a connection V for the simultaneous transmission of user information of a
20 number of services S1, S2, S3 between a base station BS and a mobile station MS. An operation and maintenance center OMC implements control and maintenance functions for the mobile radio system or for parts thereof. The functionality of this structure can be transferred to
25 other radio communication systems in which the invention can be used, especially for subscriber access networks with wireless subscriber access.

 In the connection V, the data d1, d2, d3 of three different services S1, S2, S3 are simultaneously
30 transmitted in accordance with figure 2. These three services S1, S2, S3 greatly differ in the possible values and the dynamic range of the data rate. The block sizes B and absolute or relative coding were selected correspondingly.

With reference to Figure 3, channel coding is carried out at the transmission end as the first step in data transmission for each service S1, S2, S3, and is selected for each service individually as a function of the required maximum bit error rate (BER). Then, as an option for each service S1, S2, S3, the data d1, d2, d3 are scrambled over a number of frames fr (interframe scrambling), and the steady-state rate matching factors SRF_i are then determined for each of the services i. A service-specific quality of service is set in the process.

Rate matching is carried out as the next step, with the algorithm that is described in the following text at the same time including the multiplexing of the services. The rate matching and the multiplexing are followed by scrambling of the data within a frame fr (intraframe scrambling).

The service-specific rate matching factors SRF_i for each service i describe expansion or compression of the data, with expansion being achieved by addition of redundancy (for example repetition of individual bits), and compression being achieved, for example, by puncturing. The coding, and hence the addition of redundancy, can also be set adaptively depending on the specific rate matching factors. These service-specific rate matching factors SRF_i do not depend on the amount of data to be transmitted for each service S1, S2, S3 in the next frame fr, but on the channel coding method.

In order to optimize the code efficiency, the service-specific rate matching factors SRF_i are related to their geometric mean value, so that:

$$\prod_{i=1}^n \text{SRF}_i = 1 \quad (1)$$

The calculation of the factors SRF, DRF, RF, SF, m needed for rate matching and multiplexing is explained with reference to figure 4.

Using the minimum spread factor ($SF = 4$), N_{max} bits can be transmitted in a frame fr . Thus, the following inequality can be specified which describes the dependence between the transmission capacity in a frame, given by the number m and the respective spread factor SF_j ($j = 1..m$) of the transmission channels and that required by the data blocks of the n services:

$$DRF \cdot \sum_{i=1}^n B_i \cdot K_i \cdot SRF_i \leq \sum_{j=1}^m N_{max} \cdot \frac{SF_{min}}{SF_j} \quad (2)$$

The right-hand side of equation (2) describes the number of bits per frame fr available with m transmission channels whereas on the left-hand side of the inequality, the capacity required by n services, of which in each case K_i blocks with the block size K_i and the steady-state rate matching factors SRF_i are to be transmitted, is given.

The dynamic rate matching factor DRF introduced in equation (2) provides for the additional uniform expansion and compression of all data in a frame fr . This factor DRF is call-oriented. The equals sign applies if the frame fr has to be filled completely with data in order to avoid a discontinuous transmission (DTX).

When the call-oriented dynamic rate matching factor DRF is determined, it must not drop below a minimum value which is the quotient of the minimum total rate matching factor RF_{min} and the minimum of all steady-state rate matching factors SRF so that the code efficiency is not impaired too much by puncturing.

$$DRF \geq DRF_{\min} = \frac{RF_{\min}}{\underset{i}{\text{Min}}(SRFi)} \quad (3a)$$

According to the preceding inequality (3a), the calculation of the minimum value DRF_{min} is valid for the special case where the same minimum total rate matching factor RF_{min} applies to all services *i*. In general, however, individual total rate matching factors RF_{min} can also apply to different services *i*. Thus, for a certain service *i*, for example, the case may occur that no puncturing is performed (RF_{min} = 1) whereas puncturing is still performed for other services *i*. Depending on the coding method used, an individual minimum total rate matching factor RF_{min} can thus be allocated to each service *i*. To take this variability of the service-dependent total rate matching factor RF_{min} into account, the inequality (3a) is expanded in the following manner:

$$DRF \geq DRF_{\min} = \underset{i}{\text{Max}} \left(\frac{RF_{\min, i}}{SRFi} \right) \quad (3b)$$

20

Analogously, neither should a maximum value be exceeded which is the quotient of the maximum total rate matching factor RF_{max} and the maximum of all steady-state rate matching factors SRF so that not too much transmission capacity is given away by repetition.

25

$$DRF \leq DRF_{\max} = \frac{RF_{\max}}{\underset{i}{\text{Max}}(SRFi)} \quad (4)$$

Using equation (2), the values for *m*, SF_{*j*} and DRF which allow optimum utilization of the physical channels can thus now be calculated in dependence on *B_i*, *K_i* and SRF_{*i*}. For this purpose, it is only necessary to establish an unambiguous order of spread-spectrum

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codes between transmitter and receiver, which are allocated in dependence on the total number of bits to be transmitted in a frame fr. This mapping rule is

established throughout the system or is signaled at the beginning of a call.

In the text which follows, a boundary condition is assumed which stipulates occupation of the least number of transmission channels possible. In this case, it holds true that when $m > 1$, all transmission channels apart from one transmission channel must have the minimum spread factor SF_{min} . It should be emphasized that the coding rule according to equations (5) to (7) is one of a number of possible examples since other boundary conditions can also be assumed.

Using the minimum permissible value of the dynamic rate matching factor DRF_{min} from equation (3a, 3b), the following is obtained for the required number of channels m ($\lceil \] =$ rounding-up operator):

$$m = \left\lceil \frac{1}{N_{max}} \cdot DRF_{min} \cdot \sum_{i=1}^n B_i \cdot K_i \cdot SRF_i \right\rceil \quad (5)$$

and the spread factors

$$SF_m = \left\lfloor \frac{SF_{min} \cdot N_{max}}{DRF_{min} \cdot \sum B_i \cdot K_i \cdot SRF_i - (m-1) \cdot N_{max}} \right\rfloor \quad (6)$$

where $\lfloor \]$ is the rounding-down operator to the next possible spread factor

$$SF_j = 4 \text{ for } m > 1 \text{ and } j = 1..m-1. \quad (7)$$

The dynamic rate matching factor DRF is now recalculated in deviation from its minimum value DRF_{min} :

$$DRF = \frac{N \max \left(m-1 + \frac{SF \min}{SFm} \right)}{\sum_{i=1}^n B_i \cdot K_i \cdot SRF_i} \quad (8)$$

Instead of the product $B_i \cdot K_i$, a volume of data N_i can also be used if there is no block-by-block transmission or the block size B_i is equal to one bit.

To impair the code efficiency as little as possible, the expansion or compression should be restricted to the minimum required, with the consequence that the dynamic rate matching factor DRF should be as close as possible to 1. This means that in the case of discontinuous transmission, the possible transmission capacity must be completely utilized if, as a result, the compression can be reduced. Even with discontinuous transmission, a value is taken from equation (8) as long as it is less than or equal to 1. If $DRF > 1$, DRF is set to 1.

Knowing the dynamic rate matching factor DRF means that the resultant rate matching factor R_{Fi} can be specified for all services i :

$$R_{Fi} = DRF * S_{FRi} \quad (i=1..n) \quad (9)$$

If $R_{Fi} > 1$ for a service i bits are repeated and if $R_{Fi} < 1$, puncturing is performed. In each case, only one of the two methods is used by the rate matching in one step for the data d_1, d_2, d_3 for each service.

Combining steady-state and dynamic rate matching automatically minimizes the number m of transmission channels needed and, at the same time, maximizes the spread factors SF in order to generate as little interference as possible. Thus, the implicit dynamic rate matching also has an advantageous effect if DTX is permitted.

Optionally, if the dynamic rate matching factor is

DRF > DRFmax, individual blocks of those intended for transmission and temporarily stored in a wait loop can be selected and added to the blocks already allocated to the frame fr. The factors SRF, DRF, RF are
5 recalculated in the sense of an optimization loop. If the number m of transmission channels does not need to be increased and the spread factors SF do not need to be reduced, the block can be transmitted in addition to the other data.

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CLAIMS:

1. A method for matching the data rate of a simultaneous radio transmission of data (d1, d2, d3) of a number of services (S1, S2, S3) of a connection (V) between
5 a base station (BS) and a subscriber station (MS), in which

data (d1, d2, d3) of the services (S1, S2, S3) to be transmitted in a frame (fr) are compressed and, respectively, expanded using service-specific resultant rate matching factors (RF),

10 wherein the resultant rate matching factor (RF) of each service is dependent on a service-specific steady-state rate matching factor (SRF) which sets a service-specific quality of service

and wherein the resultant rate matching factor
15 (RF) of each service is additionally dependent on a connection-oriented dynamic rate matching factor (DRF) which matches the sum of the volume of data of all services (S1, S2, S3) of the connective (V) to the transmission capacity available in the frame (fr), taking into
20 consideration the respective service-specific steady-state rate matching factors (SRF).

2. The method as claimed in claim 1, in which the dynamic connection-oriented rate matching factor (DRF) is set to a minimum value (DRFmin) related to the service
25 (S1, S2, S3) to be compressed most severely and for this purpose, a number (m) of transmission channels and of spread factors (SF) to be used during the transmission is determined in accordance with a predetermined coding rule, and thereupon the dynamic connection-oriented rate matching
30 factor (DRF) is redetermined as a quotient of the maximum volume of data available for the connection and the sum of

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the volume of data of all services (S1, S2, S3) of the connection (V), taking into consideration the respective service-specific steady-state rate matching factors (SRF).

3. The method as claimed in any one of claims 1 or 2,
5 in which, if the dynamic connection-oriented rate matching factor (DRF) is greater than a maximum value related to the service to be expanded most severely, additional data (d1, d2, d3) are accepted into the frame (fr) and the dynamic connection-oriented rate matching factor (DRF) is
10 redetermined.

4. The method as claimed in any one of claims 1 to 3,
in which the data (d1, d2, d3) of the services (S1, S2, S3) are inserted in a frame (fr) in accordance with a predetermined coding rule which is oriented toward a minimum
15 number (m) of transmission channels for the connection (V).

5. The method as claimed in any one of claims 1 to 4,
in which, before the dynamic connection-oriented rate matching factor (DRF) is determined, the steady-state rate matching factors (SRF) are referred to their geometric mean
20 in such a manner that the product of all steady-state rate matching factors (SRF) of a connection (V) is equal to one.

6. The method as claimed in any one of claims 1 to 5,
in which the volume of data per service (S1, S2, S3) is signaled for each transmitted frame (fr).

25 7. Apparatus for matching a data rate of a simultaneous transmission of data (d1, d2, d3) of a number of services (S1, S2, S3) of a connection (V) between a base station (BS) and a subscriber station (MS),

comprising means for compressing and,
30 respectively, expanding data (d1, d2, d3) of each service

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(S1, S2, S3) to be transmitted in a frame (fr) with a service-specific resultant rate matching factor (RF),

wherein the resultant rate matching factor (RF) of each service is dependent on a service-specific steady-state rate matching factor (SRF) which sets a service-specific quality of service

and wherein the resultant rate matching factor (RF) of each service is additionally dependent on a connection-oriented dynamic rate matching factor (DRF) which matches the sum of the volume of data of all services (S1, S2, S3) of the connection (V) to the transmission capacity available in the frame (fr), taking into consideration the respective service-specific steady-state rate matching factors (SRF).

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PATENT AGENTS

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Fig. 1

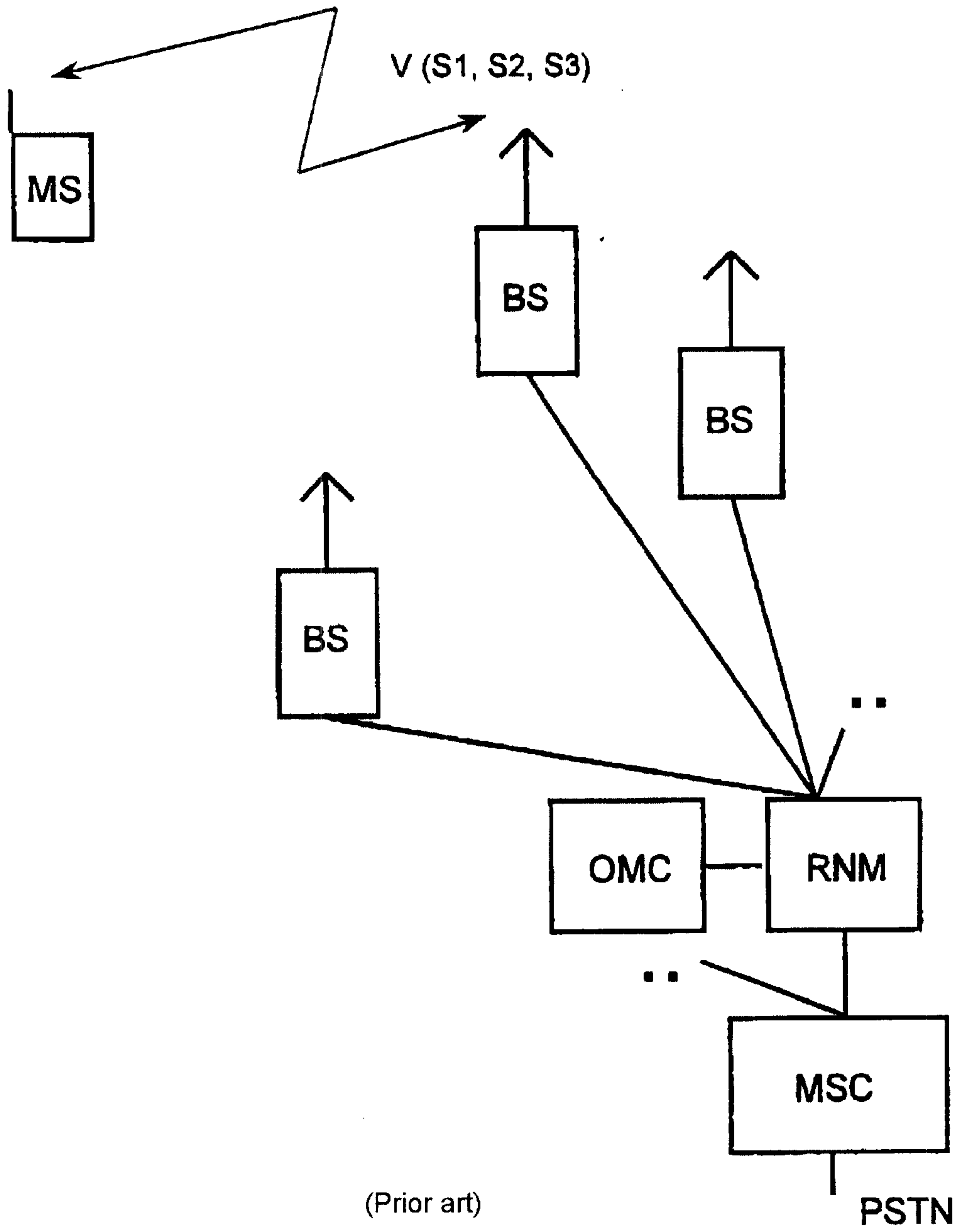


Fig. 2

	Maximum gross data rate	Minimum gross data rate	Dynamic range	Block size	Coding
Service S1 (d1)	200 kbps	40 kbps	Only two possible rates	400 bit	Absolute with 1 bit
Service S2 (d2)	1200 kbps	0 kbps	High	600 bit	Relative
Service S3 (d3)	80 kbps	80 kbps	Constant data rate	800 bit	Not required

Fig. 3

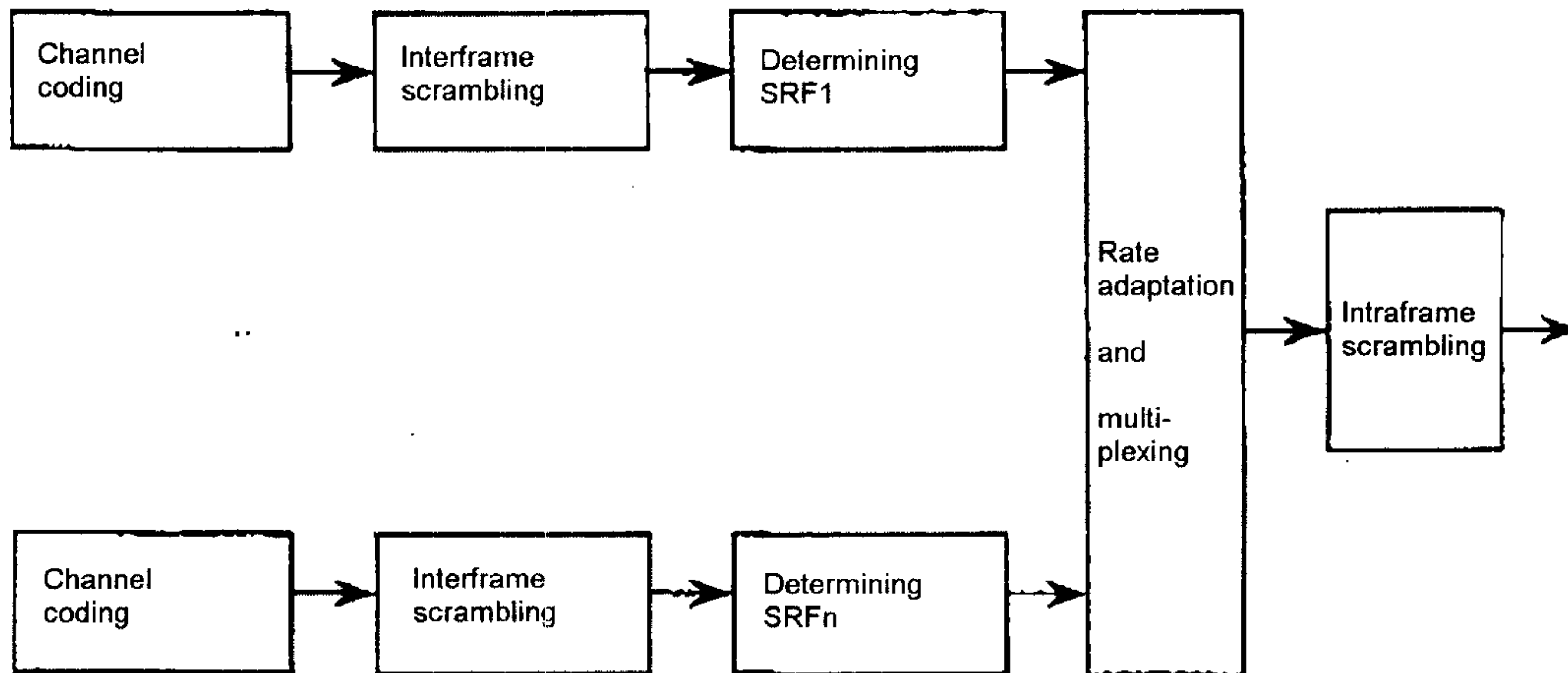


Fig. 4

