System for Transmission of Data Flow in Data Communication Networks

The invention pertains to a system for transmitting data flow in data communication networks, for example in cellular networks or in stationary multi-computer networks.

In recent years, parallel with the traditional cellular networks for voice communication, there has been an increase in the development of widely-varying cellular networks for the mobile transmission of data. The significance of these networks may be perceived from the fact that some network service providers are already making inter-continental networks available.

These networks, however, present to some degree considerable differences in regard to their underlying technology, their fee structure, and the geographical area which they cover. Beyond this, the network subscriber or network user often requires specific interfaces for individual user programs.

Owing to the existing heterogeneous cellular infrastructure, and since the mobility of today's users frequently dictates that network subscribers go beyond the coverage area of one cellular network and move into the coverage area of another, it is often necessary to operate with varying data-communication networks simultaneously.

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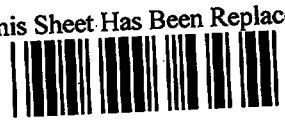
Generic transmission systems which only allow specifically-defined communication with a single physical network are already known. In the simplest instance, this type of system consists of a highly-specific applications program interface (API); in the most complex case they provide a standard protocol for data transmission to the user. There is, however, no known system of this type which integrates the varying physical networks under a single standard protocol.

It is therefore the object of the present invention to provide a generic system which makes it possible for users to be able to select freely between the most varying networks, with as little technical expenditure as possible, and with minimal initial costs for equipment as well as operational costs, in order, for example, to respond to limited geographical coverage areas or to be able to move freely in terms of fees charged.

It is an additional goal that a mobile network subscriber's change from one mobile network to another should remain completely seamless for users in a stationary network or in another mobile network subscriber, in other words, that this change takes place exclusively between a stationary gateway and the mobile subscriber.

As a solution to achieve this objective, the system in accordance with the invention provides: a user level, through which each network subscriber communicates and which is independent of a particular physical network; a network level possessing a network protocol which is independent of physical networks; a network integration unit, which integrates at least

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two varying physical networks and allows these networks to appear as one physical network at the network level; and also a network interface, which is configured between the network integration unit and the network level.

Network subscribers may be, for example, stationary or portable data processing equipment or test devices.

The network interface in accordance with the invention is designed as a common interface to all physical wireless networks. This arrangement is characterized first of all through a structural form which is simple to implement technically. In addition, the uniform application of communication protocols is made possible with this system.

Furthermore, the structural configuration in accordance with the invention is characterized by the fact that a network subscriber may still be reached under the same address at the network level after a change of the physical network.

In order to provide the best possible support to network subscribers for their individual applications and in their user areas, the varying mobile data communication networks may be wholly integrated by means of the system in accordance with the invention, and are accessible for user programs from a standardized interface.

With the system in accordance with the invention it can be additionally so provided that the network integration unit is configured at the network level. This architecture makes possible an especially cost-effective structuring of the transmission system.

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Furthermore, the system in accordance with the invention can be configured so that the network integration unit provides network attributes which make it possible for the network integration unit to address a network subscriber through varying physical networks. On the basis of this addressing, the varying physical networks may be easily and efficiently administered.

Furthermore, the system in accordance with the invention can be configured so that a modification of a network attribute takes place automatically by means of a network manager, which in turn operates in accordance with an attribute management protocol and translates the network attribute(s) upon the transition from one network to another. The advantage of this form of execution may be seen in the fact that the network subscriber is required to perform only minimum adjustments, for instance a change in the radio unit, and is hence totally relieved of these activities.

Furthermore, the system in accordance with the invention can be configured so that the network integration unit is implemented as a computer program. In this way, an especially cost-effective implementation of the system is made possible, since no technical-hardware measures are required, but rather only the installation of one or more computer program modules.

Furthermore, the system in accordance with the invention can be configured so that a mobile network subscriber communicates with network subscribers in any number of wireless networks and

fixed networks through at least two different wireless networks. In this manner, the wireless networks serve as intermediaries between the mobile network subscribers and the fixed network subscribers.

Furthermore, the system in accordance with the invention can be configured so that the communication between wireless networks and fixed networks is conducted through a gateway. In this manner, several wireless networks and fixed networks can be connected simultaneously to a single gateway. In addition, several network interfaces can be applied simultaneously at one gateway, whereby each of these interfaces forms a logical network. In this way, different user groups can be isolated from one another.

Furthermore, the system in accordance with the invention can be configured so that the protocol of the network level is the so-called Internet protocol. By use of the Internet protocol, the network user is relieved of the necessity of dealing directly with the physical characteristics of the networks through which a data flow is transported, or with those of the paths which the data flow follows on its way to its goal. The advantage of the use of this protocol is to be found above all in the fact that it is a widely-spread standard protocol in the world of open computer communications.

The user should have only one logical view of the network topology. This can be described by an addressing scheme in which a so-called Internet protocol address is assigned to each interface of the network subscriber, for example that of a computer. These addresses typically consist of a so-called "network ID," which designates the network in question, and a so-called "host ID," which designates the host in this network.

Configuration of the logical structure on the physical structure takes place during system configuration. Here, the system administrator assigns an Internet protocol address for each network interface to which the computer has access.

In addition, the system administrator establishes the network interfaces through which data packets addressed to computers in other networks are to be sent.

The essential features of the invention will now be explained through the embodiment examples in the following illustrations, and within the framework of a comparison with the relevant state of the art. Specifically,

Fig. 1 depicts the functional method of a network integration with a generic device in accordance with the current state of the art;

Fig. 2 depicts a network change in accordance with current state of the art;

Fig. 3 depicts the communication of an application in a mobile unit with an application in a stationary network in accordance with an embodiment of the invention; and

Fig. 4 depicts the structure and functional method of the network integration unit in accordance with the invention.

In Fig. 1, the functional principle of a network integration on the basis of the Internet protocol in accordance with the current state of the art is represented. This protocol has established itself as the standard in open data communications and forms the basis of a world-wide data network, the so-called Internet. Through this definition, the different terminology as well as the concepts may be more clearly discerned and described.

For this purpose, an essential primary concept of the Internet protocol shall be discussed first. The basis of addressing is found in the Internet addresses 4, which consist of four bytes, and which are formed by the network address and the so-called host address. The value of the network and the host portion in the address 4 may be defined through so-called network masks. Such addresses are typically represented as a decimal quadruple, such as 19.123.6.1, whereby each element is the decimal representation of a byte. Each network interface (represented by a broken line) is assigned a unique IP-address 4. Generally, a computer retains several network interfaces of this kind, for example one for communication through a token ring 5, one for communication with an Ethernet 6, etc.

Figure 1 describes a situation with two such interfaces 7, 8. The networks 5, 6 in each case as well as their interfaces 7, 8 are a portion of the physical level, including the corresponding linking protocol. The token ring interface 7 may have as its address, for example, 19.123.6.1, and the interface Ethernet may have the address 19.123.7.6, whereby in each instance the first three bytes represent the network address,

and the host address consists only of the last byte. When addressing another computer, network level 3 (IP-level) decides which network interface is to be selected, based on "consistent network addresses." In the case of a computer with the IP-address 19.123.6.128, the IP-level selects the token ring interface, since the network addresses of the token ring interface and that of the computer to be addressed are consistent.

This example makes it clear that Internet addresses represent the "physical topology" of the computer linking in each case, since with a changing of the physical linking of a computer, for example, with a change from token ring 5 to Ethernet 6, its IP-address (not represented) is also always changed. This required change of the IP-address is independent of whether the IP-level 3 is able to administrate so-called "routing tables," which direct IP-data flows through a third computer as necessary.

It should be added that the application levels (not represented here) in each instance are linked through the corresponding IP-levels 3. It is through these levels that individual network users are linked with the transmission devices.

It shall now be clarified, based on Fig. 2, how the movement of a network subscriber from one physical network to another network is implemented in accordance with the current state of the art, that is, without an integrating network interface.

In this structure, the fixed side possesses multiple network interfaces 11, 12, and specifically one interface for each participating physical network 13, 14. Each of these interfaces possesses its own IP-address 15 and implements the formation of the IP-protocol onto exactly one physical network 13, 14.

In order to better describe the necessary processes, let it be assumed that a MOBITEX interface 11 with the IP-address 19.18.71.1 and a MODACAM interface 12 with the IP-address 19.18.72.1 are employed. For these addresses 15, the first three components represent in each instance a network address.

For communication with a mobile unit through the MOBITEX network 13, the mobile interface (not represented) shall possess the IP-address 19.18.71.10. Corresponding to the addressing mechanisms as described above, the communication between an application in a stationary network and the mobile data terminal will be conducted through the MOBITEX network interface 11, since the network address of the MOBITEX interface is consistent with the mobile IP-address in the first three quadruples.

Upon a change of networks from MOBITEX 13 and over to MODACOM 14, an action must be performed on the stationary side so that communication will be conducted through the MODACOM network interface 12 from this point. In accordance with the addressing principles in the Internet protocol 3, this can only be achieved through a change in the IP-address of the mobile unit. This has as a consequence, however, that the mobile unit changes its identity in the sense of the Internet protocol 3,

that is, for communication with the mobile unit, applications in the fixed network must use another IP-address, which conforms to the MODACOM interface 12 in accordance with the previous executions, for example, to the address 19.18.72.10. In this case, a change of the network 13, 14 is no longer seamless for the application in the fixed network or for the other mobile network subscribers.

Figure 3 describes the mechanisms in accordance with the invention for communication of one application on a mobile unit 21 with an application in a fixed network 22 through the integrating network interface 28 presented here. Based on this illustration, the possibilities of seamless roaming between different networks 24, 25 will be made clear.

For this purpose, let it be assumed that the mobile terminal unit 21 may currently be reached through a mobile MODACOM network 25, 26. The integrating network interface 23 on the fixed side 22 shall have the IP-address 19.18.70.10, and the mobile terminal unit 21 shall have the address 19.18.70.65, whereby in each instance the first three bytes represent the network address, so that upon addressing of the of the mobile unit 21, the IP-level 27 transfers the data to be transmitted together with the IP-address information 23 to the network interface (not represented).

At this point—in contrast to customary network interfaces—no immediate linking onto a single physical network 24, 25 or 26 takes place, but rather in an initial step the physical network is first selected, through which the terminal unit 21 can be reached. In this case, it is the MODACOM network 26.

It is not until a second step that the linking to the selected physical network 24, 25 takes place. Hence, in the case of the MODACOM network 25, the MODACOM-specific address information or network attributes of the so-called logical link identifier (LLI), the X25 address of the radio network gateway (RNG), together with MODACOM-specific authenticating information, are determined and communication is conducted with these linking parameters through the MODACOM network 25.

The selection of the "active" physical network can be controlled in a differing manner for each mobile terminal unit 21. In the most simple case, this is performed by the system administrator, who conducts the change from one physical network to another through input into configuration files or similar procedures. However, due to the explicit transactions required by the administrator, a different procedure is to be preferred.

The basis for this procedure is a minimal protocol between the network interfaces on the fixed and on the mobile sides. For this, when the unit is switched on or upon activation of the communication units in question, for instance a MODACOM cell modem 26, a MOBITEX cell modem or a GSM hand-held phone, the mobile side 21 automatically communicates to the network interface 23 on the fixed side 22, through which physical network 24, 25, and in what manner it is to be reached.

If the user of the mobile terminal unit 21 should now leave the coverage area of the MODACOM network 25 (in Germany, for example) and move into an area covered by a MOBITEX network 24,

in The Netherlands for example, this is completely seamless for the application on the mobile side 21, as well as on the fixed side 22. This is demonstrated by the following discussion of procedures and protocols.

In an initial step, the user on the mobile side 21 activates his MODACOM cell unit 26 and the corresponding network interface 28. Upon activation of the network interface 23 on the mobile side 21, a minimal control protocol is run to the network interface 23 on the fixed side 22, with which the network interface 28 on the fixed side 22 is informed of the change of the physical network 24, 25. It is critical here that the IP-addresses of the participating network interfaces 23, and especially the one located on the mobile side, are not changed in any manner, so that the change of the physical network 24, 25 remains completely invisible for the IP-protocols 27 and all levels lying beyond it.

In Fig. 4, the architecture and the functioning method of the network integration unit 28 are represented. For this, it is again assumed that the mobile unit has the IP-address 19.18.70.65, and may be reached at this time through the MODACOM network 25. This information is administered in the network integration unit 28 in the form of a network attribute. Along with this information on the active network, other attributes are administered here as well, such as address-information for all of the physical networks for which the mobile unit is actually registered.

Corresponding to this attribute allocation, a flow-control 32 conducts the IP-data flow through the physical MODACOM network to this mobile unit, whereby the MODACOM address attributes for MODACOM-specific addressing are used.

If the mobile unit leaves the covered area of the MODACOM network or changes for other reasons to a MOBITEX network, an authentication 33 can be achieved by the network integration unit 28 upon the first linking attempt by use of a password. After successful authentication, the individual network attributes are modified by an attribute administrator 31 in such a manner that MOBITEX is designated as the active physical network, with the appropriate address information. After this, the flow control 32 conducts the IP-data flow correspondingly through the MOBITEX network.

If the mobile unit should go into an area not covered by any network, the flow control 32 informs the attribute administration 31 of this through a corresponding return acknowledgment of the physical networks, so that the active network is undefined, and the flow control 32 disables the IP-data flow to the mobile unit entirely. In a similar manner, the flow control 32 possesses the capability, after an extended passive period of the mobile unit, of not regarding it as active until a new authentication is made.

So-called adapter modules (not represented) serve for adaptation of flow control 32 to the different physical networks, making a uniform internal interface available upstream, and which however use specific API's of the physical networks downstream.

The over-all architecture of the network integration unit grants a high degree of flexibility and expandability of the system in accordance with the invention.

Beyond this, the functioning methods of the system as well as the interaction of the structural components which make it up are an objective of the invention.
The corresponding procedures were described in detail in the preliminary description.

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1. A system for the transmission of data flow in data communication networks (5, 6, 13, 14, 24, 25, 26) with

an application level, through which each network subscriber communicates and which is independent of specific physical networks (5, 6, 13, 14, 24, 25, 26);

a network level (27), to which a network protocol belongs, which is independent from physical networks (5, 6, 13, 14, 24, 25, 26);

a network integration unit (28) which integrates at least two different physical networks (24, 25) and which allows these networks to appear to the network level as a physical network; and

a network interface (23) which is configured between the network integration unit (28) and the network level (27).

2. A system in accordance with Claim 1, which is characterized by the fact that the network integration unit (28) is arranged on the network level (27).

3. A system in accordance with Claim 1 and /or 2, which is characterized by the fact that the network integration unit (28) provides network attributes which make it possible to address a network subscriber through different physical networks (24, 25).

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4. A system in accordance with one or more of the Claims 1 through 3 which is characterized by the fact that a modification of the network attribute takes place automatically by means of a network-attribute manager, which operates in accordance with an attribute management protocol and which, upon passing from one network into another, translates the attribute(s) accordingly.

5. A system in accordance with one or more of the preceding Claims which is characterized by the fact that the network integration unit (28) is implemented as a computer program.

6. A system in accordance with one or more of the preceding Claims which is characterized by the fact that a mobile network subscriber (21) communicates through at least two different cellular networks (24, 25) with network subscribers in cellular networks and fixed networks as desired.

7. A system in accordance with one or more of the preceding Claims which is characterized by the fact that the communication between cellular networks and fixed networks is conducted through a gateway.

8. A system in accordance with one or more of the preceding Claims which is characterized by the fact that the Internet protocol is used as the protocol of the network level (27).

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9. A system in accordance with Claim 8 which is characterized by the fact that user programs on the fixed network subscriber side (22) address a mobile subscriber through the use of a single Internet protocol address (23).

10. A system in accordance with Claim 8 and/or 9 which is characterized by the fact that the Internet protocol address (23) is independent from the physical network through which the network subscriber (21) is moving.