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Enhanced Data Rates for Global Evolution EDGE Classic & EDGE Compact for ANSI-136 Networks

Nokia's vision for a service platform
supporting high-speed data applications

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Executive summary

With the business of wireless data expected to grow in the region of 100–200 % per annum, the consensus in the mobile communications industry is that wireless data services will form the foundation for future business. The success of short messaging in mobile networks demonstrates that people accept the benefits of non-voice services.

Many wireless data applications today can be implemented with 9.6 kbps data. However, bandwidth-hungry fixed line data applications – Web browsing, access to corporate data bases, and so on – would benefit from higher transmission speeds when used over the mobile network. Further, bringing cost-effective wireless access to Internet applications that deliver bursty data traffic will require a packet-based air interface, on top of the current circuit switched mode of operation.

The ANSI-136/TDMA system will meet the mass-market deployment demands of these wireless multimedia applications through the simultaneous introduction of General Packet Radio Service (GPRS), a packet switched network, and 136HS, an air-interface standard based on EDGE (Enhanced Data Rates for Global Evolution). The combination of 136HS and GPRS is commonly referred to as EGPRS-136HS in ANSI-136/TDMA systems and will be deployed as an overlay on the existing ANSI-136/TDMA system.

There are two variants of 136HS in ANSI-136/TDMA systems, EDGE Classic and EDGE Compact. 136HS will be available in both 850 MHz and 1900 MHz ANSI-136/TDMA systems. EDGE Classic is the same as EDGE in GSM systems and is designed for systems with a spectrum of 2.4 MHz or more. EDGE Compact, on the other hand, is designed for ANSI-136/TDMA systems where the amount of available spectrum for initial deployment of the wireless data solution is limited to 1 MHz. EGPRS-136HS will provide the same advances in ANSI-136/TDMA systems as that offered by EGPRS in GSM systems, namely higher data rates and “always on-line” direct Internet connectivity. This will enable greater sophistication as end-user services move towards personal multimedia.

In this document, the term EDGE is used to refer to both EDGE Classic and EDGE Compact. The term EGPRS is used to refer to EGPRS-136HS.

The use of the same basic technology, EGPRS, in both TDMA and GSM systems makes global data roaming possible between these two systems and also leads to the possibility of convergence of ANSI-136 and GSM systems.

EDGE, a new radio interface technology with enhanced modulation, increases the data throughput of ANSI-136/TDMA systems to over 473 kbps per carrier. EDGE, expected to be deployed in 2001, is a major step in providing 3G services over ANSI-136/TDMA systems. As an overlay solution to existing

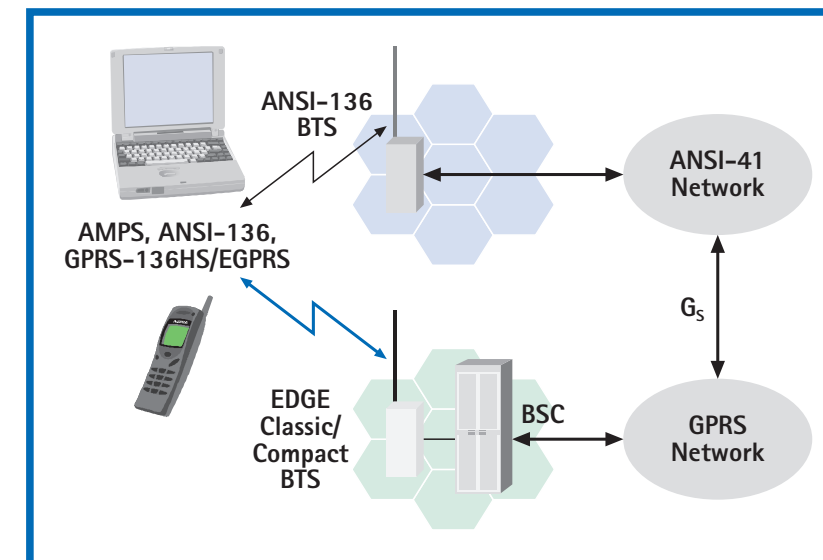
ANSI-136/TDMA networks, EDGE does not require modification to the existing ANSI-136 30 kHz air-interface. EGPRS-136HS network elements will be overlaid on top of existing ANSI-136/TDMA networks, and will provide packet data services that will add to the circuit switched services that are currently provided by the ANSI-136/TDMA networks.

EGPRS is especially attractive to ANSI-136/TDMA operators that do not have additional spectrum allocated for UMTS, but still wish to offer competitive personal multimedia applications using the existing band allocation. Additionally, EDGE can co-exist with UMTS, for instance, to provide high-speed services for wide-area coverage while UMTS is deployed in urban hot spots.

EDGE is also expected to evolve to support voice services in addition to the data services. Nokia is an active participant in the ANSI-136/TDMA system architecture evolution discussions, in the relevant standards forums, regarding Voice over EDGE over the air-interface and VoIP over the core packet switched network.

Wireless data is a steady evolution, not a revolution. Nokia is dedicated to supporting ANSI-136/TDMA operators with wireless data solutions that help them create value in the market place, both now and in the future. Wireless data operators can use Nokia’s experience in building skills and know-how that will be needed to attain market leadership in the personal multimedia era. This White Paper describes Nokia’s understanding of the role and benefits of 136HS/EDGE as wireless data evolves towards personal multimedia.

Figure 1. EGPRS-136HS data overlay in a ANSI-136 system



EDGE

Technical standards are being developed to support mobile services in ANSI-136/TDMA systems with radio interface data rates of up to 473 kbps. This work is being performed by the UWCC (Universal Wireless Communications Consortium) and ETSI.

The major change in the ANSI-136/TDMA standards to support higher data rates are the new modulation schemes, known as 8-PSK (Phase Shift Keying) and GMSK (Gaussian Minimum Shift Keying). With 8-PSK, it is possible to provide higher data rates with a somewhat reduced coverage, whereas GMSK will be used as a robust mode for wide area coverage.

EDGE Classic

The EDGE Classic air-interface is based on the EDGE standard developed by ETSI. EDGE Classic is ETSI-EDGE with minor modifications, primarily information related to ANSI-136, that enable it to be overlaid as a packet data carrier on top of the existing ANSI-136 30 kHz air-interface. Examples of such information are pointers to the ANSI-136 Digital Control Channels (DCCH) covered by the EDGE cell and some of the broadcast information available on the ANSI-136 DCCH. A class B ANSI-136 terminal (a terminal with ANSI-136 voice and EDGE packet data) needs this information when camping on the EDGE packet data channel in order to originate and terminate circuit-switched services, e.g., incoming and outgoing voice calls.

Operators who can set aside 2.4 MHz of initial spectrum for data applications can overlay EDGE Classic on top of their existing ANSI-136 air-interface.

EDGE Compact

EDGE Compact uses the same modulation scheme as EDGE Classic. However, there are certain key differences that enable it to be deployed in less than 1 MHz of spectrum. The key characteristics that differentiate EDGE Compact from EDGE Classic are:

Inter base station time synchronization

A key characteristic of EDGE Compact is that the base stations are time synchronized with each other. This makes it possible to allocate common control channels in such a way as to prevent simultaneous transmission and reception. This creates a higher effective reuse, necessary for control signaling, e.g., 3/9 or 4/12.

The base station synchronization is carried out such that the timeslot structure is aligned between sectors and the hyper-frame structures are aligned between all sectors.

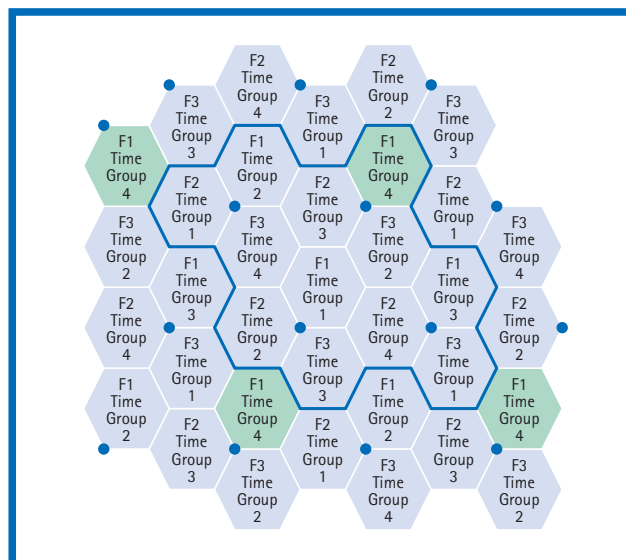
Time Groups and Discontinuous transmission

Each base station site is typically allocated at least three frequencies, one per sector, using a 1/3 frequency re-use pattern. Inter base station time synchronization makes it possible to create time-groups within every frequency. Each sector is assigned one time-group. EDGE Compact is capable of supporting up to four time-groups per carrier. The typical re-use configurations with three carriers are:

- 3/9 re-use using three out of the four time-groups
- 4/12 re-use using all four time-groups

When a sector belonging to one of the time-groups transmits or receives common control signaling,

Figure 2. Time Group concept in EDGE Compact

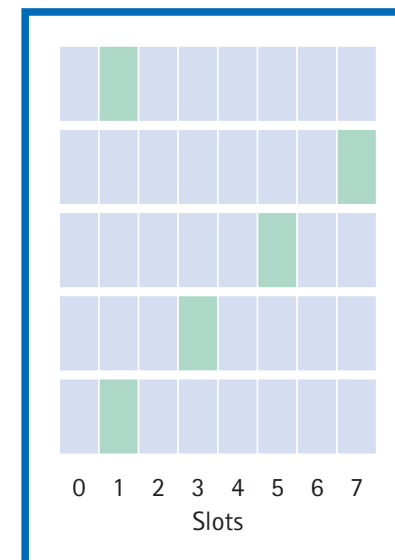


the sectors belonging to other time-groups are idle, i.e., are silent in both uplink and downlink. It is worth noting that the data traffic is carried over these same frequencies without using the time group concept. This results in a 1/3 re-use pattern for data traffic.

- New logical control channel combination based on a standard 52 multi-frame
- Time Group rotation of Control Channel.

EDGE Compact time group (Control Channel) rotation always occurs from frame number 3 to 4 within a 52-frame multi-frame. The pattern of rotation, as shown below, in a physical channel's timeslots, is as follows: 1, 7, 5, 3, 1... This rotation makes neighbour channel measurement feasible when the mobile station is in the middle of a packet transaction.

Figure 3. Time Group rotation in EDGE Compact



EDGE Brings More Speed and Capacity when Needed

In mature markets, cellular data penetration is forecast to increase exponentially during the early 2000's. New wireless data applications and innovative terminal types will generate completely new markets. In a Yankee group survey, over 77 % percent of corporate respondents said that the minimum data speeds required to make mobile data viable was 56 kbps. Aggressive operators can expect to obtain up to 30 % of their air-time and revenue from wireless data by 2000.

It is also possible for EDGE to evolve to provide a voice service. EDGE transceivers would then be capable of carrying multiple speech calls per time slot, increasing voice capacity. Also, high quality codecs, e.g 32 kbps,

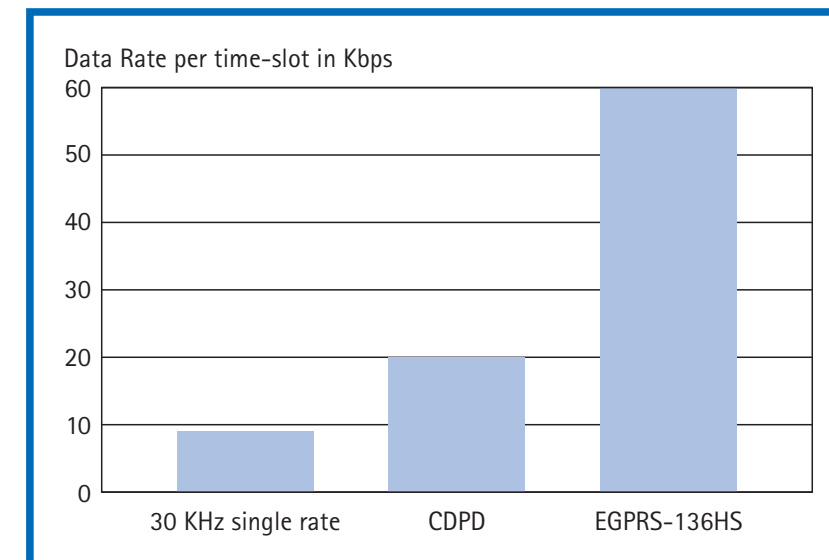
would be feasible. EDGE, as a voice solution, looks especially interesting for indoor systems because of its easily increased capacity.

EDGE Boosts Data Rates

The EGPRS standard, for EDGE Classic and Compact, is scheduled for completion in the first quarter of 2000. It is expected that packet data will dominate circuit switched data in future ANSI-136/TDMA data networks, calling for EGPRS solutions with high flexibility and spectral efficiency. Also, high data rate real time services are seen as important for applications such as video retrieval and video telephony.

EDGE will provide very high data rates over the 200 kHz carrier. The data rates being specified provide raw data rates of up to 60 kbps/timeslot. The aggregate

Figure 4. Data Rate evolution in ANSI-136/TDMA systems



data throughput of all timeslots in a EDGE carrier could exceed 473 kbps. The EDGE features will enable enhanced modulation to adapt to radio circumstances and hence offer the highest data rates in good propagation conditions, whilst ensuring wider area coverage at lower data speeds per timeslot.

EDGE Complements UMTS

EDGE will allow operators without a UMTS (Universal Mobile Telephone System) license to stay competitive in wireless data markets. However, operators can also use EDGE for gradual roll-out of high-speed data services and for wide area coverage, where UMTS would be used for urban areas.

EDGE Builds On Existing ANSI-136 Network

The introduction of EGPRS as an overlay to the existing ANSI-136/TDMA network ensures that EDGE builds on the operator's existing investment. EGPRS capable terminals receive ANSI-136 services over the existing 30 KHz radio channels, in addition to the new services enabled by GPRS and EDGE.

EDGE Data Applications

With EDGE, ANSI-136/TDMA will deliver personal multimedia and will enable new high-speed data applications.

Enhanced General Packet Radio Service

The dominant data networking protocol, on which most data network applications are running, is TCP/IP, the Internet Protocol. All Web applications are run on some form of TCP/IP, which is by nature a protocol family for packet switched networks. This means that EGPRS is an ideal bearer for any packet switched application such as an Internet connection. From the end user's point of view, the EGPRS network is an Internet sub-network that has wireless access. Internet addressing is used and Internet services can be accessed. A new number, the IP address number, is introduced with the telephone number. From the Internet's point of view, the EGPRS network is just one sub-network among many others.

Typical EGPRS applications are:

- On-line E-mail
- Web
- Enhanced short messages
- Wireless imaging with instant pictures
- Video services
- Document and information sharing
- Surveillance
- Voice over Internet
- Broadcasting.

Market potential

Gradually, non-voice services are expected to account for one third or more of traffic and revenues. This will not happen overnight, however, as wireless data is an evolution, not a revolution. Thus a step-by-step approach to educating the market and introducing more sophisticated services is vital. EDGE provides a boost to data speeds using the existing ANSI-136/TDMA network, allowing the operator to offer personal multimedia applications before the introduction of UMTS. The time between EDGE and UMTS introduction clearly improves the business case for EDGE and may prove to be instrumental in gaining a long-term advantage over competitors.

As wireless data becomes available to all subscribers and they demand a full set of high-speed services and shorter response times, EDGE will provide an operator with a competitive advantage. EDGE also enables data capacity to be deployed when and where demand dictates, minimising the investment required.

Added Benefits with EDGE

For the Operator

Migration to Wireless Multimedia Services

The operator can increase data revenues by offering attractive new types of applications to end-users.

Improved Customer Satisfaction

Increased data capacity and higher data throughput will decrease response times for all data services, thus keeping end users satisfied and connected.

Possibility of Early Market

Deployment of Third Generation Type Applications

EDGE networks are expected to emerge in year 2001, when mature markets are likely to start demanding multimedia applications.

Quick Network Implementation

EDGE will be deployed as an overlay in ANSI-136/TDMA systems and will therefore require minimal changes to the existing network. Further, EDGE capability can be introduced to the network gradually.

For the End User

Improved Quality of Service

Increased data capacity and higher data throughput will decrease response times for all data services, thus keeping end users satisfied and connected.

Personal Multimedia Services

Attractive new types of applications and terminals will become available.

Potentially Lower Price Per Bit

The lower cost of data capacity for high-speed data applications gives the operator flexibility in pricing.

Conclusions

EDGE will provide the solution for operators wanting to offer personal multimedia services early and who need to increase the data capacity in their ANSI-136/TDMA network prior to UMTS deployment. EDGE is especially valuable for operators that do not deploy UMTS.

EDGE will not replace existing investments or services but will upgrade them to a highly competitive level through gradual investment.

EDGE rollout can satisfy increased data demand and produce increased revenues by first launching EDGE services in urban and office environments for business users and then providing wider area coverage as private usage takes off.

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