Universal Access to Mobile Telephony as a Way to Enhance the Autonomy of Elderly People

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ABSTRACT
The rise of mobile telephony has opened a vast diversity of new opportunities for older people with different levels of physical restrictions due to ageing. Mobile technology allows not only ubiquitous communications but also anytime access to some services that are vital for elderly people's security and autonomy. Nevertheless, with the numerous advantages, remote services can also introduce important social and ethical risks for this group of users. This paper tries to analyse the novelties that mobile technology may introduce into the lives of older users, points out some dangers and challenges arising from the use of these technologies and revises some future applications of the present mobile technologies.

Categories and Subject Descriptors
C.2.1 [**Computer communications networks**] Network Architecture and Design. *Wireless communications,*

D.2.2 [**Software engineering**] Design Tools and Techniques. *User Interfaces.*

General Terms
Design, Security, Human Factors, Standardization.

Keywords
Universal Design, Ubiquitous Computing, Mobile communications, Assistive technology.

1. INTRODUCTION
The enormous social change that the development of mobile telephony has supposed for many people is well known. The possibility of establishing communications from anywhere and at anytime, without the need of being linked to a fix telephone, has opened a great variety of new possibilities for personal communication, information, employment and leisure. This is even more real for people that have particular physical or cognitive limitations due to ageing. Many older people have experiment a great enhancement of their possibilities of carrying out an independent life just transporting and using a mobile telephone.

In next sections diverse use cases of mobile telephony by elderly people are analyzed. The objective is to urge the incorporation of older people's needs to the design process, which is only possible in the framework of the "universal design" approach. This proposal is made from the conviction that the advantages of this technology will materialize -and its risks will be avoided- only if they are taken into account in the design of both, equipment and services, provided through mobile communication networks.

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2. ACCESS TO WIRELESS COMMUNICATIONS FOR OLDER PEOPLE
Older users expect from mobile communications fully reliable personal communications and services to improve, as much as possible, their safety and quality of life. This is not very different from what the generic user expects from these services. Where are the differences? Mainly in a greater user dependence on this services and in some specific interface requirements.

The only way to obtain equipment and services that fulfil these expectations is to take into consideration elderly users needs though the whole design process. There are many methodologies to collect and analyze users needs, but to have a clear and intuitive picture of the requirements that older users have and the context in which these requirements appear, the analysis of some typical scenarios in which common uses and the surrounding circumstances are well described results very adequate.

Therefore, in next section some scenarios of use are described in detail, to help us in the identification of elderly user's requirements for mobile telecommunications. Concretely some situations in which the mobile telecom user might be found will be illustrated:

- "On the telephone"
- "You have a message"
- "I am lost"
- "I need help"
- "I don't feel well"

These basic scenarios will eventually expand into more complex ones according to the presence of disabilities or other particular circumstances. A deep analysis of these scenarios will allow us to find the needs, procedures of use, barriers, etc., that older people can find when they use these services.

3. SCENARIOS WHERE OLDER USER CAN EXPERIMENT PROBLEMS TO USE MOBILE PHONES

3.1 "On the telephone" Scenario

This scenario is related to the most frequent use of mobile communications. The user just wants to speak to somebody. This is, apparently, a very simple situation, but when it is more deeply analyzed it is found that certain people in specific environments can experiment serious difficulties.

In this scenario the user has to locate the phone, to hold it, to somehow dial the number, to be able to talk and hear during the conversation, to hang it up and, probably, to place the phone somewhere. Due to their difficulty to perform one or more of these tasks some users hardly fit in this scenario. Even if the generic problems are not very different from those experienced over fixed networks[1], in the mobile environment new features and services are available.

The use of many mobile terminals is extremely difficult and consequently many older users do not feel able to handle them. Even if badly designed terminals, with too many buttons, small displays and complex operating procedures are still very common, good design practices that reduces these problems significantly are expanding. Currently there exist terminals with large displays, that keep most common functions easy to use, but there is still great room for improvements. The enhancement of the in the last years, is probably due to the market significance of this user group.

In addition, older people with particular disabilities can experiment extra difficulties to use mobile phones:

- Hard of hearing users experience important problems when using GSM mobile phones or DECT wireless terminals [9]. These are due to the interference between the phone radio frequency transmissions and the hearing aids. These effects can be minimised if they are considered in the design phase of both the phone and the hearing aid.
- Users with mobility restrictions is one of the human groups for which mobile phone can be, in principle, more beneficial. A mobile phone can be the most natural element to communicate with their friends or relatives or to contact emergency services in case of need. In this case, the biggest problem is not the conversation itself, but the possibility of starting and ending it. Most of these users have very limited control over their hands, which makes difficult picking up the terminal, holding it and dialling in the common way.
- Users with visual limitations can also have some accessing problems when using mobile phones for voice communication. Some of these users may profit from a complete hands free terminal.
- People with severe confusion problems could also benefit largely from mobile communications. In this case, the external aspect of the user interface must be kept much simpler than in all the cases above, but the internals may require great complexity. This is the case in situations where the system has "to decide", with little user participation, whom to call. This situation will be explained in greater detail in the "I am lost scenario" below.

3.2 "You have a message" Scenario

In this scenario the user is informed that a message is available in the voice mailbox. Operators perform in different ways when messages are available. Basically all of them will send the associated terminal a text notification indicating the presence of the message[2]. Some operators will later make an automatic voice call to the user informing her or him that some messages are available and giving instructions on how to listen them[3].

Older users usually do not like text messages and prefer voice notification. For these users it is important to keep the options in the mailbox management system as simple as possible. As indicated above, the best solutions can only be implemented if the way in which the operator handles the mailboxes can be adapted to the specific user needs.

In addition, if the users have specific disabilities:

- Hard of hearing users can listen to messages if they can handle regular voice conversations but will generally prefer to be notified by text messages although, it is not uncommon that they would like both types of notifications.
- Low vision users should obviously be notified by voice.
- For mobility restricted users, the main problem is usually to select among the different options given to them by the mailbox management system. In this case it is important not to place too short[4] limitations in the time the users can take to select a command. It is preferable if these parameters can be modified by the user.
- In the case of users who experiment large confusion problems voice mail is probably not a good idea independently of its implementation.

Furthermore, some elderly users with specific disabilities may want to communicate using text messages. Text messaging in mobile networks has become increasingly popular in the last years[5]. But text messages have their own accessibility problems. These problems are very well known because they are just a variation of the computer access problems that were common before the multimedia era.

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[1] Roe [13] and von Tetzchner [17] present good revisions of these topics.

[2] Except in the case of analogical networks, that may not be able to send text messages.

[3] If a terminal can read text messages using text to speech it can generate the voice notifications without operator intervention. See the "Text message scenario" for a more detailed discussion on this topic.

[4] Users with severe mobility limitations must be taken into account in the definition of what "too short" means.

[5] A good revision of the motivations for this and the ideas that operators may follow to encourage text message use is available in http://www.gsm.org/technology/sms_03.html

It is interesting to note that some ideas originally developed for users with strong mobility restrictions like *word prediction* [5] and *reduced keyboard disambiguation* [11] have reached the mainstream market through their application in mobile telephony. The size requirement of an ordinary mobile phone rules out standard QWERTY keyboards for text input and, thus, the standard 9 or 12 keyed keyboard must be used for this propose. When this is done all users are in the same situation that people with motor impairments are and they must employ techniques that users with little control over their mobility have been using for years. That means that all the approaches invented to reduce the number of keystrokes required to write a word have become important to the public in general[6]. This process will be beneficial for older users in the long run as it will make word prediction and disambiguation techniques improve.

In principle, voice recognition is an attractive alternative for composing messages. This is much more complex than the design of voice controlled terminals that have only to deal with command recognition. For this application the system has to be able to recognise dictated text. The technology for this purpose, although currently available, is still not fully reliable and its processing requirements are above those available in mobile terminals. This situation will hopefully change in the near future.

3.3 "I Need Help" Scenario

Sometimes the user may need some kind of assistance, although we are not including in this scenario the cases in which the user safety may be in risk. The situations where the user is lost, or the user experiments health problems, are dealt in specific scenarios. The "I need help" situation is reserved for those cases where the user needs information about the network operation, phone numbers, etc. That is, the cases where the user needs generic help[7] and also the cases where the user wants to contact a standard emergency service[8]. For users with no significant disabilities this aspects are well covered in most networks as they provide specific numbers for network help, generic help and emergency. Even for these users there is an important problem when roaming, as different networks use different numbers for these services. Sometimes these numbers can be used from any terminal, at least in the operator country whilst, in other cases, they can only be used within the specific network. This situation is annoying when help is needed and especially in the case of older people. A good solution could be to provide specific keys: a relatively large button in the terminal to ask for help in emergency situations and a smaller one to ask for network and generic help.

Another generic problem is related to multilinguality as many people, and specifically many older people, will like to be answered in their own language when they need help.

[6] As an example, the Tegic T9 algorithm is based on ideas that have been known in the Assistive Technology community for years [see http://www.tegic.com]. Although, we are not questioning in any way the originality of the specific details of the Tegic patent (U.S. Patent No. 5,818,437).

[7] Like in asking for a taxi, making an hotel reservation, changing a flight, etc.

[8] Such as the "112" emergency service in Europe.

3.4 "I am lost" scenario

When the user is lost and needs assistance, mobile telecommunication devices can be of great help. All cellular networks provide mechanisms that allow the course localisation of the terminal. In some situations, e.g. when the user wants to know by which road is she or he driving, this information could be sufficient but for most common situations this is not the case. GPS satellite based positioning system provides worldwide absolute positioning within less than 15m[9]. Currently mobile terminals embedding GPS receivers are already available and some operators are starting to offer this type of services. It is necessary to remind that other solutions for localisation are also possible.

In principle, everyone could benefit by being able to ask for help in finding a specific route or, being able to ask for a taxi in the street without having to explain the pick up location. Of course the same arguments hold for calling and ambulance, the fire station or the police. Elderly users who experiment some confusion could find these functions especially attractive if they could be used in very simple ways. The user interface for this type of device must be studied very carefully if they are to be useful.

3.5 "I Don't Feel Well" Scenario

This scenario is closely related to those described in 3.3 and 3.4. If the user is able to dial the help numbers (or to press the specific emergency button) and to handle a conversation the services outlined in the preceding scenarios are sufficient. Even if the user was only able to push a button, help could be brought to the right place if localisation functions are available in the terminal and the network. But, what kind of help should be brought? How to handle the worst situations where the user is not even capable of pushing the emergency button? To provide an integral emergency service, these questions have to be answered. This type of service is especially useful for older people living alone.

To answer the above questions the user must wear some health-monitoring device. This devices could, in principle, analyse health parameters like heart rate, breathing rate, blood pressure, etc., and trigger and alarm to the emergency service when and emergency situation is detected and the user is not able to do so. The mobile terminal would send the health parameter information together with the user position thus making possible to bring the right kind of assistance to the right place very quickly. The success of these systems depends greatly on the design of non-invasive sensors which are comfortable and aesthetically acceptable by the users and on the provision of full control over what type of monitoring the user wants, and the possibility of cancelling it without triggering any alarm.

4. OLDER USERS REQUIREMETS

4.1 Areas of impact

From the analysis of the previously described scenarios we can conclude that the requirements that mobile communication systems for older people should met are related to one or more of the following areas of impact:

[9] The intentional degradation of GPS signal was removed on May 1st 2000.

- *Personal communication.* One of the most important needs of people with restricted movement is easy and ubiquitous access to personal communication. Elderly people with motor restrictions can experiment serious difficulties to use wired telephones. These difficulties are mainly due to the need of reaching its position in a limited period of time to be able receive a call, and the frequent inadequate location that can make wired telephones hard to use. Thus, for these users mobile technology enhances their chances of personal communication avoiding the previous restrictions to some places and some times in the day.
- *Security.* Many older people experiment motor restrictions that can led them to potentially risky situations that increase when they try to carry on an independent way of life. Situations of illness and home accidents require a quick and reliable communication channel to obtain urgent help.
- *Social integration.* In the last years wired telephones have contributed to enhance social inclusion and autonomy of many older users. But, in very isolated regions, where standard telephones are not available, mobile telephones are the only way to reach services that contribute to socialisation. Even if the access to these services does not need structural modifications, the prices charged to people using them should especially be considered and subsided, to promote their social integration and to avoid the discrimination of people living in these disfavoured regions.
- *Autonomy.* As it has been mentioned in the previous paragraphs, the combination of personal communication, security and access to integrative services gives to older people more opportunities to carry out an independent way of life.

5. SOCIAL CHALENGES AND CLICHÉS

5.1 Challenges for Older Users of Wireless Communications

The provision of services through mobile telephony can also led to social and ethical risks for older users[10]. Let us summarise the most critical of them.

- *Social isolation.* The provision of personal communication and security help through mobile systems is frequently accompanied by a reduction of direct human relations with relatives, friends and care personnel. For this reason some users may feel that the technology they are provided impedes the human relations they previously had and, consequently, they reject this technology.
- *Lost of personal autonomy.* Some services that monitor the health status or the location of the users for security may also incur in invasion of their capacity of taking decisions.
- *Lost of privacy.* The tendency to establish communication in open places (an increasingly frequent habit that many users do not even realise) makes private communications being heard by estranges. In many cases, older users can not chose the place where they use this service or may not be conscious about the openness of their communications.
- *Economical barriers.* Even if mobile services were fully accessible, there is still another important barrier: the economical one. Many of the special requirements that older users have using mobile telecommunications imply slower communication and longer use, resulting in higher prices for the same service.

The introduction of new telematic services and mobile equipment should include a deep investigation of the social and ethical impact over older users (similarly to the studies about possible environmental impact asked to potentially contaminant industries). This study should clearly point out the critical aspects that have to be avoided, and also describe the compensatory dispositions that have to be taken to avoid negative effects over their lives [1].

5.2 Are Older People Able and Willing to Use Wireless Technology?

People trying to introduce technological advancements to help older citizens have to overcome some extended clichés: the lack of ability of the hypothetical users to handle complex devices, and also their acceptability.

The last one is frequently formulated as "older people reject technology". Nevertheless, there is no evidence that older people dislike the use of novel technology in a larger measure than other people do (except, of course, very young people that are usually enthusiastic about technology). If there exists rejection, it is frequently due to the low quality of the interface, automatic teller machines being a paradigmatic example. Moreover, some studies show that adequately trained older people are in general able to use technology[11]. The origin of this cliché can be found in the fact that technological aids have frequently been introduced without a deep study of user needs, an adequate training period, and a good support service and, in many cases, substituting human care. These conditions lead to a certain failure and, consequently, the rejection.

The other frequent cliché is formulated in this way: "technological devices are too difficult to be used by older people". Many experiences show just the opposite. Designers who have had contacts with older people are surprised of the rapid adaptation and the level of efficiency that these users are able to reach in short time when the device adequately fulfils their needs. If the user-system interface is appropriately designed, there is not reason for a misuse of the device. We can also say that bad designs are difficult to be used not only by older people, but also by every one. As Thimbleby wrote, "Thus badly designed systems handicap all users" [19],

6. HOW TO DESIGN WIRELESS TECHNOLOGY FOR OLDER PEOPLE

6.1 Ergonomic factors and user needs assessment

The accessibility to mobile telephony is also conditioned by the ergonomic limitations of the handsets. Sometimes, mobile

[10] Interesting studies about ethic and social problems for disabled and older users are provided by Colon [4], Taipale [14] and Takkar [16]

[11] S. Bjørne et al, in their paper "Attitudes and Acceptance" [19], refutes the myth of the technological incompetence and disinterest of older and disabled people to use technology from experiments carried out in England, Portugal and Norway.

handsets are very difficult to handle and include an enormous number of functions, very seldom used, that makes the operation very complex[12].

Another possible cause of the misfit, and therefore rejection of telematic help systems, can be a deficient evaluation of user needs. Frequently the emergence of new technological advancements move engineers to imagine hypothetical benefits for older people if these technologies were applied to solve presumed user needs. These assumptions, when they are not based on in-depth studies about users interests, needs, wishes, likes, etc. lead to misconceptions that produce systems not suited for the target user group and hence they are rejected. Only serious studies about user needs[13] can result in systems that satisfy the true user needs and will therefore have the possibility of being accepted by them.

6.2 Design for all

The approach to enhance the accessibility of computer based devices has frequently be to patch commercial standard devices to adapt them to the special features of determined users. This craftsmanship procedure is being substituted by a design philosophy that tries to consider from the beginning the requirements of all the possible users. This design philosophy, usually called *universal design*, has proved to be very valuable not only to include more people in the use of the designed equipment, but also to enormously enhance its usability for everyone. Devices *designed for all* are easier to handle, learn, understand and use for all the users.

Nevertheless, it is very important to consider that sectors of the population that are not able to use the systems *designed for all* will possibly remain. So, it is essential that products and services are designed in such a way that, when necessary, they are open to possible adaptation for specific user needs. Moreover, for those users that cannot use these adaptations, specific services and equipment should be provided.

6.3 Use of guidelines

Design guidelines are frequently used for the storage of knowledge and the transmission of successful experiences among designers. Sets of guidelines also help to maintain coherence in large design teams. The design of wireless fully accessible telecommunication systems can profit from the previous experiences and design-validated recorded as guidelines. Among the many types of guidelines that exist, the ones devoted to the design of inclusive systems are vital for the design of devices and services accessible to everybody, including older and disabled users [3].

I this way, mobile telephone terminals have to improve very much to be fully accessible for older people[14]. Designers have many useful guidelines that can help them in the design of telematic services and equipment [5] [6]. As an example, the booklet published by the RNIB[15] on behalf COST 219 bis[16] offers clear guidelines to improve the usability of mobile handsets[17] [7]. These guidelines give useful advice about key issues, such as ergonomics of the handset, including the visual display and keyboard, the need of on-line audio help, volume control, wireless connection to other devices via infrared port, and so on.

We must insist in the idea that all the enhancements in the accessibility of mobile telephone handsets are also useful for everyone. Moreover, frequently people make use of the mobile phones under some conditions that put them in similar situation to older or disabled users. For instance, a user of mobile telephone in the car, thus, without the possibility to look at the display, has the same requirements for the mobile terminal than a blind user.

7. MIXED TECHNOLOGIES FOR FUTURE WIRELESS TELECOMMUNICATIONS

The impressive influence of mobile telephony on older people lives will be multiplied by the use of combined technologies. Let us show some of the most challenging possibilities in this area.

7.1 Text Telephony

Digital telephones can transmit coded characters. If the telephone handset has any type of textual keyboard, the typed characters can be shown in the receptor's display. A difference with the fax communication, this textual communication is interactive, giving the interlocutors the possibility of dialoguing.

In some countries, text telephony is frequently used by deaf people for personal communications [8]. When a text telephone is used, it is necessary that at the other end there is either another text-telephone, or a relay service that acts as a translator for not deaf people. Other possibilities of communication, using voice-to-text and text-to-voice translation are under research, due to the difficulty presented by speaker-independent continuos discourse speech recognition with telephony voice quality.

The mobile text telephone can not only fulfil the needs of communication of deaf people. It can also help heard of hearing older people having understanding difficulties to obtain help from special services. In this way, they can use their mobile text telephone to make consultations on line, ask for clarifications, etc.

Usually text telephone includes alphanumeric keyboards, containing a large number of keys. But recently, some studies have been carried out about the use of the classic telephone keypad for text transmission, and how to cope with the ambiguity

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[12] "Number storing, redialing, credit card management, call waiting, call forwarding, autoanswering, number screening, and on and on are constantly being squeezed onto the real estate of a thin appliance that fits in the palm of your hand, making it virtually impossible to use. Not only do I not want all those features; I don't want to dial the telephone at all. Why can't telephone designers understand that none of us want to dial telephones? We want to reach people on the telephone!" N. Negroponte [12].

[13] Such as the one mentioned by S. Collins et al. in "Telecommunications Needs as Expressed by Elderly People and People with Disabilities" [19]

[14] "A telephone handset is probably the most redesigned and overdesigned appliance on earth, yet remains utterly unsatisfactory. Cellular telephones make VCRs pale with their unusable interface." N. Negroponte [12].

[15] See http://www.rnib.org.uk/

[16] See http://www.stakes.fi/cots219.htm

[17] See http://www.stakes.fi/cost219/mobiletelephone.htm

generated by the fact that the number of key is smaller than the set of characters [9], [3].

7.2 Light Terminals To Access To Internet

Even if nowadays Internet is not widely used by older people it is expected that in the near future this use will expand greatly due to two factors. O the one hand, the accessibility to www is increasing rapidly[18] and, on the other hand, the content of some www pages would be of great help for older people. This information is unforeseeably needed: it is not possible to previously know when and where it will be consulted. For this reason mobile terminals will become very valuable for ubiquitous access to Internet. But they will be useful only if the information is provided in a fully readable format.

The palmtop computers that include mobile phones and the mobile phones that include accessibility to Internet, already in the market, are far from guaranteeing the accessibility to older people. The web accessibility guidelines issued by TRACE Center[19] specify the characteristics that a mobile terminal has to have to be fully accessible to Internet for every one.

An important issue is that when accessing the Internet using a current generation mobile terminal (GSM or CMDA) the user is immediately restricted to limited display capabilities and very reduced bandwidth[20]. This means that most of the materials present in Internet pages has to be transformed to adapt it to the capabilities of the used device. This situation is absolutely parallel to the situation of many disabled users accessing the Internet using their standard terminals. In this way, everyone is carried to a disabling situation by the mobile telecom environment. This has very important consequences as any initiative that tries to bring internet access to regular mobile terminals will also easy internet access for disabled users. The Wireless Access Protocol[21] (WAP) and its associated Wireless Markup Language (WML) are very strongly typed, in the sense that every specific type of media embedded in the pages must have and associated type and alternative representation when possible. A great effort is being made to provide WAP gateways for standard HTML pages. This can, at least in principle, improve the access to the Internet in general for older users.

With the emerging Bluetooth standard, a user will be able to use her/his mobile phone controlling it from any other device including not only PDAs and notebooks but also Assistive Technology devices such as communicators and wheelchair controllers. In this last case a bridge will be used to connect it to the chair standard bus. As this standard, which is based in a 2.4 GHz radio frequency connection, supports wireless networks with a 10m range (that can be extended up to 100 m) it can also be used for connection to fixed networks while the user is at home or at the office.

7.3 Tele-Guidance

GPS technology allows the localization[22] of the receiver with increasing accuracy. In fact, using elaborate methods, the precision can reach to the meters. This type of devices, which is already in the market[23], will probably become more widespread in the future. Their use by older people will increase because they are basically necessary to orientation helps (e.g. to cope with the "I am lost" scenario). They are also very useful for the provision of health care support to users away from home ("I don't feel well" scenario) and to answer generic emergency calls ("I need help").

As applications for mobile phone terminals with localisation capabilities in many areas are potentially very large, the success of these systems is easy to predict[24]. The real benefits for older users will depend to a great extend on their needs being considered during the design phase and, to a very great extend, on the possibility of controlling these systems from other devices using an open protocol.

8. CONCLUSIONS

Mobile communications technology has a great potential to change the lives of older people. The industry is starting to take in account this collective as a potential market, mainly due to three reasons: the rising proportion of older people in occidental societies, the possibility of governmental subsidised prices for older people and the potential introduction of some of these devices into the main-stream market. But the advantages offered to older people can only be useful if the design is made taking into account their real needs and requirements.

The benefits that older people can obtain from mobile access to some services are accompanied by some risks that have to be evaluated and avoided. In this way, the authors propose the inclusion of an ethical and social impact study in every project related to mobile equipment and remote services older users, in which possible dangers are pointed out and compensatory actions are described.

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[18] Find information about the Web Accessibility Initiative (WAI) of the World Wide Web Consortium (W3) in http://.w3.org./wai/

[19] See http://trace.wisc.edu./world/web

[20] This situation will change in the so-called 3G mobiles, e.g. UMTS.

[21] The Wireless Application Protocol Architecture Specification, from Wireless Application Protocol Forum, Ltd, 1998, is available at http://www.wapforum.org/

[22] Several other alternatives are available for mobile phone localisation. In the US localisation capabilities will be mandatory in all mobile terminals in the near future.

[23] For instance, Benefon is offering a GSM terminal with embedded GPS receiver (designed as a result of the European TIDE More project).

[24] For instance, the Finish telecommunication operator "Keski Suomen Puhelin" provides orientation services through a server for localisation of users of a specific model of GSM. (http://ultra10.almamedia.fi)

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