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ENHANCING VIRTUAL MOBILITY USING 3G WIRELESS SYSTEMS

SUMMARY

Using generalised systems methodology, the paper considers the approach to effective functional integration of transport and telecommunications technology in solving mobility problems. Basic functions and structure of third generation of wireless systems (3G) are evaluated from the aspects of traffic technology. The paper elaborates how increased accessibility and reliable broadband capabilities of 3G systems combined with Internet application can improve the existing teletraffic technologies. Evolutionary network migration to 3G networks has been suggested as an effective strategic choice for mobile operators.

KEY WORDS

technology, virtual mobility, wireless 3G network, functional integration

1. INTRODUCTION

The basic roles of transport and telecommunications technologies are similar or even homomorphic: to transfer or convey entities from one place to another over available network facilities, or simply - *to enable mobility*. Traffic technologists or engineers have to look at all modes and possible solutions (›technologies) which might be used to provide traffic (transport and telecommunications) services in the particular problem area.

Classical transport engineers and planners are focused only on partial modes or submodes of transport. They cannot design effective and efficient solutions because they do not consider all available technological solutions to the mobility problem. Other professionals deal with the specific technical design or operational features of the individual components of transport/traffic systems. They do not consider the basic *system* (*user*) *requirements* and functional (→ technological) systems design which can satisfy the *input/output requirements* with optimised performance function according to generalised system methodology [11].

Traffic technologists as system engineers have to consider the *functional system design* which satisfies different requirements for mobility and therefore, *what* the technological system or subsystem should do, rather than *how* the system does that at the technical level. According to marked systems approach and methodology, we want to consider a new scope of possible *virtual mobility solutions* based on the new third generation (3^{rd} G) wireless systems. Also referred to as IMT-2000 (International Mobile Telecommunications) mobile broadband system or UMTS (Universal Mobile Telecommunication Systems) - 3G is commonly associated with new wireless technology which can solve different telecommunications and transport (→ ITS) requirements.

The basic thesis of this paper is that effective system design and deployment of 3G wireless technologies can radically improve the existing telecommunications and also new transport solutions for a large part of mobility requirements. In effective association with Internet (IP), 3G technology can deliver a rich set of bearer broadband services, teleservices and new value-added services.

2. FUNCTIONAL INTEGRATION OF TRANSPORT AND TELECOMMUNICATIONS TECHNOLOGIES

By recognising the deeper interdependence or basic functional relations between transport and telecommunications technology, we can optimise (harmonise) future activities in developing and deploying more effective and integrated solutions for mobility problems. Intelligent transport system (ITS) development and deployment can be considered as the first step to more effective integration of transport and telecommunications [2], [9].

There are several papers which consider basic "competition" or "substitution" relations between transport and (tele)communications [6], [9].

More recent debate about "National Information Infrastructure", "Information Super Highway" and "Sustainable Mobility" presents new insights in classical isolated approach and suggest new orientation in network infrastructure development [5].

Transport and telecommunications systems are an equivalent set of network facilities, operations, services and protocols. Their basic mission is similar: providing technology for effective and efficient mobility of people, goods and information. Successful functional integration of transport and telecommunications technology at a generalised level can be based on advanced system developed methodology [3], [11].

Basic presumption is that higher level of policy harmonisation and technological integration of transport and telecommunications systems can produce more effective and efficient solutions for mobility problems. Instead of marginal technological co-operation we propose technological and beyond-technological integration of transport and telecommunications systems. Effective functional integration can produce sustainable mobility solutions and gains for all relevant stakeholders:

- customers and end-users,
- network operators,
- service providers,
- local community,
- government,
- suppliers, etc.

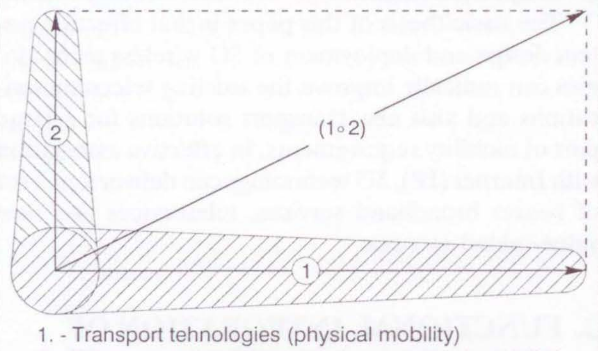

Figure 1 - Expected gains from effective functional integration of transportation and telecommunications systems

According to the basic thesis of this paper and background research the effective development and deployment of new teletraffic 3rd G technologies can radically improve or innovate telecommunications and also transport (ITS) solutions for large part of mobility requirements. Increased (total) accessibility with reliable broadband capabilities of 3rd generation of wireless technology enable significant benefits for almost all relevant stakeholders: from end-users to service providers and community. Combined with *Internet Protocol* (IP), new 3G technology can deliver a rich suite of narrowband and broadband services including: voice, data, fax, video, telemetry, ITS (Intelligent transport systems) services, etc. These can radically improve the existing traffic technologies.

Expected effects or gains from effective functional integration of transport technologies and telecommunications can be more formally described:

$$E(F_{TR} || F_{Cm}) < E(F_{Tr} \circ F_{Cm})$$

where:

E – effects or gains,

F_{tr} – functions of transport systems and technologies,

F_{cm} – functions of (tele)communications system and technologies,

|| – operator for parallel association (marginal co-operation),

∘ – operator for composition (functional integration).

3. OBJECTIVES AND SCOPE OF REGULATIONS

The scope of possible technological solutions is strongly influenced by the concrete regulations and standards. These limit the space of all functional system designs and technologies which can satisfy the user requirements or input/output requirements. A simplified illustration is given in Figure 1.

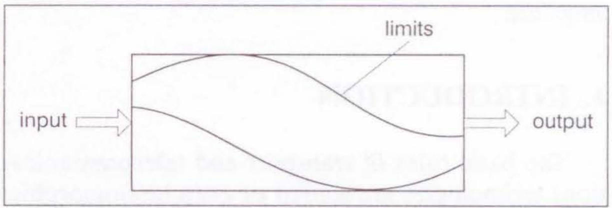

Figure 2 - Illustration of functional design limited by regulation and standards

In the European countries (EU) there is a broad agreement that regulation should aim to be "technologically neutral". It means that equivalent services should be regulated in an equivalent but not necessarily identical manner. For example, telecommunication services using Internet Protocol-based networks should be treated in the same way as the equivalent cable TV network services. The same principle is recommended for different mobile networks: analogue mobile networks (NMT 450, AMPS, TACS), digital mobile networks (GSM 900, D-AMPS, etc) and new (3G) universal mobile telecommunications system (UMTS). However, same experts (particularly from telecom operators) suggest that technological neutrality could be used as an instrument for increasing regulation and extending regulation from one market to other markets, which had not been previously regulated [10].

In most countries, the government has an important role as a co-ordinator of national (transport and telecommunications) policy and as a catalyst for regulations and standards development. Government also controls key resources which make it a central figure in several key decisions such as road licences, radio spectrum allocations, authorisations, etc. In liberalised environment the general principle is that regulation should be reduced as competition increases.

In the modern market economy, the government has to be focused on several tasks in relation with the effective network infrastructure development and supervision of competitive (service) markets. The main roles of the government are to:

- determine transport and telecommunications policy (i.e. "integrated traffic policy") which enables harmonised network infrastructure development;
- co-ordinate network development with other public and private projects and activities;
- encourage market environment in which customer choice can be freely exercised, and private firms can maximise their rewards by responding to these choices;
- create regulatory frameworks that protect customers against abuse of monopoly position or market power and permit concessionaires to earn a reasonable rate of return
- ensure compliance with safety and environmental standards.

New regulatory framework has to be more robust and capable of dealing with the challenges of rapidly developing markets and technologies. In EU almost all telecom operators, manufacturers and public authorities support the increasing use of general authorisations, but there are different views about specific authorisations. Some regulatory authorities and certain network operators (who already had licences) argued that specific authorisations were necessary for the operation of fixed network infrastructure. The majority argued that specific authorisations were justified for the use of radio spectrum. Satellite operators suggest that specific authorisations are necessary only where frequency band has not been harmonised.

Successful technical and technological standardisation bring a host of benefits for all stakeholders, from consumer, product/services developers and network operators to the whole community. The Internet demonstrates the value of establishing basic standards that are responsive to user and other stakeholders' requirements. The Internet paradigm for standards development can be a model recommended for most standards developments. The Internet approach has been successful both because of technological strength of its protocols and because of effective institutional strategies.

4. EVOLUTIONARY NETWORK MIGRATION TO 3G NETWORKS

Effective deployment and exploitation of mixed 2nd G and 3rd G mobile networks are the key tasks of teletraffic engineers and managers of mobile operators at the beginning of 21st century. Although there are critical differences between 2nd G (GSM) and 3rd G (UMTS IMT 2000) network facilities and services, these two systems have to be systematically treated to enable effective migration from one system to another.

Teletraffic engineers in mobile operators and service providers have to intensively research 3G standards and system development although they do not manufacture the equipment (HW, SW) for mobile networks. Selecting a network infrastructure supplier will be a critical strategic decision for mobile operators deploying networks to carry GPRS (General Packet Radio Services) and 3G teletraffic. High licence fees and financial implications of the migration towards 3G require also new business models and vendor/operator partnerships. Today, we can identify alternative migration from the existing "2 G" to "3G" mobile network, which are illustrated in Figure 3.

Some mobile operators (like DoCoMo in Japan) envisage the 3G network as a completely new network which employs new technology. The new 3G network is treated as a separate overlay network to the existing network (PDC network in Japan). Common share network elements will be *home location register* (HLR) which enables subscribers to migrate from 2 G to 3G mobile systems.

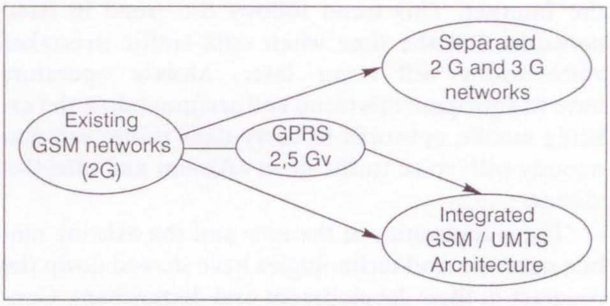

Figure 3 - Possible alternative migration to 3 G mobile networks

Another alternative approach is more integrated GSM/UMTS architecture which is illustrated in Figure 4. In this approach, UMTS is regarded as an extension to GSM and not as a replacement. GSM/UMTS architecture has two different radio access systems (GSM radio access and UMTS radio access) and a common *core network*. Using dual mode, mobile terminals can be adapted to GSM, UMTS or both.

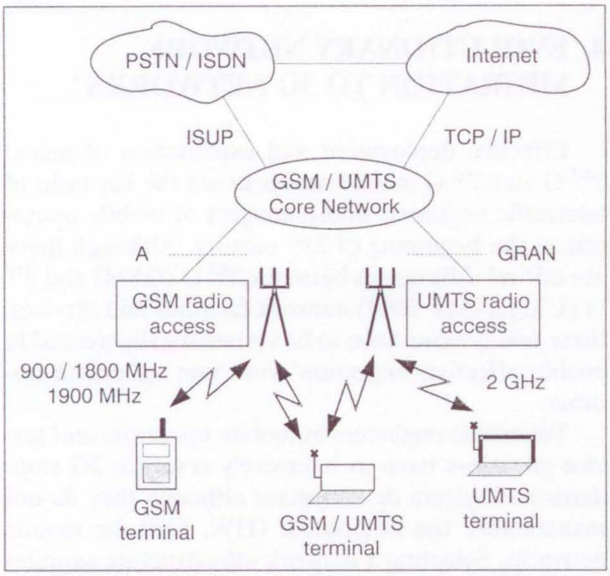

Figure 4 - GSM/UMTS network architecture (Source 7)

According to IMT 2000 specifications, the interface between radio access and core network is essentially an expanded version of the GSM-A interface. There are three frequency alternatives to the A- interface:

- 900 MHz,
- 1800 MHz,
- 1900 MHz.

The interface between the core network and the UMTS radio access is called *generic radio access network* (GRAN) which is in the 2 GHz band.

It has been forecast that data traffic over mobile networks will account for an increasing portion of teletraffic, and that its destination will often be the Internet. This trend follows the trend in fixed networks, but the time when data traffic overtakes voice traffic will occur later. Mobile operators have to anticipate this trend and accommodate the existing mobile networks to carry data traffic simultaneously with voice traffic in an efficient and effective manner.

The complexities of the new and the existing mobile networks and technologies have slowed down the progress in their development and deployment. Concrete impact of the delay in implementing 3^{rd} generation wireless systems is the introduction of General Packet Radio Services (GPRS) as an intermediate step (2+ or 2,5 G). GPRS enable efficient transmission of high-speed data over the current GSM and other TDMA - based wireless network infrastructures. GPRS packages the user data and transfers them over *Public Land Mobile Networks* (PLMN) using an *Internet Protocol* (IP) backbone. Since GPRS has fast connection set-up, the end-user has the perception of being "always on" for continuous operation.

The impressive growth of cellular mobile networks as well as the number of Internet users promises an excellent potential for services that combine both innovations. Combined with IP, 3G technology can enable a suit of narrowband and broadband services including voice, data, fax, video, telemetry, etc. Moreover, voice and other circuit-switched teletraffic can be migrated in the packed mode in a way that protects investment in the existing network infrastructure.

5. CONCLUSION

Physical and/or virtual mobility problems can be solved using different transport and/or telecommunications technologies. Using generalised system methodology, traffic technologists can improve functional systems design and technologies for solving mobility problems.

New third generation (3G) wireless systems (also known as IMT-2000 and UMTS) open new scope of possible new solutions for virtual mobility (›telecommunications) and, also, physical mobility in relation with Intelligent Transport Systems.

Evolutionary network migration towards GPRS and 3G network can be suggested as the most effective strategic route. Mobile network operators have to protect investment in existing infrastructure and ensure smooth transition to the next generation of teletraffic technologies and services. The high licence fees spent by 3G operators, and investments in 2.5G and 3G capable infrastructure require new integrated technological and business partnership model.

Further systems research should be directed to establishing more structured description and formalisation at generalised technological level and system specific level. Systems (standard) formulations and recommendations for advanced mobile systems can be used for improving functional system design and technological specifications.

GLOSSARY OF ABBREVIATIONS

3G – Third generation wireless (mobile) networks
CDMA – Code Division Multiple Access
GPRS – General Packet Radio Services
IP – Internet Protocol
ITS – Intelligent Transport Systems
IMT-2000– International Mobile Telecommunications 2000
NII – National Information Infrastructure
TDMA – Time Division Multiple Access
UMTS – Universal Mobile Telecommunications System

SAŽETAK

POBOLJŠANJE VIRTUALNE MOBILNOSTI PRIMJENOM BEŽIČNIH SUSTAVA 3G

Primjenom sustavne metodologije razmotren je pristup djelotvorne funkcijske integracije transportne i telekomunikacijske tehnologije za rješavanje problema mobilnosti. Bazične funkcije i strukture treće generacije pokretnih sustava (3G) analizirane su i vrednovane s aspekta tehnologije prometa. Objašnjeno je kako rastuća (totalna) dostupnost i pouzdani visokopropusni kapaciteti sustava 3G kombinirani s Internet aplikacijama, mogu poboljšati postojeća rješenja u tehnologiji prometa. Sugeriran je postupni evolutivni prijelaz prema mrežama 3. generacije kao efektivni strategijski izbor za mrežne operatere.

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