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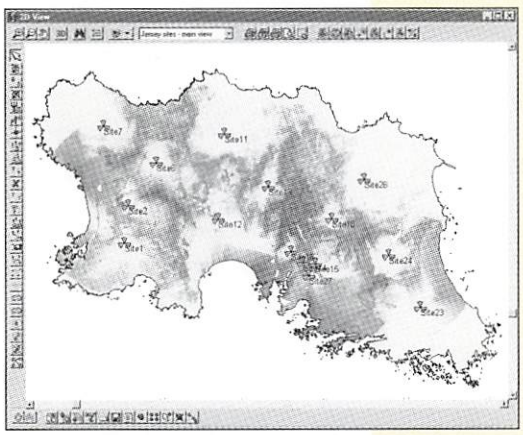

3G soft handover prediction (more likely in darker areas) using Aircom's Enterprise tool. Hugo Pinto discusses UMTS radio planning with such tools. (Figure: Aircom International Ltd.)

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Foreword

James Irvine, Editor

Some thoughts on the subject of participation, or, in the first case, lack of it.

The Spring VTC this year was intended to be held in Israel, but the situation there meant that it had to be moved to Rhodes. This move was carried out prior to the confirmation of paper acceptance, and as a result of the move, a handful of papers which were accepted withdrew. Unfortunately, at the conference itself, 81 people who had registered to attend did not turn up, 69 of whom were students. The latter figure is particularly dissappointing given the high level of subsidy the student rate enjoys.

This problem can't be blamed on the conference location since the level of no-shows, about 10 to 15%, is similar to that seen in Boston, which is hardly out of the way. The problem has been more apparent in recent years and it is hard to escape the conclusion that given registration for the conference is a prerequist for publication in the proceedings, some people have noticed that paying the registration fee and then simply not turning up is an extremely cheap way of getting published quickly.

Left unchecked, such a selfish attitude threatens the whole premise of a technical conference, where dialog occurs and ideas are shared. Authors who want cheap publication have the option of putting papers on a web page, but renaging on a promise to present a paper brings the conference organisers and Society into disrepute, as they advertise accepted papers in the advance program.

Of course, in some cases unforeseen circumstances will intervene, but almost all technical papers are co-authored, and all authors share a responsibility to ensure their obligations are fulfilled. Even if a colleague cannot help out, leaving an empty chair without a phone call or email is hard to justify.

As a new policy, for VTC2001-Fall in Atlantic City, there will be a one-year moratorium at VTC on the acceptance of papers from authors who, having submitted the final version of their paper, fail to present their paper. This is still more lenient than some IEEE societies, which have longer bans, sometimes extending to their Transactions as well.

On the more positive side of participation, this issue again leaves me in the position of having to hold some material for the next issue since there is simply so much going on 44 pages won't cover it. Society membership is rising again as well, which is always a good sign. I am always gratified, and extremely grateful, for the willingness of society members to respond when we send them an email along the lines of 'we noticed you were doing something interesting on 'X' and wondered if you would be willing to contribute a feature article?'. However, with an editor's fear of the empty in-tray, I'd like to invite all members to consider if they could contribute an article. With over a dozen features over the past year, you should have an idea of what we are looking for – nothing too technical, but a good practical overview of an area accessible to members. Transportation articles in particular are solicited.

If you don't want to commit to an article, why not write us a letter. The letters column of IEEE Spectrum has been busy with VT subjects lately. That should get you started.

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UMTS Radio Interface Roll Out Aspects

Hugo Santos Pinto, TMN Portugal

Differences between 2G TDMA cellular systems and 3G CDMA systems mean that there are some fundamental changes in the planning process. This document describes the procedure associated with the planning of an UTRAN radio interface. It presents an overview of the radio dimensioning process (for license bid or roll out) and highlights the aspects that differ from GSM / DCS cell planning and the impact of those differences.

Possible strategies for the roll out, assumptions, and dimensioning options are discussed. The article draws conclusions about the process and about migration to UMTS cell planning, and illustrates some of the challenges to be faced by planning divisions of the operators in the near future.

1. Introduction

UMTS network roll out and the cell planning process behind it is a key issue today, as licenses are issued and operators start creating and dimensioning a new radio interface. The efficiency of the roll out is important as new services are going to be offered, and a quick growth of the number of 3G clients is critical for future UMTS operators.

Many companies already have their business cases and main options for UMTS defined, but now implementation and planning details are being encountered, and cell planning departments need to migrate from 2G to 3G. The impact of this migration is going to be felt in many ways, from human resources to dimensioning tools and even the overall planning process itself.

First of all there is the need to have a global view of the network roll out and the questions to be answered prior to the network dimensioning. Section 2 will present some of the main issues related to this. Following on from this, the dimensioning itself will be discussed and the main differences to 2G and the obstacles to be overcome will be presented.

2. The Cell Planning Process

This section presents some of the main topics related to cell planning in UMTS and their associated inputs. Some examples of possible solutions to be adopted either for existing GSM/DCS networks or for completely new networks will be discussed. The cell planning process can vary from operator to operator, but the structure presented here gives an example of how the process can operate.

2.1 Generic Cell Planning Process Overview

PLMNs (Public Land Mobile Networks) are based on a cellular structure, reusing the same radio resources (frequencies or codes, for example) in cells deployed sufficiently far apart from each other to avoid contention. A core network supporting these cells deals with mobility management, resource handling and service and security establishment. Figure 1 presents the Network Architecture for a combined UMTS and GSM mobile network as defined in [1]. Although in the picture the radio interfaces (Um for GSM and Uu for UMTS) seem negligible in comparison with the complexity of the rest of the network this is not the case. There is the need to manage thousands of simultaneous connections using these interfaces all over the network, and there might be thousands of Node B's and tens of UMTS Radio Network Controllers (RNC's) and GSM Base Station Controllers (BSC's). This does not occur with all the other elements of the network, some of which are unique in a network and or may exist in very small numbers. The planning of these latter elements might only relate to capacity or software updating. Note that the figure shows the logical structure of the network. It is quite common for some of the network elements to be physically implemented in the same equipment.

To deploy such a network there are several steps related with the radio interface to be fulfilled, however it is important to highlight that the cell planning process in a network is continuous. This is so because the traffic keeps on increasing, moving the goals of the planning from coverage to capacity assurance. Actually the cell planning in a network only ends when the technology is replaced (which means a new network and the restart of the process).

The major steps in the deployment of a new radio network (we will skip the ones related with the core network) consist in obtaining a nominal cell plan, site surveying, accurate cell planning and troubleshooting and tuning. These steps differ from technology to technology but the process itself is quite similar. When it comes to a new technology, there is a need to perform these steps for the first time, whereupon obviously more mistakes will occur. This means that there may be the need to revise some principles to adjust the engineering forecasts to the financial capacities.

2.2 The Nominal Cell Plan

Why is the nominal cell plan so important for the roll out? First of all there is a nominal cell plan to be made before trying to win a licence. This plan will be used to estimate costs and to evaluate if the mobile market is interesting for that particular country. It may be reviewed after winning the licence and will also be used to estimate the engineering effort to be made (from site acquisition and building to planning and deployment). It is a very important guideline for the following steps and for several implementation decisions.

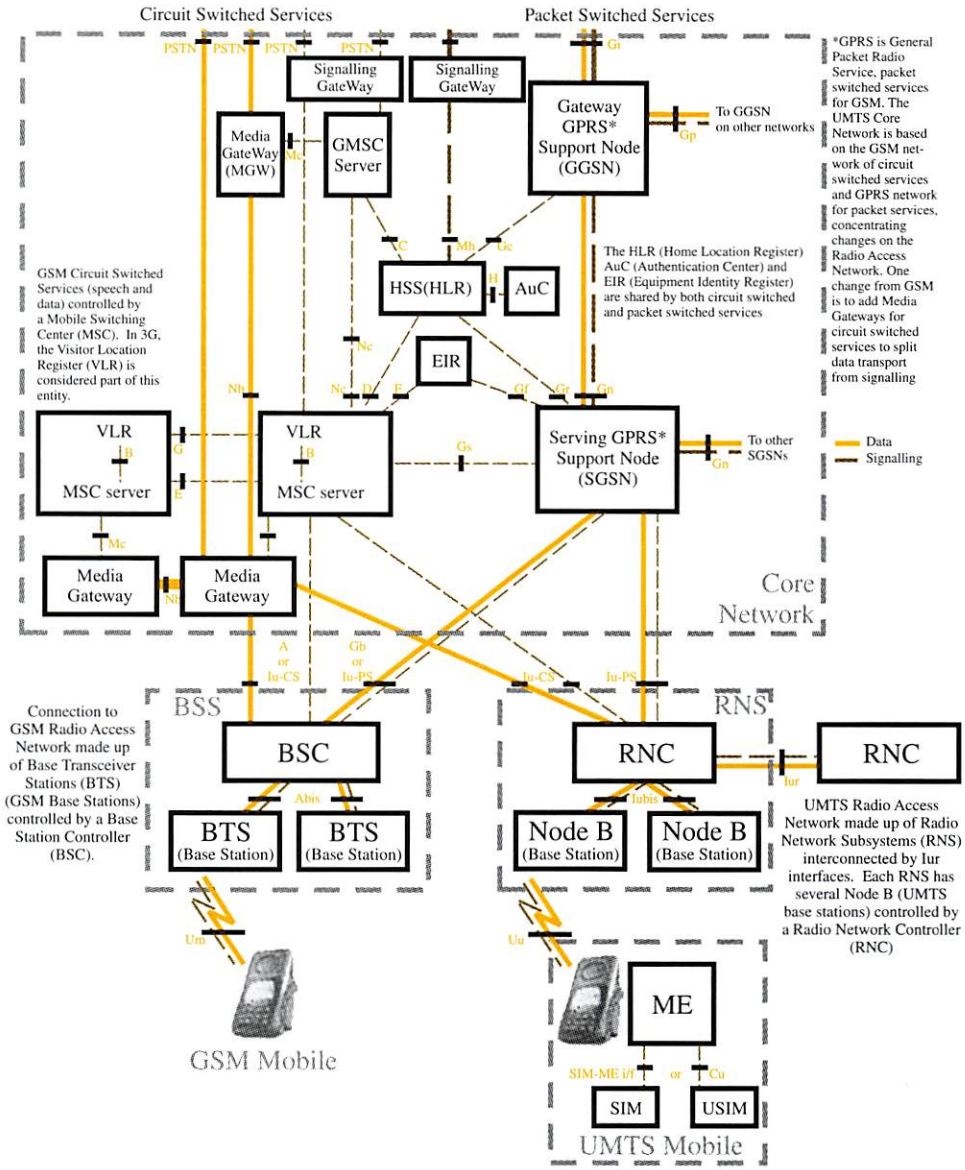

Figure 1 UMTS Network Architecture

There are several inputs needed for UMTS radio planning, some of which are not directly related to pure engineering. It is important to highlight that these inputs are sometimes reviewed after the dimensioning drafts are produced. This means that the cell planning process is iterative in an early stage in terms of inputs and outputs. The whole process may be illustrated by the Figure 2.

The first step is to estimate some typical inputs that can be divided in several groups:

Strategic decisions:

- ✦Areas to be covered per year
- ✦Services to be offered in those areas per year
- ✦Coverage probability to be assured
- ✦Uniform/non uniform service coverage
- ✦Spectrum use

Traffic estimations:

- ✦Traffic per user per year and service
- ✦Subscriber penetration per year
- ✦Subscriber density distribution

Parameters Influencing the Link budget:

- ✦Maximum cell load
- ✦Penetration margins
- ✦Coverage margins (after coverage probability decision)
- ✦Fading margins
- ✦Path loss models (theoretical+tuning)
- ✦Antenna gains
- ✦Noise figures
- ✦Handover gains
- ✦Power distributions

Although only the link budget parameters are engineering related, all influence the roll out. Some of the non-engineering parameters have a large impact; the areas to be covered, for example.

An important input is the link budget. This is a summation of parameters related with radio propagation, transmission, reception, connection losses, etc., that usually will return a MAPL (Maximum Available Path Loss). This represents the maximum radio loss per connection for a certain morphology. Cells in dense urban areas and rural areas, for instance, will have different MAPLs, which, associated with the fact that the path loss models will also be different, will imply different cell sizes. This means that changes in the inputs that lead to the link budget will have impact on the number of sites.

The conclusion is that after the inputs are decided there is the need to perform a nominal radio plan in order to see if the decisions made were right or if some were too ambitious. Several readjustments may have to be performed until the number of sites is compliant with the business plan and the strategy of the project. After the nominal planning becomes stable, the accurate planning using a tool with geographic information can start. To do so it is very important to analyze the inputs and outputs of the nominal plan and to have a good overview of the capacity and interference constraints in UMTS.

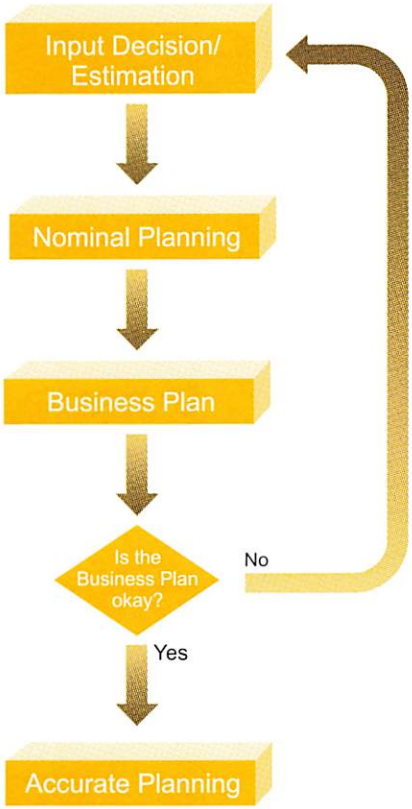

Figure 2 The Cell Planning Process

2.3 Capacity vs Coverage in the UMTS Radio Interface

There are a number of challenges related to UMTS cell planning, one of which is the fact that capacity and coverage are closely related. In fact in the uplink the noise rise due to interference may bring about situations were some mobiles may not have enough power to overcome the noise and experience the cell breathing effect. This is like a room with many people speaking different languages (the codes used on the radio interface between people). As the number of people increases, the background noise rises. In the uplink (mobile to the base station) of a UMST network however, all mobiles "talk" with the same base station (Node B in UMTS) that serves that cell and might be quite far away. If the number of users increases, the mobiles that are very far away (in the limit of the MAPL) will not be able to "speak louder", limiting the cell size in an effect similar to a cell breathing. In the downlink (from the base station to the mobile) the shared resource is the available power at the Node B (the code/language pool is a shared resource also) which may also mean that cell breathing effects may appear for certain highly unbalanced traffic distributions. This means that the sites to be chosen have to be close to the high traffic generating areas, which may not be an easy task to achieve.

It is important to highlight that UMTS uses a very tight power control, meaning that the transmitted power for each connection will be kept as low as possible and still be audible at the reception (it is like if everybody would speak as quietly as possible in a public space). The use of power control is one of the most important features in UMTS because it is the only way to assure a frequency reuse of 1 (all cells can use the same carrier) and avoid the near far problem (if there was no power control, mobiles far away would reach the Node B with lower values of C/I and their connections would drop). To illustrate the cell breathing problem consider the uplink and the downlink cases (there are many references with analytical considerations on the subject but only qualitative analysis will be performed here, please see [2]):

- In the Uplink the interference seen by each connection associated with each kind of service is the same, as all mobiles reach the Node B with the same power (although the transmitted powers are different). This is so because the target C/I (Carrier to Interference Ratio) is the same for each service and the power control will be perfect. Actually the C/I for each service in each connection is adjusted by the outer loop power control, however the adjustments will be neglected here. Of course, nothing is perfect but we can assume it is in this case, which is common in the literature. Assuming a non-uniform traffic distribution it is clear that if the traffic is close to the Node B, the achieved capacity can be much higher because the remaining power in the mobiles' power amplifier will be higher on average. Therefore, although the interference seen in the node B remains unchanged due to power control, if the mobiles are further away, the capacity limit is much lower.
- In the downlink the power demanded by each mobile is related to its location. If the traffic is uniformly distributed, a mobile close to the Node B will ask for less power than a mobile far away from the Node B due to path loss. Furthermore the interference seen by a mobile that is far away from the Node B can be higher due to inter (from another) cell interference and it may have to perform soft handover (multiple connections, sometimes referred as "make before break"). The mobile may even have to perform an inter frequency handover (inter frequency handovers are always hard, i.e. "break before make") due to quality problems. The downlink however usually is not the bottleneck of the system because the intra cell interference is strongly reduced by the use OVSF (Orthogonal Variable Spreading Factors) codes (please refer to [3]).

The conclusion is obvious. If the traffic is close to the Node B the capacity is increased in both links, decreasing the risks of cell breathing and improving the inter cell interference.

This is a very important question in UMTS cell planning because the coverage does vary with the traffic demands during the day. Furthermore, with multiple services, the busy hour is highly random because the different service loads might vary independently during the day. This concept is new when compared with GSM cell planning and makes the reuse of some sites impossible.

2.2 Traffic and its Importance

As seen in the previous section there are some differences to GSM/DCS Cell planning.

Actually the task of the cell planner in UMTS is to assure that coverage and capacity are balanced leaving margins for capacity variations. As shown, these margins have to be decided taking into account the deployment strategy of the company and should, for instance, be calculated based upon traffic estimations (that can have different degrees of accuracy) or spectrum availability (if an operator has several frequencies available the network is more immune to cell planning mistakes because capacity improvements can be done).

To illustrate the dimensioning process let us assume that we have a traffic forecast per user for UMTS. We will also suppose that there is a UMTS cell planning tool available. Let us assume also that the traffic forecasts are available in a raster[1] which can have more or less accuracy depending on the assumptions used. These traffic forecasts have to be produced according to the contents and services to be provided by each operator and play a key role in all the process being the major input of the cell planning process. Basically what the tool does is to estimate the noise and transmitted powers

[1] A raster is a matrix describing traffic for different positions within the environment.

associated to the physical scenario in both the uplink and the downlink. This is done according to the traffic distribution, the link budget parameters and the sites' characteristics. Typically the outputs are plots for several important radio performance indicators as well as coverage plots and statistic reports. It is important to say that most tools are based on sampling algorithms that produce averaged results taken from several different snapshots of similar traffic distributions, therefore the need for statistic reports.

Usually the tools have some customizable link budget parameters and one of them is an interference margin that is related to the maximum traffic load to be allowed in each cell. This cell load should be set somewhere between 40% and 70% (which is translated in dB using the noise rise calculus, performed by the tool or by a spreadsheet for instance) and it's calculation can be found in [4] or [5].

Although this value is fixed for each simulation performed by the tool, there may be a need to tune it according to the simulation results. If you assume a certain margin and the expected traffic within each cell is very low, you will be coverage limited (the margin is too high in dB and the tool will report coverage holes due to an aggressive link budget). On the other hand if you assume a very low margin, the cell will increase because the MAPL (Maximum Available Path Loss) is larger. However, the traffic to be processed in the cell will increase with its size and the coverage may become limited by the interference.

This is a major danger because it would mean that the cells would be planned for exactly the traffic they should process. This is not reasonable for two reasons: the traffic estimations have a certain margin of error, and the expected traffic may be quite inaccurate because a new group of services is going to be deployed and there is no experience in the field yet.

Even accurate traffic estimations only give you an average traffic value and to plan a network using these estimations and leaving no margin would imply cell breathing due to traffic variations around the expected traffic load. This is even more dangerous in urban and dense urban areas where the high bit rate services will be offered, leading to strong interference variations caused by a possibly small number of users.

These dangers are also associated with the other margins to be set in the link budget.

Other difficulties are related to the time period to which the traffic forecasts refer to. It is reasonable to admit that to plan a network with a 4 to 5 year advance may be a good solution, because there are several improvements (multi user detection and adaptative antennae, for instance) expected on the radio interface that will increase the capacity available on the network. This would allow the operator to cope with the expected traffic increase that could otherwise lead to coverage holes. However, to predict the traffic for 2005/6 is far more difficult than to predict it for 2003 and the errors may be quite large. In addition, each company has economic business plans and service roll out strategies that have implications on the radio planning guidelines on a year basis and on number of node B's to be deployed. For instance, planning each cell assuming that all services will be available in the whole cell or planning on the basis that each cell may have unmatched service coverage will yield different results, and this choice may change along the roll out. All this information has to be gathered and evaluated to perform the radio planning guidelines for each clutter type (penetration margins, traffic load margins, service mix to be deployed, etc.) for each year, having a strong impact on site planning.

2.4 Spectrum use

From what we have seen already it easy to understand that if an operator has several UMTS carriers available it may perform a more relaxed cell planning. This is due to the fact that if a cell breathes due to interference it might be possible to underlay a microcell using another frequency (if the traffic is generated in a hot spot) or to increase the capacity by adding another carrier. It may be even necessary to deploy a microcell layer in a particular area of a city for instance.

However, it is important to highlight that although there is no need to perform radio planning between cells of the same operator as the frequency reuse is equal to one in UMTS, there might be the need to be careful when using the carriers adjacent to the spectrum used by other operators. This is due to the dead zone effect that consists of adjacent channel interference caused by a carrier from operator B in a poor coverage area from operator A. This effect can only happen when the difference between the powers seen on both carriers is very large (very strong coverage provided by operator B and poor coverage provided by operator A), but this situation is quite possible when the mobiles are very close to a microcell (typically in line of sight) from one operator and are far away from the macrocell that is serving their connections.

One possible solution to avoid this problem is to agree with the other operators on spectrum use. To do so all the operators have to agree where the microcell carriers form one operator cannot be adjacent to macrocell carriers of any other operator. For instance if each operator has two carriers available one may be used in dense traffic areas by the microcells and the other by the macrocells. If all the operators agree in using the carriers associated with the microcell layers adjacent to each other and the same for the macrocell layers the dead zone problem may almost disappear. On the other hand, if everybody has three carriers available assigning the central frequency to the microcell layer may avoid the problem. In poorly covered scenarios (rural for instance) the problems may have to be solved (if they happen) on a case by case basis (like adjacent channel interference in GSM).

Radio resource and interference management algorithms are being developed in order to see if traffic profile distribution on a layer or carrier basis brings significant benefits in UMTS.

2.5 Site reuse

For the existing GSM/DCS operators this question is very important because there are some constraints when doing GSM/DCS site reuse for UMTS.

First of all each operator must estimate the typical cell radius for the expected service mixes for each morphology type for each year of the roll out. To do so link budget calculations have to be performed. There is a lot of literature on this also but the idea is to estimate some margins (penetration, lognormal fading, interference, noise figures, etc.) either by experiences/measurements or by analytical methods and estimate the MAPL. Once the MAPL is achieved the cell range can be calculated and compared with the actual cell radiuses in the GSM/DCS network (which will present some differences but a certain resemblance). By doing so a rough estimation of the number of new sites to be deployed can be made. This estimation is quite important because it gives an approach to the number of site surveys that have to be done.

After this brief quantification there is the need to identify sites that cannot be reused. Often these sites were acquired in the beginning of the operation of GSM/DCS networks and were sites designed to provide wide coverage in areas where the traffic density would be low. A few years later the traffic increased and these sites became troublesome due to interference and overshoot. The problem is very serious in UMTS because a site that provides very wide coverage experiences higher coverage variations due to traffic evolution and can be very damaging to other sites due to interference. Careful frequency choice in UMTS won't solve the problem because the frequency will, typically, be the same for all macro sites.

Other sites to be carefully filtered may be those which cannot guaranty the needed coverage due to capacity constraints.

It may be needed to redesign a large number of sites because the link budget produces a cell radius lower than the one that is implemented in the 2G network but not low enough to drive to the need of building new sites. This means that if you do not relocate the existing site some coverage holes are expected but they won't be large enough to justify new sites and may even only exist in the busy hour. However instead of reengineering wide areas of the network it may become cheaper to deploy two carriers from the beginning of the operation in the sites that are expected to be capacity limited. This is another reason why a good traffic prediction plays a key role in the UMTS network planning process.

The challenges faced by new 3G only operators are different when it comes to site choice and coverage. New operators will typically have roaming agreements with previous 2G operators in order to start the operation. The goal is for their clients not to be unsatisfied when comparing to clients from 2G+3G operators. Some UMTS sites may be shared with other 2/3G operators but many times the sites will have to be developed from the beginning, avoiding the dilemmas associated with site reuse and compromise solutions, which may drive to better planned networks. It is obvious however that the already existing operators have the advantage related with field experience, from site building and maintenance to network and geographic knowledge.

2.6 Possible strategies and their impact

As already said the strategy brings strong implications to the radio planning. There are several possible answers for the questions related with strategy for the roll out that were presented before, having more or less impact in the number and position of the sites to be deployed. This section presents some of the questions and the implications of possible answers.

2.6.1 Geographic/population distribution of the roll out

The roll out of a network is done according to a predefined schedule. This schedule usually is associated with strong population coverage (covering high populated areas) in the early years followed by geographic expansion in the middle of the roll out. In the end, usually, the target should be to cover 99.9% of a country and its population. Typically you may start to cover large percentages of the total population of a country by covering very small percentages of its area. As an operator increases its effort to cover more population the areas that are less dense in terms of population will represent the major part of its network. These decisions are not related with engineering, however the planning outputs will be completely different if you wish to cover 80% or 40% of the population of a country in the first year of the roll out because that may represent more than the triple of the number of stations.

In UMTS the urban and dense urban areas represent the most interesting scenarios in the network due to the high bit rate services to be deployed. These scenarios, as well as the main roads and some particular spots considered important will be covered in the first year (or two) of a standard roll out. The other areas will be deployed sooner or later according to company strategy and realistic planning. To cover 95% of a country in the first year is almost impossible due to lack of equipment, construction difficulties and other constraints, even if the operator has the money to do it. This is why the nominal cell plan is used as input to the business plan and vice versa in an early stage.

2.6.2 Penetration and coverage probability margins

It is true that high margins will assure good network coverage/capacity, however they will also impose high site density and network cost and their impact will have to be evaluated also.

Usually a coverage probability between 95% and 99% is used when planning a network, this means that the effects of the fading will be overcome by this margin more than the specified time percentage. Obviously the margin increases close to exponentially when the probability becomes close to 100%. These margins can be different according to the type of scenario (which implies a different radio channel model) but their impact on the link budget may be significant.

Penetration margins are usually estimated according to penetration measurements. Some license bid proposals and vendors used the measured penetration losses for DCS (1800MHz) and added 1dB due to the frequency spacing for UMTS. These penetration margins are also environment dependent and will be typically determined by the radio/quality department of each operator.

2.6.3 Service deployment in the roll out

Other strategic decisions that will not be made directly by the radio department alone and that will be a compromise between cost and benefit are related with service deployment. The impact of the services to be provided is related to the Eb/N0 values and the processing gains associated to each one (please refer to [3]). High bit rate services will require high C/I values being high noise generators and power consuming. This means that if an operator decides to deploy a high bit rate service (like UDD 384 kbps) in very wide areas the total number of sites may increase very much.

For each service to be deployed there is a maximum cell range, that is, even when you consider the traffic mix some services have higher footprints than others.

This leads to the second question to be answered: Should the high bit services be assured continuously? If an operator decides so, the cell radius will be given by the most restricting service and power reduction will be used in the others to equal the coverage. This leads to an increased number of sites but assures that spare coverage is reserved for the less restraining services.

2.7 Link Budget Example

We have now discussed almost all the important issues that have impact on the link budget. However it is important to say that power distribution in the downlink also plays a key role in the planning process. It is important to assure that the pilot channels have higher coverage than traffic channels to allow handover and signaling exchange in the cell borders.

In Table 1 an example of a nominal link budget is presented. This link budget clearly shows that the services are balanced because the MAPL is the same for all of them leading to continuous service mix coverage. The cell planning tools typically have some of these parameters customizable but some will be calculated automatically (mainly those related to traffic and interference) and reported after simulation.

3. Planning Migration, The Challenge

As already seen the aspects that differ from GSM to UMTS cell planning have a serious impact on the cell planner task. Furthermore the reports produced and the structure of the 3G planning tools are significantly different. The interpretation of the reports is a very important phase of the cell planning process because they present the interference distribution due to traffic and soft handover statistics, as well as power management forecasts, etc. This may drive to cell relocation/reorientation, tilt adjustment, parameter adjustments, etc... It may seem obvious, however an increase in the downtilt may result in a coverage increase in UMTS and there are negative Eb/N0

Parameter	Unit	Uplink						Downlink					
Service Type		CS 8	CS 64	CS 144	PS 64	PS 144	PS 384	CS 8	CS 64	CS 144	PS 64	PS 144	PS 384
W-CDMA Parameters													
Ratio Channels/Total Channels		82%	11%	5%	1%	0%	0%	81%	11%	5%	1%	1%	0%
Activity Factor		60%	100%	100%	100%	100%	-	60%	100%	100%	100%	100%	-
Orthogonality factor		-						0.4					
Service Bit Rate	Kbps	8	64	144	64	144	384	8	64	144	64	144	384
Processing Gain		480	60	26.67	60	26.67	10	480	60	26.67	60	26.67	10
Target Eb/N_0	dB	4.2	2	1.3	0.8	0.1	-0.80	3.3	2.5	1.5	0.8	0.1	-0.3
TX Parameters													
Combining and cable losses	dB	0						3					
TX Antenna Gain	dB	0						17.5					
TX Power per Service	dBm	-						19.4	15.8	15.3	3.1	7.9	2.0
Total TX Power	dBm	15.5	19.3	22.0	18.1	20.8	24.0	27.2					
Total TX EIRP	dBm	15.5	19.3	22.0	18.1	20.8	24.0	41.7					
RX Parameters													
RX Antenna Gain	dB	17.5						0					
Cable and Connection Loss	dB	3						0					
Receiver Noise Figure	dB	5						9					
Thermal Noise	dBm/Hz	-174											
Service RX Sensitivity	dBm	-125.8	-118.9	-116.1	-120.1	-117.3	-114	-122	114.4	-111.9	-116.1	-113.3	-109.5
Gains and Margins													
Log Normal Fading Margin	dB	7.1						2					
Penetration Margin	dB	6	6	6	6	6	6	6	6	6	6	6	6
Body Loss	dB	3	0	0	0	0	0	3	0	0	0	0	0
Soft Handoff Gain	dB	0	0	0	0	0	0	3	3	3	3	3	3
Max Available Path Loss	dB	121.9						121.9					
Specific WCDMA Parameter													
Loading Factor	%	21.1						15.9					

Table 1 Typical UMTS link budget

target values, which are issues that may seem strange at the beginning to some less advised planners.

The question posed to the cell planning departments is related to how to migrate from GSM to UMTS planning.

Much of the know how associated to cell planning may be reused from 2G to 3G and GSM planners will adapt to UMTS very well if they receive the right training on WCDMA and UMTS radio interface structure (spreading, modulation, logical to physical channel mapping, soft handover, power control, etc...). The problem is that most of the training available today is associated to UMTS system overview but does not discuss the capacity and interference constraints, meaning that training must be another well planned issue now.

These considerations lead to the conclusion that the percentage of networks that will be deployed in a turnkey basis may be quite strong because the vendors migrate the skills of their employees faster than the operators and have experts on the subject dedicated to network deployment and optimizing.

With this approach the operators may gain time but sooner or later some major changes have to be made in the planning departments, therefore it is time to make the right (or not) options and wait for the results.

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[6] GPP TS21.905 "3G Vocabulary"

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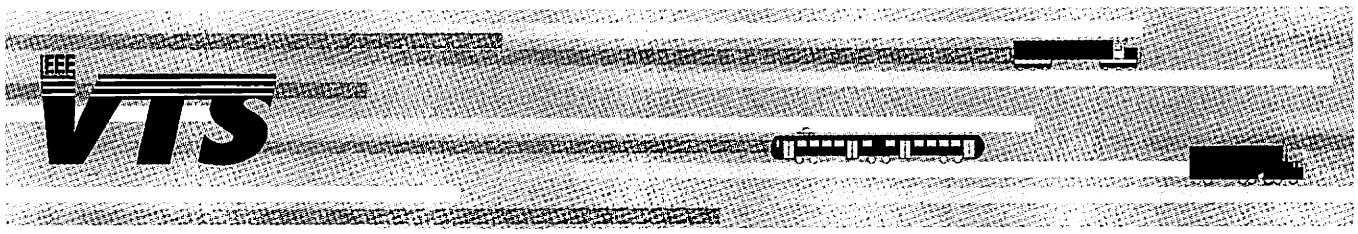

VoIPoW Robust Header Compression Field Trial Results

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The market for mobile telephony as well as data traffic has increased exponentially over the last decade. Data traffic is about to outgrow voice traffic in all public networks while the number of mobile phone users are growing rapidly. Hence the evolution of mobile telephony systems is towards providing its users with the same access to the Internet as the users have when connected to the fixed Internet.

Today's second generation mobile systems are based on a circuit-switched environment, but to be able to provide the users with full Internet access the third generation mobile systems will be packet-switched. However, packet-switching technologies, such as IP, introduces some overhead by prepending headers to the data packets to enable correct delivery of the data sent.

To enable voice to be transmitted in a spectrum efficient way over the air, a robust header compression algorithm must be used. This article describes the field trial when ROCCO, RObust Checksum-based header COmpression, for the first time was used as the header compression algorithm for transmitting voice over IP over a wireless air interface. The results presented in this article show that ROCCO works as well as expected while the existing header compression schemes does not work efficiently when used over bit-error prone cellular radio links.

1 Introduction

As the accumulated volume of data traffic is on the verge of surpassing the accumulated volume of voice traffic in all public networks, the telecom industry is starting to embrace the IP protocol suite as the technology of choice for the future. IP introduces service flexibility by allowing applications to communicate independent of network, creating a base where many players can participate and develop new applications. In parallel with the growth of data traffic there has also been an exponential growth of mobile telephony over the last 8-10 years. GSM, originally an European standard for digital mobile telephony, has become the world's most widely used mobile system, used in over 100 countries all over the world. However, mobile systems to date have been optimized for spectrum efficiency and voice transport, and there is almost no service flexibility since they are circuit-switched. Modern data networks designed for data traffic, such as IP, are packet-switched to allow different types of traffic (i.e. web surfing, streaming, IP-telephony etc) to share the bandwidth in an efficient way.

With the growth of wireless voice and data, the combination of mobility and Internet access, mobile Internet, is the natural merger of two fast-growing technologies. To attain full service flexibility for future mobile networks IP has to be applied all the way to the end terminals, that is, to send IP over the air. The third-generation mobile systems, that are currently undergoing standardisation to allow the first commercial systems to be launched in May 2001, will be packet-switched to allow for an all-IP based environment. Voice over IP (VoIP) will become a main service in 3G networks in years to come.

The requirements in terms of spectrum efficiency and voice quality for VoIP services will be reasonably similar to current requirements on the circuit-switched service. This introduces new challenges when realizing VoIP over Wireless, VoIPoW.

One fundamental challenge is to reduce IP header related overhead while retaining voice quality and maintaining transparancy of all header fields when sending over narrow-banded, bit-error prone wireless links. To avoid quality degradation in voice services it is important to minimize the delays. To avoid large delays small voice packets are transmitted often, typically 15-30 bytes of data every 20ms. If this voice packet is to be transmitted over an IP network it will have an IPv4 header (size: 20 bytes, IPv6 is 40 bytes), an UDP header (8 bytes) and a RTP header (12 bytes), adding 40 bytes (60 bytes for IPv6) to the payload. It is not spectrum efficient to send packets that contains more than 50% overhead. However, there exist techniques to compress the IP/UDP/RTP headers, called header compression. The existing algorithm, called Compressed RTP (CRTP) [1], does not perform well over cellular radio links. Hence, a more robust and suitable algorithm has been developed by Ericsson in cooperation with Luleå University of Technology, called Robust Checksum-based header Compression algorithm (ROCCO) [2].

This paper presents the field trial when ROCCO was used for the first time to send IP-based voice traffic over a WCDMA-channel. The field trial was conducted in the Tokyo area, Japan, during July and August 2000, and was a joint cooperation between Ericsson and Japan Telecom [3]. During the field trial IPv4 was used as the network layer protocol. Hence, if not explicitly stated otherwise, IP implies IPv4. The rest of the paper is organized as follows: Section 2 presents some of the challenges transporting voice over IP over a wireless network, section 3 describes both the existing header compression algorithm (CRTP) and why it does not work efficiently over cellular radio links, as well as how ROCCO works. Section 4 describes the field trial setup while the results gathered during the tests are analyzed in section 5. Section 6 presents what has happened after the field trial with standardisation within IETF of a Robust Header Compression (ROHC) algorithm, while section 7 gives a summary.

2 VoIPoW Challenges

To date all cellular systems have been optimized for *spectrum efficiency* and *voice quality*. Voice codecs that recover from bit errors and packet losses yields good voice quality even

Background

Computer networks have a layered structure, where different layers are assigned different tasks. Each layer on a host communicates with its peer layer on the remote host it is communicating with, see Figure 1. Information exchanged between peer layers are transmitted in headers that are prepended to all datagrams.

IP (Internet Protocol) is a network-layer protocol and responsible for transmitting datagrams between end-hosts through a network that might consist of multiple intermediate routers. UDP (User Datagram Protocol) is a transport layer protocol. As IP is responsible for delivering packets to the correct hosts, UDP is responsible for delivering packets received from the IP layer to the correct application on the end host. RTP (Real-time Transport Protocol) provides information to a waiting real-time application, such as timestamps used to play out the payload, what codec is used by the sending application, a sequence number to detect if packets arrive out of order or if packets are lost, etc.

The current de-facto way of transporting real-time data, such as voice, over IP-based networks is to encapsulate the data packets generated by the real-time application into IP/UDP/RTP-packets that are transmitted through the network. The information in the headers are used to route the packet to the correct host, to transmit the packet to the correct application on that host, and finally to transmit the data in the correct order at the right time to the decoder.

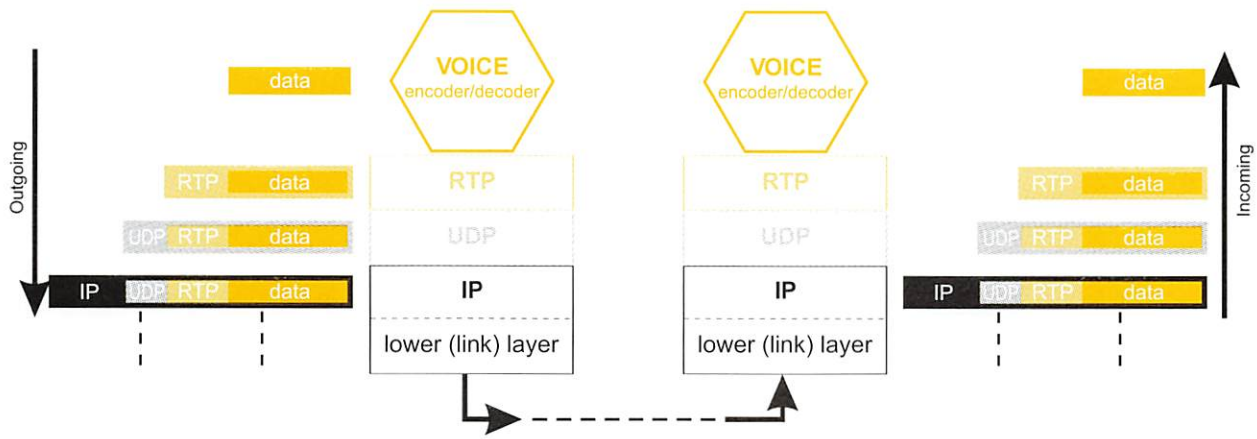


Figure 1 Packets sent and received through the IP/UDP/RTP stack

over error prone links while the circuit-switched environment guarantees efficient use of spectrum. The main advantage of running an all-IP environment is *service flexibility* [4]; since there are no dependencies between an application and the access network, almost anyone can develop new applications. *Service flexibility* adds a third dimension to the two dimensions *spectrum efficiency* and *voice quality*. As can be seen in Figure 2, circuit-switched voice has very good spectrum efficiency and voice quality, but limited service flexibility — a person can speak to someone else and send Short Message Service (SMS) messages, but nothing else. Voice sent over IP (VoIP) on the other hand has decent voice quality and excellent service flexibility, but small voice packets with large headers yields poor spectrum efficiency. The main VoIPoW challenge is to achieve at least as good voice quality and spectrum efficiency as in a circuit-switched network while having the same service flexibility as in a wired IP-based environment [5,7].

3 Header Compression

High spectrum efficiency implies that almost all bits transmitted are used by the receiving application. It is not spectrum efficient to transmit voice over IP, since more than 50% of the packet contains data not used by the application but used to route the packet to the receiver where the application lies. However, there exists a technique called *header compression* (HC) that temporarily (on a link point-to-point basis) improves the spectrum efficiency by reducing the header size. For example, the existing IP/UDP/RTP header compression standard, called CRTP, compresses the 40 byte IP/UDP/RTP header to a minimum size of 2 bytes on a link point-to-point basis.

To understand how this is done one has to analyse the different header fields. While all fields are needed to send a voice packet from one application to another over an IP network, there is a high degree of redundancy between header fields in consecutive headers in the same packet stream. There are several static fields that do not change during a call, for example the IP source and destination addresses. These fields do not have to be sent more than once (in the first packet), the decompressor then remember these fields and set their values when decompressing subsequent packets. There also exist fields that are known before transmission, e.g. the RTP version number; there exists only one RTP

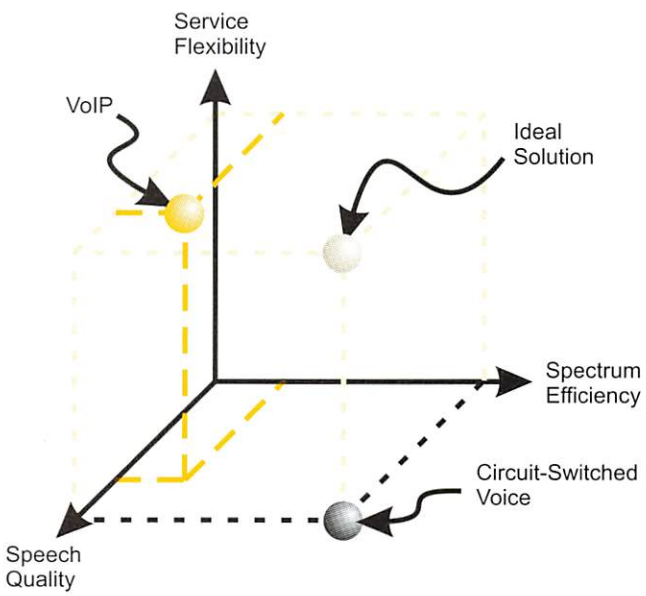


Figure 2 The Voice-over-IP-over-Wireless (VoIPoW) cube

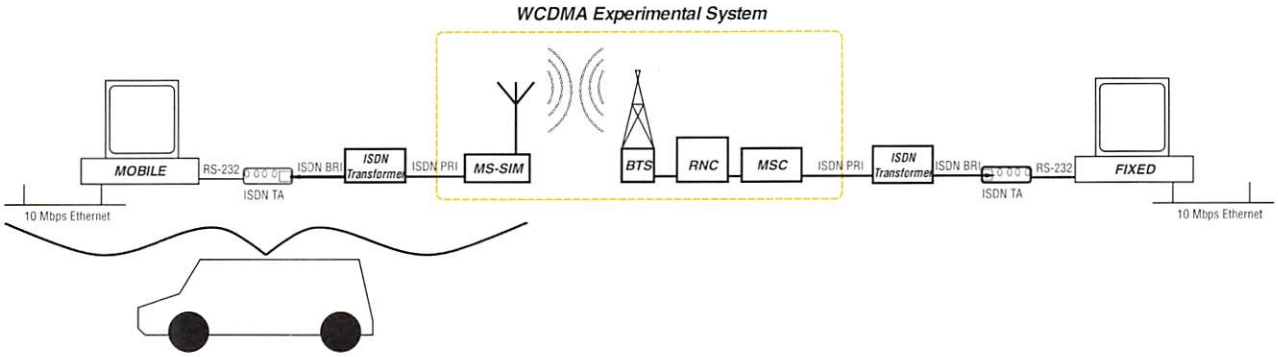


Figure 3 A view of the equipment used during the field trial

version, therefore everyone knows the version number. Moreover, some fields that do change during a session either change in a predictabe way or the changes are small. If they change in a predictable way the changes do not need to be sent, the decompressor can predict their values. If the changes are small only the difference has to be transmitted, not the entire field.

To enable header compression on a packet stream the compressor and the decompressor must be able to maintain a context (essentially the uncompressed version of the last packet sent), and the compressed packet headers only transmits the changes to the context. This implies that header compression can be performed over a point-to-point link basis only. All header information is used by intermediate routers to route a packet over several hops to the correct receiver.

If a compressed packet is lost over the link the decompressor cannot reconstruct the headers in a correct way, the decompressor has lost its context. Therefore, when a compressed packet is lost the decompressor detects that it has lost the context and sends a request to the compressor for a context update (i.e. the full, uncompressed headers). When the context update packet arrives at the decompressor the decompressor regains the context and knows once again how to rebuild subsequent compressed packets. However, all packets received by the decompressor after a packet was lost but before the context update packet arrives are discarded because the decompressor does not know how to uncompress these packets.

The current IP/UDP/RTP header compression standard, CRTP, works as described above. Hence, CRTP works well over narrowband links with short round-trip times (RTT) and low bit-error-rates (BER), and its compression ratio is good enough for spectrum efficiency. However, since CRTP discards all packets received by the decompressor after a packet loss but prior to the arrival of the context update packet, CRTP is far too fragile to work well over realistic cellular radio links with high BERs and long RTTs [6]. A header compression algorithm suitable for cellular radio links must be able to recover from several consecutive packet losses [7,8]. Also, the probability for transmitting an incorrect reconstructed header must be kept below a very low threshold.

A header compression scheme with a high degree of compression and robustness suitable for wireless usage has been developed by Ericsson and Luleå University of Technology. The scheme is called RObust Checksum-based header COmpression (ROCCO) and is heavily geared towards local context repair. ROCCO compresses the IP/UDP/RTP header down to a minimum of 1 byte, ROCCO can recover from up to 28 consecutive packet losses, and ROCCO verifies that it has reconstructed the full headers with a checksum. To achieve high compression ratio without loosing generality ROCCO is constructed as a framework, explaining the general concepts of ROCCO, with profiles optimized for different types of RTP streams and channel conditions. Before a packet is compressed the compressor calculates a CRC checksum over the full headers. This checksum is placed in the compressed header and sent to the decompressor, who uses the checksum to verify that it has rebuilt the headers correctly. Also, if the decompressor fails its first attempt to reconstruct a header (the checksum fails) it can try to rebuild the header again and then verify whether this new attempt was successful or not. The compressed ROCCO headers also includes an encoded sequence number, allowing the decompressor to realize whether there has been any packet losses between the last packet that arrived and the current packet. The encoded sequence number allows the decompressor to recover from up to 28 consecutive packet losses without loosing its context.

4 Field Trial

Theoretical analysis as well as extensive simulations and emulations have been performed to compare the behaviour of ROCCO and CRTP, and to verify that ROCCO is as robust as the theoretical results yield . However, these results were generated by simulators and emulators and had to be verified by actual test results. In order to verify the actual performance and behavior of ROCCO, a field trial was conducted in cooperation with Japan Telecom during July and August, 2000, in the Tokyo area [3]. The field trial was performed over Japan Telecom's WCDMA Experimental System (WCDMA-ES). The WCDMA-ES comprises of a Mobile Station Simulator (MS-SIM) on the mobile side, and a Base Transciever Station (BTS), a Radio Network Controller (RNC) and a Mobile Switching Center (MSC) on the fixed side. The MS-SIM communicates with the BTS through a transparent Unrestricted Digital Information 64 kbps (UDI-64) channel WCDMA radio link. This is a Dedicated Traffic Channel (DTCH128) with spreading factor 16, (R=1/3, K=1/9) convolutional encoding and bit interleaving. The BER of this cellular radio link is approximately 10^{-3}. The outer (Reed-Solomon) encoding was disabled to allow us to manually set the E_b/I_o [2] target value and thereby vary the channel BER between test runs. The mobile part of the ES (the MS-SIM) was placed in a van to allow field tests to be conducted in a mobile environment. Figure 3 shows the equipment used during the field trial. The BTS antenna was mounted about 50m above the ground pointing in the direction of where the field trials took place, while the mobile antenna was mounted on the roof of the van. The ES communicates with the user equipment through two network termination units (ISDN transformers, Groomers), one connected to the MS-SIM and the other connected to the MSC. The round-trip-time through the ES was approximately

[2] The E_b/I_o value can be likened to the Signal-to-Noise Ratio (SNR) of the radio channel; a larger E_b/I_o value implies a cleaner and less bit-error prone channel.

400ms and was mainly contributed by the ISDN transformers and could not be removed.

The user equipment used during the field trial consisted of two laptop PC's, connected to the ES through two ISDN Terminal adapters, see figure 3. The sending application generates a single unidirectional GSM-like[3] stream that is encapsulated in a Point-to-Point Protocol (PPP) frame before transmitted through the WCDMA-ES. If header compression was used the IP/UDP/RTP headers were compressed prior to the packets being encapsulated into PPP frames. At the receiving side of the ES packets were decompressed (if header compression was enabled) and logged for post-transmission analysis. Packets were transmitted in the uplink direction only during the field trial. Five different scenarios were tested for every E_b/I_o value: Packets transmitted with uncompressed, full headers with UDP checksum enabled (pkt size: 72 Bytes(B)), packets with uncompressed, full headers but the UDP checksum disabled (pkt size: 72 B), packets compressed with CRTP (pkt size: 34 B), packets compressed with ROCCO profile 8[4] (pkt size: 34 B) and ROCCO profile 7[5] (pkt size: 33 B). CRTP was setup to transmit one context update request packet when a packet loss was detected and then wait for the update packet to arrive. If the update packet was lost as well, a timeout occured and the decompressor transmitted a new context update request packet was transmitted. Twice[6] was not used.

PPP contains a checksum that is calculated over the entire PPP frame, to allow the receiver to detect and discard PPP frames containing bit errors. However, modern day speech codecs are capable of extracting information from bit-errored packets. Hence, such packets with bit errors in the payload part of the packet should be delivered to the application while packets containing bit errors in the header must be discarded, since correct header information is vital for delivering the packet to the correct application on the correct receiving host. To allow this, a modification, called PPPLite, was made to PPP allowing the user to specify how many bytes should be covered by the PPP checksum. During the field trials the PPPLite checksum was set to cover the header (compressed or uncompressed) part of the packet plus the first byte of the payload.

5 Results

The field trial comprised of two parts, one part when the van was standing still and one part when the van was driven along a predefined route. During the stationary part the van was parked about 50m from the BTS with a direct line-of-sight between the antennas. During this part 10,000 packets were transmitted for each of the five scenarios mentioned above before the E_b/I_o value was altered. The results from these test-runs are used to show the difference in behavior between the algorithms regarding Packet Loss Rate, Mean Header Size and Consecutive Packet Losses.

Packet Loss Rate tells how many packets are lost on the link either because they were hit by bit errors or because the decompressor loses context. Figure 4 shows the results for the different packet streams at different channel qualities. Mean Header Size is the total number of header bytes received divided by the total number of packets received. If no Header Compression (HC) is used all packets will have a 40 byte header and, hence, the mean header size will be 40 bytes. HC algorithms generally transmit larger headers in the beginning of a stream before transmitting smaller compressed headers. Also, if the decompressor looses its context it must ask for context update, which will be transmitted in larger headers as well. This implies that as the link quality deteriorates the mean header size grows, more bandwidth is used to transmit voice packets when the link quality is poor than is used when the link quality is good. Consecutive Packet Losses tells how many consecutive packets are lost. As can be seen in figure 5 CRTP frequently looses 20 consecutive packets while ROCCO profile 7 mainly display single packet losses. Figure 5 clearly displays the difference in behavior between CRTP and ROCCO, and will be discussed shortly.

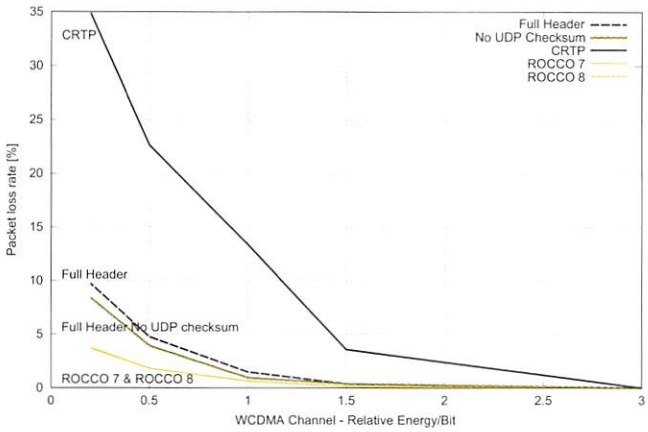


Figure 4 Packet loss rates at different channel qualities with the stationary van

During the moving part of the field trial the van was driven along a predefined route, as shown in figure 6. The speed of the van was approximately 30km/h, and one lap took about 5 minutes to complete. The black boxes in figure 6 are obstacles where direct line-of-sight between the BTS and MS-SIM antennas was lost.

The moving tests were only performed for ROCCO profile 7, CRTP and Full headers with the UDP checksum disabled. As for the stationary part, packet loss rate (figure 7), mean header size and number of consecutive packet losses (figure 8) were investigated.

The target E_b/I_o value, in this article presented as Relative Energy/Bit, was set to several different values during the field trial, ranging from a good, almost bit-error free channel to a poor, bit-error prone channel. A high relative energy/bit value represents a channel with higher E_b/I_o value than a channel with a low relative energy/bit. As can be seen from the different figures, different header compression algorithms yield different results when looking at packet losses, mean header sizes and consecutive packet losses, even though the compression rate is roughly the same (40 bytes compressed to 1 - 2 bytes).

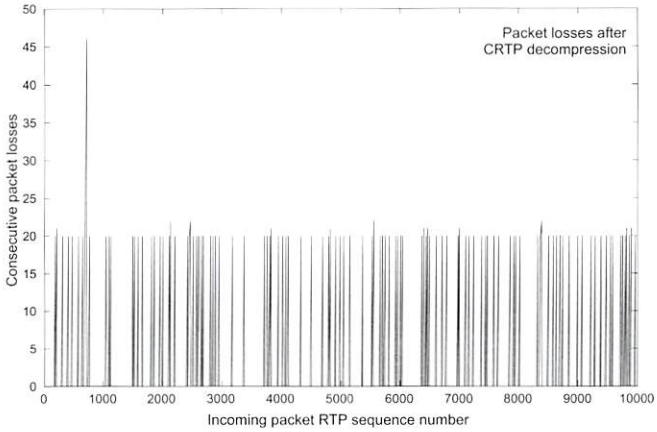
ROCCO yields fair results even when the link quality decreases because the decompressor never lost its context during the tests. This implies that if a packet is struck by bit errors in the header, that packet is discarded. But if subsequent packets are not bit-errored they will be decompressed and transmitted to the application, i.e. the decompressor does not have to discard error-free packets while waiting for a context update to arrive. The mean header size does not grow as the channel deteriorates because no large update packets has to be transmitted. ROCCO yields a lower packet loss rate, not only compared to CRTP but also compared to transmitting un-

[3] A stream consisting of 72 bytes big packets (40 bytes of IP/UDP/RTP headers followed by 32 bytes of 'audio' payload), one packet transmitted every 20 ms.

[4] ROCCCO profile 8 has a 2 octet compressed header and can recover from up to 28 consecutive packet losses

[5] ROCCCO profile 7 has a 1 octet compressed header and can recover from up to 12 consecutive packet losses

[6] Twice is a simple mechanism for local repair that makes assumptions about what the lost packet header contained. If Twice is used there must be a way to verify whether the attempted repair was successful or not. See [1] for details.



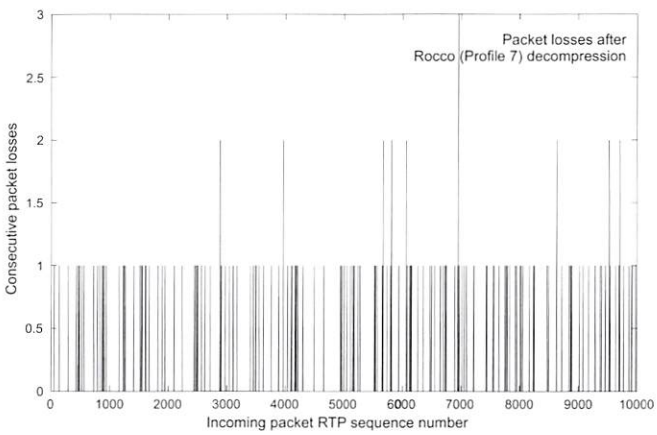


Figure 5 Number of consecutive packet losses with the relative energy/bit set to 0.5 and with the stationary van. Note the different scales on the Y-axis

compressed headers because there are not as many sensitive header bytes sent that can be hit by bit errors.

CRTP yields very large consecutive packet losses, higher overall packet losses and larger mean header sizes than ROCCO. CRTP was not created for bit-error prone links with high BERs and adapts poorly to such an environment. This becomes evident when the link quality decreases. Every time a compressed packet is lost over the link the CRTP decompressor has to issue a context update request and wait for the context update packet to arrive before the CRTP decompressor knows how to rebuild any headers, all packets sent between the lost packet and the context update packet are discarded independent of if they were damaged or not. In the environment of the field trial, where a packet was transmitted every 20ms and the RTT was about 400ms, this means a minimum of 20 consecutive packets being discarded by the decompressor before the update packet arrives. This behavior can be seen in figure 9, which displays an incoming compressed packet stream before and after CRTP decompression. Two packets were lost on the link, but each packet loss generated a big gap in the packet stream after decompression. An environment with a smaller RTT (GSM typically has a RTT of 160ms) would yield less consecutive packet losses. However, 8 consecutive packet losses is far too big a gap for any present-day voice decoder to recover from without the user noticing it.

These discarded packets cause more than a reduction of available bandwidth for other traffic. In a WCDMA system each stream appears as interference to other streams. Hence, these packets which are destined never to reach the remote application due to loss of the decompressor's context, will create unnecessary interference to other traffic streams.

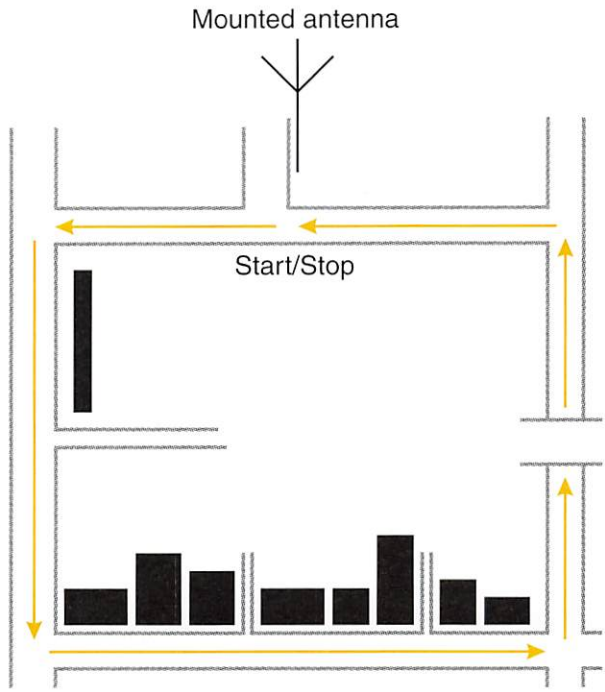


Figure 6 The route driven during the mobile part of the field trial. The black boxes shows where direct line of sight was lost between the van and the BTS antenna

Furthermore, since CRTP frequently asks for context updates the mean header size grows as the cellular radio link quality deteriorates. The results gathered during this field trial show a 30% increase in mean header size between the lowest and the highest relative energy per bit used during the stationary part of the test. The corresponding increase of the mean header size during the moving part of the field trial yield a 10% increase. This is an undesirable behavior to use more radio resources as the link quality decreases. Also, the update packets are larger in size and hence more prone to be hit by bit errors in this high bit-error environment. The mean header size for ROCCO remained constant during the field trial since ROCCO never issued a context update request.

The minimum value used for relative energy/bit was 0.2 for the stationary part, and 2.0 for the moving part of the field trial. The distance between the van and the base station altered, and direct line of sight was temporarily lost during the moving tests. The relative energy/bit had to be set to a value that prevented the link breaking during the harshest parts of the test run. Since the link quality did not alter as much during the stationary part, the relative enerby/bit could be set to a lower value.

Figure 5 and figure 8 show this behavior. The relative energy/bit was set to 0.5 in figure 5 while the relative energy was set to 2.0 in figure 8. The packet losses, caused by bit errors, are evenly distributed in figure 5, while most of the packet losses in the moving test, see figure 8, occur when the direct line of sight is lost between the van and the base station antenna.

Packet streams sent with full headers yield about twice as many packet losses as packet streams compressed with ROCCO, even though these packet loss rates are significantly lower than the packet loss rates achieved with CRTP. The reason packet streams sent with full headers yields a lower packet loss rate than if compressed with CRTP is obvious, no packets are discarded due to the decompressor being out of context. Every packet carries full header information. The problem is transmitting voice over IP over wireless without any header compression is not spectrum efficient.

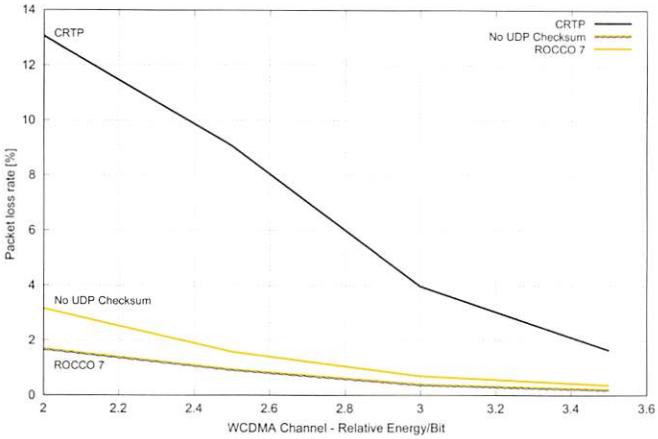


Figure 7 Packet loss rates at different channel qualities during moving tests

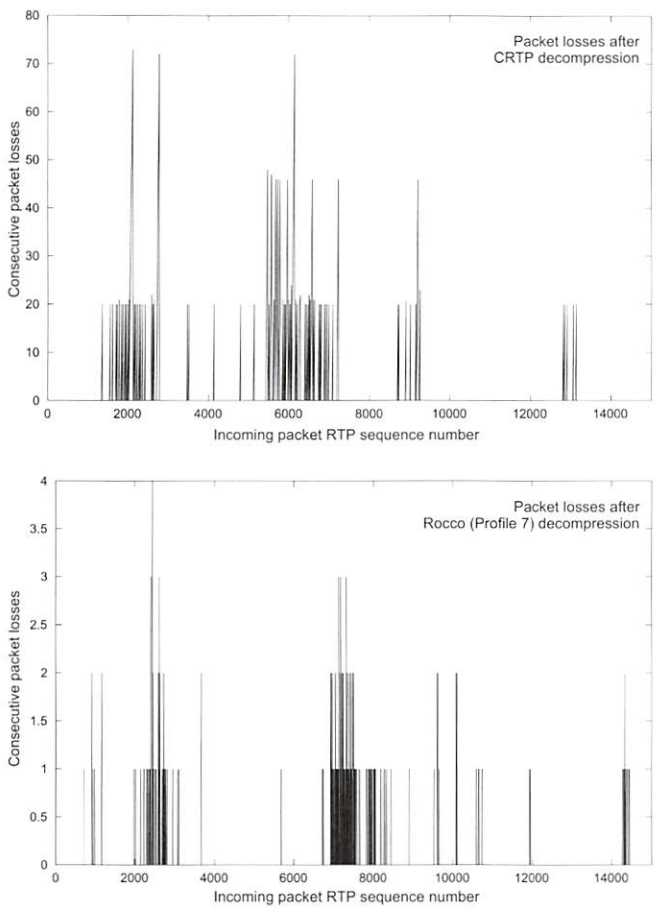


Figure 8 Number of consecutive packet losses with the relative energy/bit set to 2.0 during the moving tests. Note the different scales on the Y-axis.

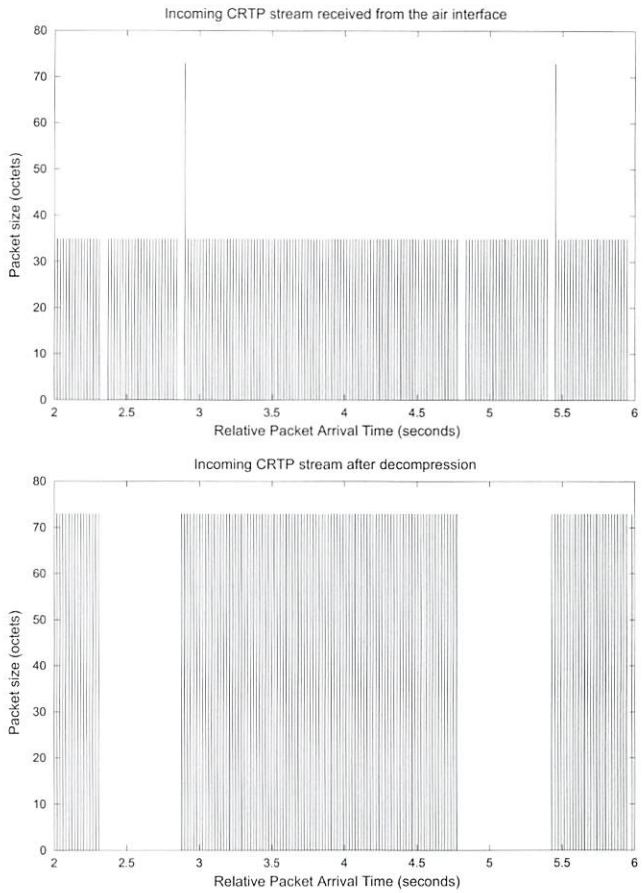


Figure 9 Before and after CRTP decompression. The figure show two packet losses before (top) and after (bottom) decompression. Several packets are discarded because the decompressor has lost its context and waits for a context update.

6 Standardisation activities

Field trials are important to ensure that a developed scheme (e.g. ROCCO) works as expected also over real WCDMA air interfaces compared to simulations. However, to enable use of such a header compression scheme in a large scale and in systems such as WCDMA and EDGE, the scheme needs to be standardized. Further, a header compression scheme such as ROCCO is applicable to basically any cellular system and shouldn't be tailor-suited to only one system. Hence, ROCCO was presented to the Internet Engineering Task Force (IETF) during the summer of 1999. The drawbacks of CRTP over wireless links was shown and ROCCO was presented as one solution to this problem. This resulted in the creation of a new IETF working group called ROHC (RObust Header Compression) by the beginning of 2000. The ROHC working group have the development of robust header compression schemes suitable for wireless usage on it's charter.

During year 2000 the ROHC working group have created the ROHC standard. ROHC is a framework for robust header compression that contains several header compression profiles. The first set of profiles are mainly targeted for real-time IP (i.e. compression of RTP/UDP/IP) but contain capabilities for compression of UDP/IP only, IPSec headers, IP tunnels, etc. The ROHC framework and the first set of profiles will also be adopted by 3GPP for compression of IP headers over the air interface for UMTS and EDGE systems. The ROCCO scheme has been a main contributor to the ROHC framework and it's compression profiles; two of three modes in ROHC are based on ROCCO as well as general techniques such as the concept of compression profiles, the usage of header checksums, robust encoding technique for e.g. sequence numbers and timestamps, packet types identifiers, etc. Hence, these field trials serve not only as a verification of the ROCCO scheme, but also as a partial verification of the ROHC standard used over WCDMA since ROHC is to a large extent based on ROCCO.

7 Conclusions

Today's circuit-switched cellular systems yield good voice quality and spectrum efficiency, but they provide very little service flexibility. Transporting voice over IP, on the other hand, provides the user with full service flexibility, but very poor spectrum efficiency. To minimize delays in voice traffic, small voice packets must be sent often; GSM transmits one packet of 32 data bytes every 20ms.

Several algorithms exist that increases the spectrum efficiency by compressing the headers. However, these algorithms are not designed for radio networks and they behave poorly over such links.

A more robust, checksum-based header compression algorithm (ROCCO) has therefore been developed by Ericsson and Luleå University of Technology. ROCCO compresses the headers to a minimum of 1 byte and recovers from multiple consecutive packet losses without loosing synchronisation. The field trials verify that ROCCO performs well and is sufficiently robust when used over a WCDMA radio link.

ROCCO has been a major contributor to the Robust Header Compression (ROHC) working group within IETF, standardizing a robust header compression algorithm. Hence, this field trial gives an insight into what is possible to achieve with the ROHC algorithm.

8 References

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Johan Nielsen <johan.nielsen@era-t.ericsson.se> joined Ericsson Research, corporate unit, in 1999. Johan has been working with efficient transportation of real-time IP traffic in IP-based 3G cellular systems and ad-hoc networks. Johan has during spring 2001 started his PhD studies as part of his employment at Ericsson.

Krister Svanbro received his MSc in Computer Science from Luleå University of Technology in 1997. Krister has been working at the corporate unit Ericsson Research since 1997. Krister is currently working as a research manager heading a team developing algorithms enabling efficient realizations of real-time IP services in all IP 3rd generation cellular systems.

Vicknesan Ayadurai obtained a BE in Electrical and Computer Systems in 1991 and has six years of experience in the field of data and telecommunications. In 1999 he obtained his MSc and has since been working with Ericsson Research. His areas of research include implementing new algorithms in the area of real-time IP communications.

Yukimaru Matsuya is deputy general manager of Mobile communications department ,Information and Communication Laboratories of JAPAN TELECOM. That department is actively involved 3G and beyond 3G mobile RAN technical field. He participated as a leader of WCDMA experiment 3 years ago. In his current role he manages execute WCDMA radio tuning in actual network of J-PHONE.

Isao Sato received the MSc degree in 2000 from the Department of Electrical and Electronic Engineering, Tokyo Institute of Technology in Japan. In April 2000, he joined Japan Telecom Corporation, where he has been engaged in research and development of next generation mobile communication systems.

Report on Joint Rail Conference 2001

This year's Conference, sponsored jointly by the Land Transportation Division of the Vehicular Technology Society of the IEEE and the Rail Transportation Division of the ASME, was held at the Royal York Hotel in Toronto on 17-19 April. The Conference started with 37 enthusiasts enjoying a Technical Tour of the Toronto Transit Commission Harvey Heavy Maintenance shop. The TTC were in the process of overhauling ALRV cars, CLRV cars and mono-motor trucks. Visitors also saw H Series dc traction motors and T-1 ac traction motors being overhauled, as well as M/A sets for H-4 cars. Over 120 people participated in the Conference from all over the world including China, Japan, Taiwan, Italy, Germany, France, and the UK, as well as from Canada and the USA. Twenty-six papers were presented on a variety of electrical and mechanical technical topics from "The Development of a Next Generation ATP System" to "Development of Locomotive wheels for Improved Adhesion and Life". All papers generated a great deal of audience interest and questions.

Keynote Speakers addressed the attendees at luncheons sponsored by the IEEE and ASME. The IEEE speaker was Robert A. Boutilier, P. Eng, Deputy General Manager of the TTC and the ASME Speaker was Dennis Waller, Vice President Engineering and Mechanical, CN/IC Railroad.

At the IEEE Luncheon, the IEEE VTS LTD Chair, Clive Thornes, PB Transit & Rail Systems, Inc., passed the gavel to the incoming Chair, John Kingham, STV Inc. The other officers elected for 2001–2002 were: Vice Chair, Al Santini, Metro-North; Secretary/Treasurer, Fred Childs, PATH; Papers Chair, Margaret Burnett, LTK Engineering; and Publicity Chair, Denise Burleson, PB Transit & Rail Systems, Inc.

Figure (Center) Happy group at the Toronto Transit Commission's Harvey Heavy Maintenance Shop, (clockwise from bottom left) Luncheon audience listens attentively to IEEE keynote speaker, Robert A. Boutilier, P. Eng, Deputy General Manager, Toronto Transit Commission, Chair Clive Thornes presents a comemorative plaque to keynote speaker Robert A Boutilier, Outgoing Chair, Clive Thornes transfers gavel to incoming Chair, John Kingham, Keynote Speaker Robert A. Boutilier, Incoming Chair, John Kingham presents outgoing Chair Clive Thornes with commemorative plaque, Local Chair, Stephen Lam of the TTC (bending on left) explaining details of monomotor truck flexible wheels.

Report on VTC2001-Spring

The 53rd IEEE VTS Vehicular Technology Conference took place in Rhodes, Greece, from 6 – 9 May 2001. The conference was originally planned for Tel Aviv, Israel, but due to the situation in Israel it was decided to move to Rhodes.

The conference contained a total of 420 oral presentations and 188 posters, and 639 people registered to attend. About 200 of these took the opportunity to attend one of the tutorials which were held on the first day.

The technical programme began on Monday 7th May. The conference was opened by the Conference Chair, Reuven Meidan. The opening speaker was Dr Kai Siwiak of Time Domain Corp, who gave an overview of Ultra-Wide Band communication. This is a new type of radio communication where rather than modulating a carrier signal, short individual pulses or wavelets are transmitted. The advantage of such a system is that multipath channels not longer cause Rayleigh interference since there is no continuing carrier for the multipath signals to interfere with. However, there are important regulatory issues with such a system because of the wide band of the transmitted signal, albeit of low power. An article introducing Ultra-Wide Band transmission is in preparation for *VTS News*.

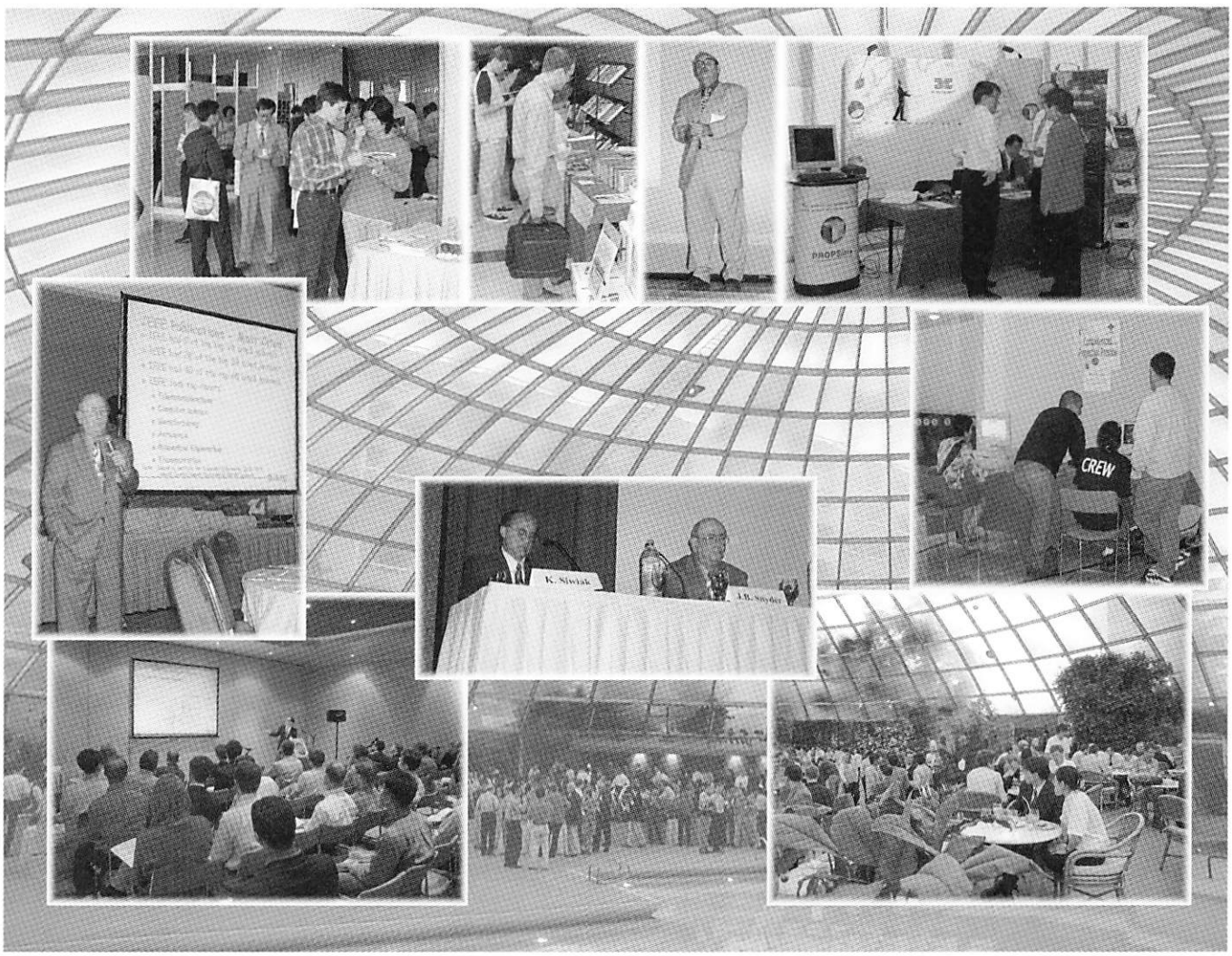


Figure Scenes from VTC2001-Spring. Guest speakers Kai Siwiak and Joel Snyder (center), (clockwise from bottom left) one of the technical sessions; IEEE President Joel Snyder addresses the conference; coffee gives an opportunity to study the posters; the three book sellers – Artech House, John Wiley & Sons, and Kluwer, do good business; Conference Chair Reuven Meidan opens the conference; VTC2000-Spring secretary Tad Matsumoto studies one of the exhibits; presenters check their electronic presentation; the evening reception.

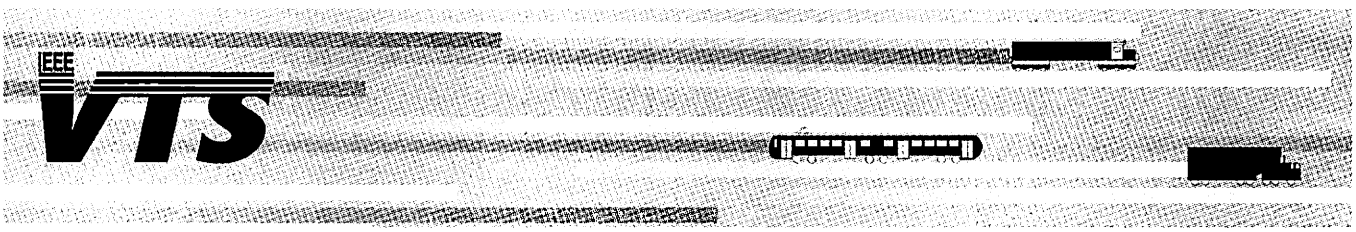
IEEE President, Joel Snyder attended the conference and addressed the lunch on the first day. He noted how the membership of the IEEE had grown substantially over the past few years, doubling over the past 25 years from 179,800 members in 1975 to 366,100 last year. A large proportion of the increase in membership has occurred outside the US, so the proportion of members coming from outside the US has risen from 8% in 1963, to 18% in 1985 and 29% in 1995 to 35% last year. If this growth rate continues it is likely that within a few years non-US members will form half of all IEEE members.

The Awards Lunch was held on the Tuesday. A full report of all the awards, along with those which will be presented at VTC2001-Fall in Atlantic City, will appear in the next *VTS News*.

As has been the practice for the past few VTCs, poster presentations were made in the same area as the coffee breaks, giving good opportunities for discussion. The poster and coffee area was also home to some exhibits and the three publishers who were present. Also popular was the fact that all presentation rooms were near to each other, allowed easy movement between different halls.

Conference organisation was in the hands of Dan Knassim, who, with Chair Reuven Meidan, have to be congratulated for their ability to switch the conference venue at such a late stage and yet still ensure everything ran so smoothly. VTC is not a small conference, and they are usually planned several years in advance, so this logistical challenge should not be underestimated. There was even room for innovation. All attendees were given a book of paper abstracts to help them choose sessions. Much of the AV equipment was brought from Israel, and presenters were invited to load their presentations on to the central system in advance for electronic presentation in the technical sessions. This avoided any difficulties and lost time in changing over laptops, as well as the experience seen at VTC2000-Fall in Boston of presenters totally reliant on their laptop (i.e. no backup transparencies) finding that their laptop and the conference's projector won't talk to each other. Moral – always take back-up slides!

Overall, the conference presented an interesting and varied technical programme in pleasant surroundings. Even the weather obliged, being warm and sunny on the days before the conference but not too good on the conference days themselves so attending sessions was not too much of a burden!



Ford's Zero Emission P2000 Fuel Cell Vehicle

Kurt D. Osborne, Mark S. Sulek, Ford Motor Company.

The P2000 Fuel Cell Electric Vehicle developed by Ford Motor Company is the first full-performance, full-size passenger fuel cell vehicle in the world. This development process has resulted in a vehicle with performance that matches some of today's vehicles powered by internal combustion engines. The powertrain in Ford's P2000 FCEV lightweight aluminum vehicle consists of an Ecostar electric motor/transaxle and a fuel cell system developed with XCELLSiS-The Fuel Cell Engine Company (formerly dbb Fuel Cell Engines, Inc.). Ballard's Mark 700 series fuel cell stack is a main component in the fuel cell system.

To support this new FCEV, Ford has constructed the first North American hydrogen refueling station capable of dispensing gaseous and liquid hydrogen. On-going research and development is progressing to optimize fuel cell vehicle performance and refueling techniques.

Introduction

Auto manufacturers have been reducing the level of vehicle emissions steadily since the US Clean Air Act of 1971. While successful, this effort has been deemed insufficient by the Environmental Protection Agency (EPA) and other foreign agencies.

A mandate by the California Air Resources Board (CARB) called LEVII (Low Emission Vehicle) sets stringent limitations on tailpipe emissions. The proposal, a four-year phase-in beginning in 2004, requires all light trucks to meet the same emission levels as cars. Additionally, it reduces the allowable level of NOx emissions from the current level of 0.4 g/mi to 0.05 g/mi [3]. California regulations also mandate that 10% of all vehicles sold in California be zero emission vehicles (ZEVs) starting in 2003.

Therefore, the new emission limits are a serious concern for automakers. While auto manufacturers are developing new vehicle technology to meet the latest regulations, only battery electric and fuel cell electric vehicles will meet the ZEV requirement. Battery electric vehicles have some disadvantages such as increased weight, limited range, and limited recharging sites. As will be seen, the fuel cell electric vehicle (FCEV) eliminates these disadvantages while retaining the electric vehicles' advantages.

Ford' commitment to this technology is apparent with their partnership established with Ballard and DaimlerChrysler in 1998. In 1999, a California Fuel Cell Partnership was formed called "Driving for the Future." Its members include Ford, Ballard, DaimlerChrysler, Honda, VW, ARCO, Shell, Texaco, California Air Resource Board (CARB), and the California Energy Commission (CEC). Together, the partnership will produce 45 fuel cell vehicles and

Property	Hydrogen	Methane	Propane	Gasoline
Lower flammbility limit (% volume in air)	4.0	5.0	2.1	1.3
Upper flammbility limit (% volume in air)	75	15	9.5	7.8
Minimum ignition energy (mJ)	0.02	0.30	0.26	0.24

Table 1 Properties of gaseous hydrogen and other conventional combustible fuels [1].

buses by 2003. This paper provides an explanation of fuel cell operation, followed by a review of Ford's P2000 FCEV and the Ford refueling station.

Properties of Hydrogen

Flammability of hydrogen is often one of the first concerns raised about fuel cells. While it is very true that hydrogen can be dangerous, the level of severity must be contrasted to existing fuels.

As can be seen in Table 1, hydrogen has a higher lower flammability limit compared to gasoline (4% volume in air vs. 1%, respectively). Also, ten times less energy is required to ignite hydrogen than gasoline, and the range of flammability is greater for hydrogen than gasoline. However, since hydrogen is the lightest element, if a leak existed, the hydrogen would rapidly disperse and float to the highest point available. This is in direct contrast to gasoline, which collects in pools when it has leaked from its container.

Another advantage of hydrogen that is important to note is that gasoline is a carcinogen, while hydrogen is not. A fact that is often unknown is that hydrogen gas is not the reason for the Hindenburg dirigible's mishap on May 6, 1937. Adison Bain, former NASA hydrogen programs manager, determined that the cotton fabric skin of the Hindenburg was treated with an undesirable compound to strengthen and protect it. This compound contained cellulose acetate (gunpowder) and aluminum powder (used in rocket fuel). Additionally, the inside of the wooden structure was duralumin coated with lacquer— another deadly, flammable combination. Reports of visible flames further illustrate another combustion source since hydrogen burns with a flame that is not detectable by the human eye [4].

Fuel Cell Operation

From a conventional point of view, it would appear that fuel means gasoline–the common fuel. This is false. In fact, the fuel that is used in these cells is hydrogen. The most basic way to describe the fuel cell is that it is one of three types of cells:

1. Primary—uses self-contained reactants
2. Secondary—same as the primary cell except that it can be recharged by driving it in reverse
3. Fuel Cell—reactants are continually supplied and products are continually removed

What makes this type of cell unique in comparison to the other two cells is that it will continue to provide electricity as long as it is "fueled." It does not require recharging.

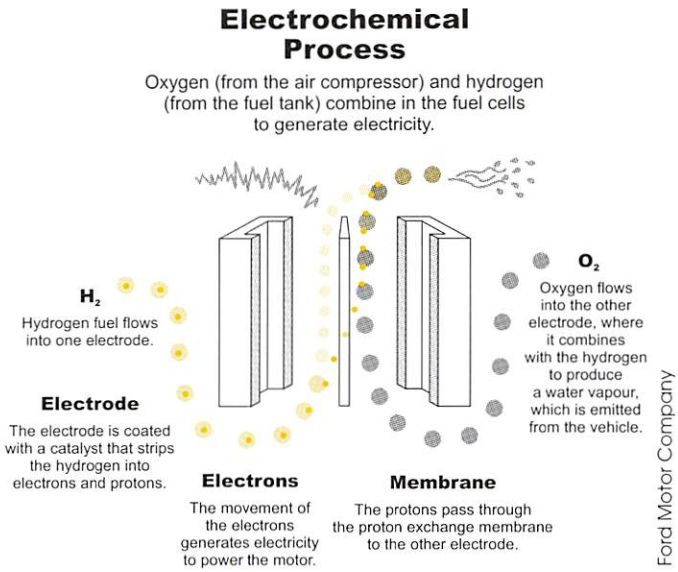


Figure 1 Fuel cell stack electrochemical process.

A fuel cell system consists of one or more fuel cell stacks (see Figure 2). Each stack is comprised of multiple cells in the same way that a battery consists of multiple cells.

Through an electrochemical reaction between hydrogen and oxygen, electricity and warm water is produced as detailed in the redox equations that follow. Therefore, the only by product of the reaction is water and there are no harmful emissions to pollute the earth.

Oxidation: $H_2(g) \rightarrow 2H^+(aq) + e^-$
Occurs at the anode

Reduction: $O_2(g) + 4H^+(aq) + 4e^- \rightarrow 2H2O$
Occurs at the cathode

Overall: $O_2(g) + H_2(g) \rightarrow 2H_2O$
Cell Voltage = 1.2288 V

As can be seen in Figure 1, hydrogen fuel is supplied at the anode side of the fuel cell, while air is supplied to the cathode. A catalyst present between each electrode and the membrane aids the dissociation of hydrogen resulting in two hydrogen protons and one electron.

The proton exchange membrane (PEM) allows the hydrogen protons to pass through to the cathode side to combine with the oxygen atoms and electrons, which results in the formation of water. This occurs after the electrons, which are blocked by the PEM, arrive via the path around the stack—an external circuit—that powers a load such as motor.

Figure 2 below shows a Ballard Mark 700 series fuel cell stack. The six silver caps are the inlet and outlet ports for fuel, air, and cooling water. Fuel and air delivery systems are necessary to control and regulate the flow of reactants to the fuel cell stack. These systems must operate under precise control so that enough energy is always present when requested by the driver. As the driver requests more power, more electrons are depleted from the fuel cell stack. Additional electrons must be generated to meet present and future demand. This is accomplished by increasing the flow of reactants to the stack. It should be realized that meeting the driver's transient demand can be quite a control challenge. Remember that there is also an upper voltage limit that must be observed to prevent damage to other components. This means that meeting future driver demand is not simply a matter of endlessly supplying reactants.

Figure 2 A Ballard fuel cell stack.

Figure 3 Ford P2000 FCEV.

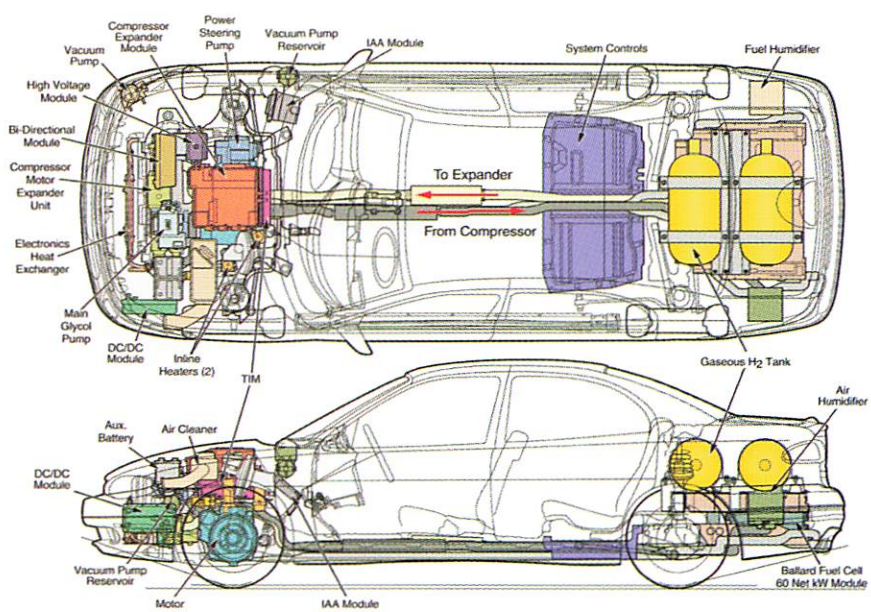


Figure 4 Vehicle component locations [5].

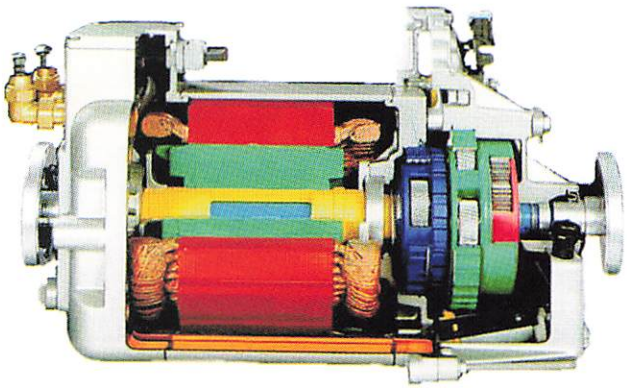


Figure 5 Ecostar electric motor used in P2000 FCEV and EV Ranger.

It is also important to point out that there are many different types of fuel cells as shown Table 2. Automotive manufacturers have selected the proton exchange membrane (PEM) type since it doesn't operate at high temperatures, utilizes materials that are safe to handle, and can be pressurized to increase power density [2]. Vehicle systems benefit by utilizing PEM fuel cells since they operate at a lower temperature (80 °C) than an internal combustion engine. With a lower underhood temperature, other components' designs benefit by this less intense environment.

Ford P2000 FCEV

Body

Ford's first fuel cell vehicle is shown in Figure 3 and Figure 4. An aluminum-intensive body, developed as part of the PNGV (Partnership for a New Generation of Vehicles) program and based on the Ford Contour, helps make it the world's first full-performance, full-sized passenger vehicle powered by fuel cells. The wheelbase was stretched 4 inches giving the passenger more interior comfort. The body was used as a study in understanding methods of manufacturing aluminum working with ALCAN and ALCOA. Aluminum studies in dyes, castings, hydroforming, welding, stamping, and bonding have greatly impacted vehicle fabrication. Lightweight materials were used to generate weight reductions in various components such as Lexan® plastic rear windows, magnesium seat brackets, and ultra light padding used for seat material.

Performance

Three 25 kW stacks result in 67 kW (net) supplied to the wheels via an electric motor. The 3340 lb. extended-Contour accelerates from 0 to 60 mph in just over 14 s.

Traction System

The P2000 FCEV is a front-wheel drive vehicle that utilizes one electric motor with a single-speed transaxle as its propulsion unit. Shown in Figure 5, the electric motor, supplied by Ecostar, is a 4-pole, 3-phase, ac induction motor that is the same as the one used to propel Ford's Electric Ranger truck. It is capable of attaining 12,500 rpm and can provide 190 N·m of torque. Remember that one key benefit of electric motors over inter-

nal combustion engines is their ability to produce maximum torque at very low speeds.

An Ecostar traction inverter module (TIM), shown in Figure 6, serves two functions in the vehicle just like in the Electric Ranger. One of the functions is the overall vehicle controller (right side) and the other is a power inverter (left side). The inverter converts the dc power produced by the fuel cell to ac power that is required to operate the ac induction traction motor.

	Proton Exchange Membrane	Alkaline	Phosphoric Acid	Molten Carbonic	Solid Oxide
Electrolyte	Polymer	KOH/H_2O	H_3PO_4	Molten Salt	Ceramic
Operating Temperature	80 °C	80 – 200 °C	190 °C	650 °C	1000 °C
Fuels	H_2, reformate	H_2	H_2, reformate	H_2, reformate	H_2, reformate, CO
Oxidant	O_2, air	O_2	O_2, air	O_2, air, CO_2	O_2, air
Power	100 W–10 MW	100 W–20 kW	0.2–10 MW	> 100 MW	> 100 MW

Table 2 Types of Fuel Cells [2].

Hydrogen Storage

Two identical tanks as shown in Figure 7 provide onboard storage for a total of 82 liters of hydrogen at 3600 psi. The carbon-fiber wrapped steel tanks have withstood testing under many types of severe environmental conditions such as a crashes and fires. The tanks have an integral valve that prevents leakage if the hydrogen lines are accidentally severed.

Hydrogen can be stored onboard the vehicle in various forms such as compressed gas, liquefied hydrogen, or stored in metal hydrides. Although storing hydrogen in liquid form increases the storage density and therefore the vehicle range, the hardware associated with keeping the gas stored cryogenically increases the vehicle's weight. Also, cryogenically stored hydrogen loses a small percentage of its volume continuously due to boil-off.

Fuel Delivery

Hydrogen fuel is supplied to the fuel cell through a series of regulators that decrease the pressure down to a useable, regulated pressure above atmosphere. Typical fuel and air pressures range from 70 to 300 kPa.

Air Delivery

Oxygen for the reaction is supplied from ambient air and is pressurized with the aid of a compressor to increase power density. Since air is composed of other elements and not pure oxygen, the air flow must be increased to maintain the proper stoichiometry for the reaction. Exhaust air can be recirculated to an expander to improve the system efficiency by decreasing the electrical power required to spin the compressor.

Reformerless

An example of a simplified fuel cell system is shown below in Figure 8. Note that this figure also shows reformer components, which the P2000 did not include; it is a compressed gaseous direct hydrogen fuel cell powered vehicle. The reformation components that are shown in this figure are the gas purification stage, reformer and catalytic burner, vaporizer, and methanol tank.

The vaporizer converts the liquid methanol fuel to a vaporized methanol stream. Next, the reformer converts the methanol to hydrogen through a process called steam reformation. The output from the reformer is a mixture of H2 , CO2 , and CO. Once again, note that a reformer-based system can't be a true ZEV since it is producing CO like conventional automobiles. Therefore, the gas purification stage shown, which can actually be multiple stages, is used to reduce the level of CO to a trace amount (still not a ZEV).

After all of this processing, the resultant mixture, referred to as reformate, is approximately 70% H2 , 24% CO2 , 6% N2 , with a trace level of CO. This entire gas mixture is routed to the fuel cell instead of pure hydrogen, which is the case in direct hydrogen fuel cells.

Note that sulfur, common to all carbon-based fuels, must be removed before use in fuel cells since it "poisons" the fuel cell catalyst [4]. Similarly, CO is also a "poison" and must be removed as well.

Once again, the P2000 eliminates all of these components and substitutes a compressed hydrogen storage tank in place of the methanol tank. The result is truly the simplest fuel cell system possible.

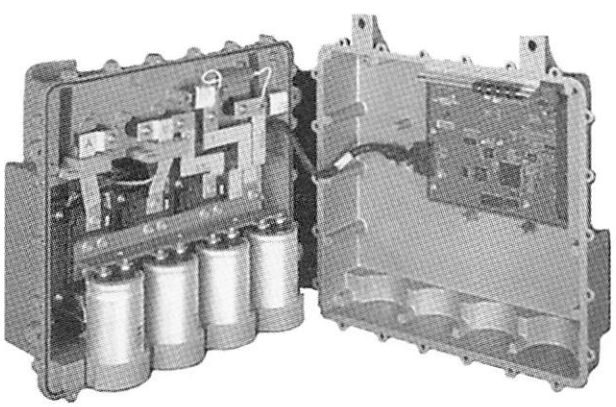


Figure 6 Traction inverter module (TIM) opened to show inverter (left) and vehicle controller (right).

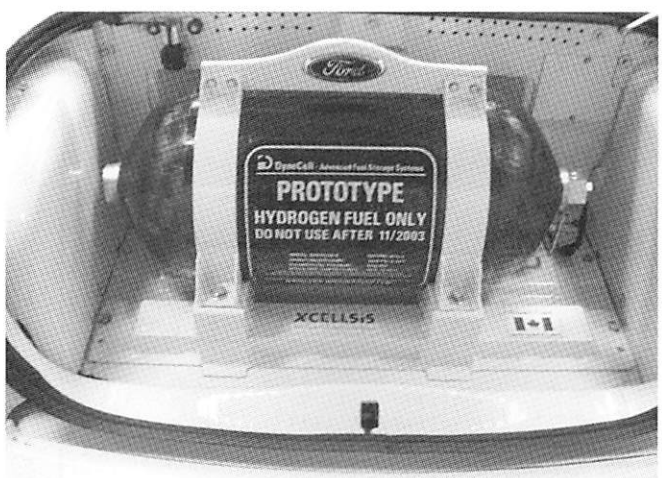


Figure 7 One of two onboard 41-liter hydrogen storage tanks shown in the trunk of the P2000 FCEV.

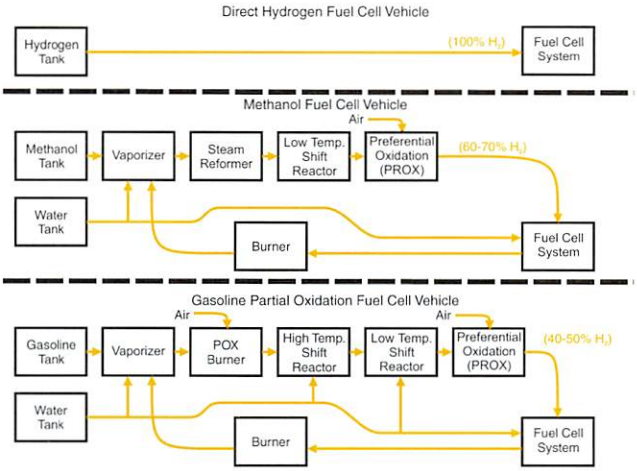


Figure 8 Illustration of the simplicity of the direct hydrogen fuel cell system compared to methanol and gasoline-based fuel cell systems.

DC/DC Converter

A buck dc/dc converter is used to convert the high voltage dc power generated by the fuel cell down to +12 V required by all of the standard automotive loads. Additionally, the dc/dc converter recharges the +12 V battery while the vehicle is operational.

Cooling

Cooling of the vehicle is accomplished via two independent cooling loops. One loop is a conventional water-ethylene glycol loop that cools the power electronics and the electric motor. The other loop cools the fuel cell stack and must be separate since the fuel cell stack requires deionized water as its cooling fluid.

Networks

Two types of communications networks are included in the P2000 FCEV. One is SCP and is Ford's implementation of SAE J1850. It is used to communicate between two controllers. In addition to SCP, two independent 500 kbps CAN networks are used to route data and control the powertrain.

Safety Systems

Many different safety systems were implemented in the design of the P2000. Extra precautions were taken since this was the very first fuel cell vehicle ever built by Ford. Any mishap could negatively impact public perception of fuel cell vehicles, cancel fuel cell programs, or result in loss of life.

As in most electric vehicles, a ground fault detection system was present to detect any current leakage. Any current leakage detected above a predetermined threshold would shut down the vehicle.

A hydrogen detection system was also employed to detect the leakage of hydrogen from any source in the vehicle. Upon detection of any level of hydrogen, the vehicle would be shutdown. Hydrogen sensors were distributed throughout the vehicle with one located underhood, one in the passenger compartment, and two in the trunk near the hydrogen tanks and plumbing. Additional protection was provided by an active ventilation system. Eight small dc brushless fans were installed in strategic areas to ventilate hydrogen. This system was active any time a hydrogen leak was detected, during vehicle operation, when the vehicle was being filled, or whenever a door was opened. In other areas of the vehicle, holes were added for ventilation.

Hydrogen Refueling Station

Reformation

Where does an individual fill up their tank with hydrogen? One proposal is to convert liquid fuels such as methanol or gasoline to hydrogen at a gas station through a process called reformation. Utilizing methanol or gasoline is a way to continue using the existing fuel infrastructure while still enabling the growth of fuel cell vehicles.

Some have proposed to include the reformation process onboard the vehicles. During the first few years of fuel cell vehicle production, an infrastructure that completely covers the US will probably not be available. Therefore, if reformers are included in the vehicle, hydrogen can be made onboard from gasoline or methanol obtained at the gas station.

This architecture (see Figure 8) does have some disadvantages. Inclusion of a reformer system onboard every vehicle increases weight, complexity (dramatically), size, decreases reliability, and results in new safety concerns (temperatures reach 850 °C). The addition of this oil refinery in every vehicle, no matter how small, is not the direction that automakers have been taking long-term.

Direct Hydrogen

The hydrogen refueling station shown in Figure 9 was a joint development project between Air Products and Ford Motor Company and is the first hydrogen refueling station in North America where gaseous hydrogen as well as liquid hydrogen can be obtained. The station has a 1500-gallon liquid hydrogen tank that supplies two separate gas pumps, one liquid, and the other gaseous. The tank consist of three layers: a 1.4 inch carbon steel outer skin, a two inch aluminized mylar middle multilayer insulator, and a one inch inner layer made out of 316 stainless steel.

To supply gaseous hydrogen to the vehicle, liquid H2 is pumped to heat exchangers that turn liquid into a gaseous state at ambient temperatures. The gas is then compressed up to 6000 psi in nine large cylinders. The gas is then pressure fed to the refueling area where the hydrogen is supplied to vehicles. At the filling station, H2 is transferred to the vehicle through high-pressure tubing leading to a Sherex/OPW nozzle, as seen in the Figure 10 below.

A standard operating procedure for refueling has been developed for the facility. This ensures proper safety standards are respected and used before and during refueling. A cable consisting of signal and power lines connects the vehicle and the station. The signals indicate if the vehicle is in park, if electrical power is disabled, and if vehicle tank pressure and temperature transducers are functioning properly. A fill can only proceed when these conditions are met.

The program sequence leading to fill is listed below.

1. Press "CLEAR," key in your PIN number, and press "ENTER."
2. Connect communications/ground cable to connector on vehicle.
3. Connect refueling nozzle to vehicle.
4. Press "DATA" and record beginning tank pressure, tank temperature, and ambient temperature in the Refueling Log.
5. Press "GO" to begin refueling. The green light will come on when refueling is complete.

Fill time is 20 to 30 seconds from empty to full. If the tank temperature or pressure passes certain thresholds during the fill procedure, filling is automatically terminated.

Figure 9 Ford Motor Company's liquid and gaseous hydrogen refueling station.

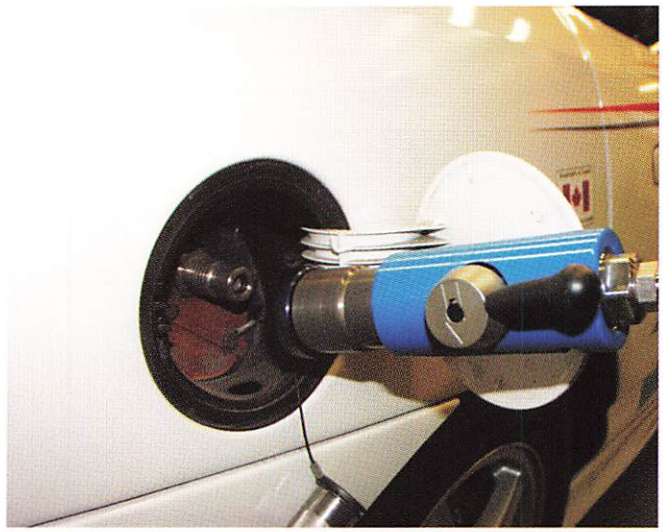


Figure 10 . Refueling nozzle as it is connected to the P2000 FCEV.

Conclusion

While some challenges still remain, fuel cell technology is proving to be the only viable answer for mandated zero emission vehicles. Fuel cell vehicles provide the benefits of battery electric vehicles while eliminating their disadvantages such as limited range and recharging. Increased effort on creating a hydrogen-based infrastructure will reduce the necessity of including methanol or gasoline reformation onboard vehicles. Ford Motor Company continues to demonstrate its environmental and electric vehicle leadership with programs such as the P2000 FCEV and it's introduction of the first gaseous and liquid refueling station in North America.

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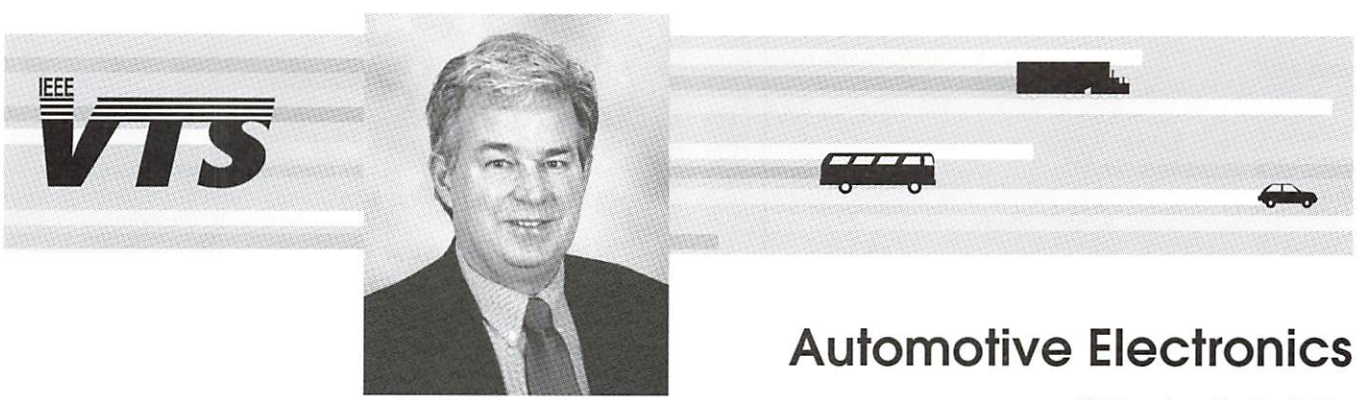

Automotive Electronics

Bill Fleming, Senior Editor

Alternative to Windshield Wipers

As a new hire at General Motors thirty years ago, one of the first things our group was asked to come up with was an alternative to windshield wipers. As I recall, we weren't able to propose anything very practical. Now, 30 years later, I noticed that Hyundai's HCD5 and HCD6 concept cars feature "no wipers." The windshield is kept clear via high-intensity air jets and a special windshield coating [1]. The objective was to eliminate moving parts to reduce wear and tear quality issues, and for cost reduction. (And, hopefully, the jets and coating will actually do a good job of clearing the windshield — no mention of this was found in Ref. [1]).

Vehicle Control-By-Wire

IEEE Spectrum recently published a review on why automakers are planning to replace vehicle hydraulic systems with electrical wires and computers [2]. The ultimate objective of by-wire systems is to make average drivers as skilled as professional test course drivers insofar as being

able to bring the vehicle back to a safe and stable condition from an unsafe one. Vehicle safety and stability are, therefore, at the heart of the push to develop automotive braking-and-steering by-wire technology. Other basic advantages of by-wire systems include [2]:

1. Both manufacturing and design simplifications, which result because brake-by-wire modules simply "plug into" the corners of a car.
2. As compared to traditional hydraulic approaches of "putting a plumbing system in each car," the connection of wires to a microcontroller will make car assembly easier and faster.
3. Electronic by-wire systems (wires and microcontrollers) weigh less than hydraulic pumps and will help improve fuel economy.
4. By-wire systems only draw power-on-demand, as it's needed, from the engine; thereby avoiding the parasitic constant power drain of hydraulic pumps and offering an additional improvement in fuel economy.

If you think by-wire systems are a little far-fetched, another recent news item [3] reports that Lockheed Martin made history last winter when, for the first time, it tested an F-16 Fighter at Wright Patterson Air Force Base in Dayton, Ohio, with electric rather than hydraulic flight control actuators. The article noted that recent advances in power switching and high-voltage dc power electronics were technical breakthroughs that made the F-16 by-wire development successful. It's stated that, "electric actuation with integrated subsystems provides additional benefits of reduced aircraft weight, improved survivability, and improved maintainability." What all this means is that, whether it's in automobiles or in jet fighter aircraft, for reasons that are very much alike, by-wire systems are inexorably on their way towards production.

Small Passenger-Car Hybrid Powerplant

A widely discussed Spectrum article [4,5] acknowledges that hybrid-powered vehicles (which combine a gasoline engine, and a electric motor), such as the current Toyota Prius; offer improvements in both fuel economy and emissions. But when "apples to apples" comparisons are made of the Prius hybrid vehicle to an almost identical sized conventional IC (Internal Combustion) engine Toyota Corolla, it was found that the price of gasoline would have to reach $5.10/gal ($1.35/L) in order for the fuel economy of a comparable-performance Prius to recover its $3495 price premium over a Corolla. (Note. *Notwithstanding Toyota's substantial cost-absorption of more than $10,000 per hybrid vehicle, their Prius hybrid still costs $3495 more than their comparable-size Corolla LE*). And, if regulators were to mandate use of Prius hybrid vehicles in order to lower pollution emissions, they would implicitly be valuing NO_x emissions at $40,000 per ton. The authors stated that there are much less expensive ways to clean up the environment [4,5].

What about hybrid vehicle road performance? "Although the hybrid powerplant adds over $3000 in cost, they do work. Jerry Flint, a writer for WARD'S AutoWorld [6], drove hundreds of miles in Toyota and Honda hybrids getting 50 mpg (4.7 L/100 km). But, he reports two problems. First, 50-mpg minis (a reference to how small the hybrid vehicles are) won't satisfy the needs of the majority of drivers in the United States who want heavier-duty sport/utility types of vehicles. And secondly, a Toyota Prius that gets 50-mpg in the summer, only gets 35 mpg (6.7 L/100 km) in the winter because cold weather requires more frequent use of the gasoline engine. Jerry said, "That's something the 'greenies' didn't tell me about." He concludes that because hybrid vehicles save less fuel than expected, tow less, and cost more; fewer than predicted today will ultimately be built, because people won't buy them if they don't make sense [6]."

Full-Size Pickup Truck Hybrid Powerplant

In an effort to improve fuel economy of large vehicles, General Motors announced that starting in model year 2004 it will build in two new key features to its biggest sellers, the Chevrolet Silverado and GMC Sierra pickup trucks [7]. First, engine displacement-on-demand will be added, where half the engine cylinders will be disabled (valves held closed and fuel cutoff) during cruise conditions — this should improve highway economy by 6-to-12 percent. And secondly, a simplified hybrid engine/electric motor powerplant will be utilized. In this hybrid, the electric motor won't power the vehicle at low speeds, but instead will restart the engine which will be shut off at stoplights instead of idling — this, along with an improved torque converter, should improve city economy by up to 15 percent. Together, the two features will improve city/highway fuel economy levels from the truck's current 16/20 mpg levels, to as much as 18/22 mpg. The vehicle will also adopt a 42-V electrical system that has the capability of supplying enough electricity to power many appliances in a house in the event of a power failure [7].

Similar to GM, Ford Motor has announced that the next generation MY'04 of their sport/utility Explorer will also incorporate a 42-V start/stop/instant-restart feature, and a hybrid powerplant. But, Ford will include two additional features of: (a) regenerative-braking energy recovery, and (b) electric-motor vehicle-acceleration-assist [8,8a].

Future Alternative Vehicle Powerplants

To review, there are many obstacles that battery-powered "pure" electric vehicles face in the automotive marketplace. First, there's the lack of battery-charging infrastructure. Secondly, there's the added cost of lightweight vehicle-construction materials. Thirdly, large-scale production of batteries — e.g., for the nickel-metal hydride battery, if it ever happens — would increase demand for nickel and cerium, further pushing up battery prices [4]. Fourthly, there's the battery pack that today costs $15,600; which would come down with volume production, but the problem now is that there isn't any volume (in fact, even GM's Impact electric car has been mothballed), so there's no volume to effect this reduction in cost [6]. Fifthly and finally, GM learned an expensive infrastructure lesson by sinking $1 billion into their EV1 "pure" electric car, a car that couldn't be refueled quickly or easily. GM thought it would be easy getting chargers into the marketplace, but it didn't turn out that way, thereby diminishing marketability of the EV1 [9].

The primary focus of future alternative powerplant R&D today is therefore on fuel cell hybrid powerplants. Fuel (methanol or gasoline) is electrochemically reformed into hydrogen (or hydrogen is simply supplied directly as a fuel). Then the hydrogen is converted into electricity that powers electric motors, which propel the vehicle. The payoff for fuel cell hybrid powerplants is zero emissions; together with performance comparable to the IC engine, and a predicted 50-percent improvement in fuel economy. (*The fuel economy improvement results because electrochemical fuel reforming involves direct chemical-to-electrical energy conversion, and is not subject to the losses associated with the internal combustion process[9a]*). Another advantage of fuel-cell direct generation of electrical power is that it will complement the transition to totally electrical by-wire controls [9a].

For various reasons, different automakers have chosen to use different fuels with their fuel cells [10]. Ford, Honda, and VW will use hydrogen itself (very clean electrochemically, but minimal supply infrastructure exists). DaimlerChrysler will use methanol (easier to reform than gasoline, and more amenable to adaptation of existing supply infrastructure). General Motors, Toyota, and Nissan/Renault will use high-purity gasoline (which requires the minimum changes in existing infrastructure for processing and delivery of new fuels). The use of gasoline allows drivers to fuel up their vehicles the same as always. But the problem with gasoline, even high-purity low-sulfur gasoline, is it's much more difficult to reform than, for example, methanol [10].

GM Concentrates on Gasoline Fuel Cell Power

In a front-page article [9], it's reported that, "GM's goal is to be the first automaker to have 1 million fuel cell vehicles on the road, and making use of the existing refueling infrastructure is the key to reaching that goal." GM ruled out methanol because it's toxic, and they ruled out hydrogen because it's difficult to store on a vehicle and lacks a widespread distribution network. GM has hired 200 engineers, scientists, and chemists to develop the technology to reform gasoline into hydrogen. Theoretically, the fuel cell will react hydrogen and oxygen to produce electricity, with water vapor as the only byproduct [9].

This is a 10-year project, accounting for 50-percent of the GM's R&D budget. The project's objective is to have an initial fleet of fuel cell vehicles by 2008, and mass-market fuel cell vehicles in 2010. Two major obstacles that GM must yet resolve are: (a) cold-weather fuel cell/reformer warm-up time (currently about 2 minutes, but needs to be reduced to less than 1 minute); and (b) susceptibility of reformer-electrode catalytic properties to chemical poisoning, especially when less-than-pure gasoline is used .

"e-This", "e-That", "e-Safety", and "e-Ticketed"

"e-Safety" System — In a recent article, collaborators from the University of Michigan's ERIM and UMTRI research proposed an "e-Safety" system which would combine the elements of vehicle by-wire control, the automated highway, real-time navigation, and predictive-radar collision avoidance [11]. The top 12 highway-fatality scenarios, which by themselves accounted for 70% of all highway deaths, were analyzed. It was found that 90-percent of these fatalities could be avoided by implementing the following types of collision-avoidance (accident-countermeasure) actions:

- ✦— driver warnings – 4 scenarios
- ✦— driver-control overrides plus warnings – 7 scenarios
- ✦— driver-control override – 1 scenario

Hence, in 8 of the 12 scenarios vehicle control must be taken over by their accident avoidance e-Safety system. It was concluded that their e-Safety approach had the potential of slashing highway fatalities tenfold.

The e-Safety group identified a key "technology solution," still unavailable, which will be needed to implement e-Safety. This key technology solution is an expert system to tell the driver what to do, or to override driver control while *"taking momentary charge of the vehicle if necessary"* [11]! Aside from the technical challenges involved, there are obvious liability issues associated with their e-Safety solution approach.

"e-Ticketing" System — No e-ticketing isn't just another way to purchase airline tickets. A recent US Patent assigned to Lucent Technologies describes the combination of in-vehicle RFID (Radio Frequency IDentification) tags in passenger cars and in-vehicle transponders in police cars [12]. This combination "affords police the ability of ticketing drivers for traffic violations" on the fly. This gives a whole new meaning to the term "e-ticket."

A related Patent, assigned to IBM, describes how "to reduce the possibility of transcription error, and hit-and-run, by automatically collecting the crash-involved party's information at the crash site [13]. The automatically transmitted data includes: vehicle identity, driver information, insurance information, time, and location (GPS-derived) of the crash. Hopefully, once every vehicle is equipped with this system, this will eliminate drivers from leaving the scene and getting away with hit-and-run crashes.

Future "e-Things" — In the world of "e-Things", for what are commonly classified as telematics things (cell phones, email, Internet, etc.); the next big step is expected to be portability [14]. Automakers have learned that relying too heavily on embedded telematics and not allowing consumers to connect personal devices to in-vehicle systems create the following difficulties:

1. Update of short-lived telematics technology is made harder
2. Consumers sometimes end up paying for services they already can access on their cell phones
3. In-vehicle phones add an extra phone number for users to manage

Automakers are now working hard to decide on the right mix of embedded and portable technology for the next generation of cars.

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Transportation Systems

Harvey Glickenstein, Senior Editor

ETRO, the Metropolitan Transit Authority of Harris County in Houston, has awarded a $120 million turnkey contract to Siemens Transportation Systems. The 7.5-mile light rail line will have 16 stations, starting at the University of Houston/Downtown station. Other stations will include Downtown Central Business District, Midtown, Museum District, Hermann Park, the Texas Medical Center complex, the Astrodome complex, and a 1200-car Park and Ride lot south of the Astrodome. The yard and shop will be located south of the last stop.

Artist's conceptions of the Downtown and Texas Medical Center are shown below.

Siemens will be providing fifteen S70 light rail vehicles under this contract (see Figure 1). The 100-foot long vehicles will have a low floor design. Stations will be designed to accommodate two vehicles at the platform.

The line is planned to enter revenue service in January 2004. METRO will be studying additional corridors for high capacity transit service this year. It is anticipated that one or more of these corridors will be approved for extensions to the original 7.5-mile line.

The Port Authority of Allegheny County in Pittsburgh, PA has awarded a $43.8 million contract to Union Switch & Signal, Inc., a unit of Ansaldo Trasporti. The contract is to design, manufacture, install, and test a state of the art system-wide signal and communication system for the Pittsburgh light rail system.

The contract is a portion of the Port Authority's Stage II Light Rail Transit Project, which includes reconstruction of 12 miles of the Overbrook, Library, and Drake lines through the South Hills; manufacture of 28 new light rail vehicles; remanufacture of the existing fleet; expansion and modernization of the Operations Control Center; and the addition of approximately 2200 park and ride spaces.

The contract includes a new signal system from South Hills Junction to South Hills Village via the Overbrook Line and a communication system on the Overbrook Line, the Beechview Line, and in the downtown subway. The system will include cab signals, automatic train protection, grade crossing warning systems, train to wayside communications, new supervisory control and data acquisition capabilities, radio base station equipment, public address system, variable message signs, telephones, and CCTV equipment.

Kowloon-Canton Railway Corporation has started a project to grade separate portions of the Tuen Mun light rail line. The grade separation project is a major part of a HK$2.3 million improvement project for the line.

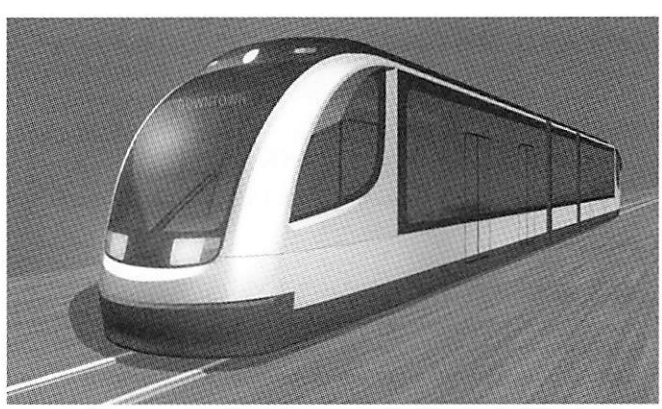
The first section to be elevated is the 4,000-foot Pui To Road Project. This section will eliminate grade crossings with three roads. It will also include an elevated stop at San Fat that will connect with a future West Rail Tuen Mun Station. This project started in May and will be completed by the end of 2003.

The second section to be elevated is at Tsing Lun Road. This section will be about 1,000 feet long. Construction is planned to start in mid 2002 and be completed in mid 2004.

The Austrian Federal Railways has awarded a contract to Bombardier for 40 four-car electrical multiple units (EMU) for suburban traffic and 11 three-car EMUs for regional traffic. All of the units have been designed with a low floor entrance about 23 inches above top of rail. The four-car units are 220 feet long and seat 200 passengers. They will operate mainly on the Vienna rapid transit network. The three-car units are 170 feet long and seat 150 passengers. They will operate on regional networks throughout Austria.

The Santa Clara County Valley Transportation Authority has broken ground for the first phase of the Vasona Light Rail Project. The 6.8-mile line will connect Campbell with downtown San Jose. It is scheduled to open for revenue service in 2004.

Spanish National Railways has ordered 32 high speed trains for the new 215 mph line that will link



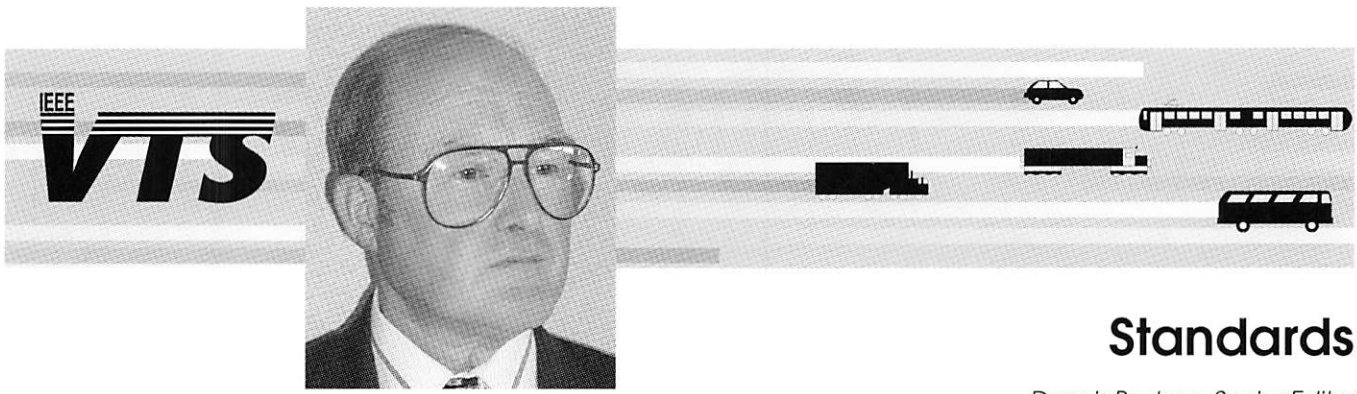
Siemens Transportation Systems

Siemens Transportation Systems S70 light rail vehicles

Madrid and Barcelona with the French Border. The order has been split between Siemens, who will supply 16 trains, and the joint venture of Talgo and Bombardier, who will supply the other 16 trains.

The eight-car ICE trains to be supplied by Siemens will seat 140 passengers.

The trains being supplied by the Talgo/Bombardier team will have two power cars and 12 trailer cars and will seat 318 passengers.



Standards

Dennis Bodson, Senior Editor

Vehicular Technology Society (VTS)/ Intelligent Transportation Systems (ITS) On-Line Standards Subscription Service

At the request of the VTS, the IEEE Standards Association established an on-line subscription service for these standards. This service enables the subscriber to access the current list of all published standards together with unapproved drafts of standard to be published. The subscription service allows the subscriber to obtain VTS standards, ITS standards, or both.

The following is a list of what is currently available for VTS and ITS standards as of the date this column was prepared:

Vehicular Technology Standards

11-2000, IEEE Standard for Rotating Electric Machinery for Rail and Road Vehicles

1483-2000, IEEE Standard for Verification of Vital Functions in Processor Based Systems Used in Rail Transit Control

1476-2000, IEEE Standard for Passenger Train Auxillary Power Systems Interfaces

1473-1999, IEEE Standard for Communications Protocol Aboard Trains

1474.1-1999, IEEE Standard for Communications-Based Train Control (CBTC) Performance and Functional Requirements

1475-1999, IEEE Standard for the Functioning of and Interface Among Propulsion, Friction Brake and Train Borne Master Control on Rail Rapid Transit Vehicles

1477-1998, IEEE Standard for Passenger Information System for Rail Transit Vehicles

1482.1-1999, IEEE Standard for Rail Transit Event Recorders

Intelligent Transportation Systems Standards

1488-2000, IEEE Trial Use Standard for Message Set Template for Intelligent Transportation Systems

1512-2000, IEEE Standard for Common Incident Management Message Sets for Use by Emergency Management Centers

Unapproved Draft P1454, D6, March 2000 Draft Recommended Practice for the Selection and Installation of Fiber Optic Cable in Intelligent Transportation Systems (ITS) Urban, Suburban, and Rural Environments as well as Transportation Operations Centers and Associated Campuses

1455-1999, IEEE Standard for Message Sets for Vehicle/Roadside Communications

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Wireless Jungle Still Waiting For Its King

Everyone wants to rule the wireless kingdom. Big-name technology makers, including Qualcomm, Motorola, Sun Microsystems, Nokia, Microsoft and Intel, are looking to become the universal standard for software developers. With projections of a multibillion-dollar future, many technology companies are vying to establish a "de facto" standard for wireless software, creating a new revenue source even if sales of cell phone handsets slip.

Waiting Game at First Internet World Wireless Show

The First Internet World Wireless Show, held 22 February in New York City, echoed a familiar theme in the wireless industry today as the technology displayed seemed to be waiting for an infrastructure to make it truly compelling. Accord-

ing to a report from ABC News, several companies were showing off innovative new ways to use your cell phone, but these advances will require handsets and high-speed networks that aren't yet available in the U.S. The wireless Web suffers from a host of problems (slow speed, primitive cell phone browsers, lack of applications) that have limited its penetration to a tiny fraction of the U.S. population. A May 2000 survey by Forrester Research found that 82.5 percent of mobile customers have no interest in wireless data services. "We haven't really figured out what the real killer app is for wireless services," said Robert Stout, a vice president at F-Secure, which was showing antivirus software for wireless devices at the show.

Wireless Networks

A self-study course from IEEE, "Multimedia Applications Support for Wireless ATM Networks," will teach you to design high-speed wireless networks supporting multimedia applications. Topics covered include: ATM and wireless networks and their architecture; congestion control and protocols; location and tracking strategies; and routing and resource management for multimedia applications. Upon completion of the course, students earn eight CEUs (which equal 80 contact hours of instruction) and a Certificate of Educational Achievement from the IEEE.

Coffee, a Glazed Donut and The Wireless Net To Go

Wireless high-speed Internet access is arriving at hundreds of access points in public and private places across the United States. With a laptop computer equipped with a wireless card, anyone within a few hundred feet of one of these access points can tap into a wireless network connected to the Internet via a broadband connection. The user can send e-mail or surf the Web, usually for a monthly or single-use fee. Industry experts say that by late 2001, thousands of these access points will be installed in major airport terminals, sports arenas and other business and consumer locations. One company expects to have access points in 4,000 Starbucks Coffee stores by the end of 2001 using the IEEE 802.11b wireless network protocol.

Blue Talk: p2p for Handhelds

Swedish software maker Pocit Labs says it has created the world's first P2P Napster-like file-swapping software for mobile devices that communicate using Bluetooth technology. The software, called BlueTalk, is expected to debut in June at the Bluetooth Congress 2001 in Monte Carlo, Monaco. Although no deals have been signed yet, Pocit Labs Chief Executive Christer Rindebratt said BlueTalk could make its commercial debut by 2002. P2P (peer-to-peer) is a form of computing in which people allow their stored data to be shared by anybody. Moving beyond high-profile music applications like Napster, the P2P technology is now being used by scientific research firms as a way for colleagues in different parts of the world to collaborate. Some universities, including Stanford, have their own peer-to-peer networks for students to use. Entrepreneurs are trying to extend the technological underpinnings of the P2P medium to the wireless Web. Analysts have mixed opinions about whether peer-to-peer for wireless devices will come close to the explosion of file swapping on the wired Web.

More on Bluetooth

"Bluetooth: Connect Without Cables," is a valuable resource for wiring professionals available from IEEE Fatbrain and published by Prentice Hall. Bluetooth is the new wireless technology that builds a microchip with a radio transceiver directly into a device, allowing it to make connections instantly and eliminate cables entirely. This new book has been updated to reflect the latest media, wiring schemes, products, and techniques - plus critical new safety and fire requirements from the latest National Fire Code. IEEE and Fatbrain.com have teamed up to bring you IEEE Fatbrain, a members-only site offering discounts on the most popular technology titles from the leading publishers in the field. For more information on this book, go to http://www.ieee.org/ieeefatbrain

New IEEE WirelessHUMAN™ Project Developing Standards for Fixed Wireless Access in License-Exempt Bands

The Standards Board of the IEEE Standards Association has approved the WirelessHUMAN™ (Wireless High-Speed Unlicensed Metropolitan Area Networks) project, a new initiative within the IEEE 802.16 Working Group on Broadband Wireless Access. IEEE 802.16 created its Task Group 4 to draft the air interface standard, which will address the explosive growth market of providing data services in license-exempt spectrum. The primary focus is on 5-6 GHz. "Unlicensed spectrum is a huge worldwide market opportunity for fixed broadband wireless access because it may be deployed by any operator without the delay and cost of acquiring a license," said 802.16 Chair Roger Marks. "Standardization is key to making this technology readily available to the public as an alternative Internet connection. Because of the special considerations of unlicensed spectrum, we needed to establish a project separate from our existing work on metropolitan area network standards in the licensed bands. Our previous success will provide an excellent baseline. We welcome new participants to our open process." For more information see: http://standards.ieee.org/announcements/wirelesshuman.html

The DECT Common Interface

A fifth edition of the 8 part standard that gives an introduction and overview of the complete Digital Enhanced Cordless Telecommunications (DECT) Common Interface (CI) has just been published. This important base standard (ETSI EN 300 175-1 V1.5.1) has been updated to include changes resulting from recent developments within DECT technology, mainly due to DPRS (DECT Packet Radio Service), the packet mode that allows DECT to reach the data rate of 2 Mb/s, these changes are mainly in the network and DLC layers. Furthermore, updates due to the development of a series of profiles such as Radio in the Local Loop (RLL) Access Profile (RAP) and the DECT/ISDN interworking profile, have been included. An important goal that EP DECT targeted and achieved is that all the changes made retain backwards compatibility, allowing evolution while assuring stability for the previously developed products. The overall objective of this standard is to make interoperability between equipment of different origin possible and therefore offer users a set of telecommunication services for voice or data, either as basic services, or with optional (and compatible) extensions. The DECT standard is designed to support versatility of applications at a cost that encourages wide adoption. DECT provides personal telecommunication services in residential, neighbourhood and business environments.

Part 1 contains an introduction to the complete European Standard. It includes a description of the system and the protocol architecture and a vocabulary of terms. This overview has been significantly updated to reflect the content of the base standard, showing the new developments that have occurred since the previous version was issued in 1999.

Part 2 specifies the Physical Layer (PHL) radio parameters such as the frequency, timing and power values, the bit and slot synchronization and the transmitter and receiver performance.

Part 3 specifies three groups of Medium Access Control (MAC) services. These are the broadcast message control

service, the connectionless message control service and the multi-bearer control service. It also specifies the logical channels, which are used by the above-mentioned services, and how they are multiplexed and mapped on to the physical channels

Part 4 specifies two groups of Data Link Control (DLC) services. These are the services for the C-plane and the services for the U-plane.

Part 5 specifies the functions for the link control, the Call Control (CC), the Supplementary Services (SS), the Connection Oriented Message Service (COMS), the Connectionless Message Service (CLMS) and the Mobility Management (MM). For these groups it contains the procedures, messages and information elements.

Part 6 specifies the main identities and addresses that are used in DECT.

Part 7 specifies the overall security architecture for DECT, the types of cryptographic algorithms required and the way in which they are to be used, and the requirements for integrating the security features provided by the architecture into the DECT air interface. It also describes how the features may be managed and how they relate to certain DECT fixed systems and network configurations.

Part 8 specifies the requirements for DECT equipment that includes all the necessary functions to provide real-time two-way speech conversation. It defines the speech encoding algorithm and the detailed speech performance characteristics such as sensitivity, frequency response, sidetone, terminal coupling loss, distortion, variation of gain with input level, out of band signals, noise, acoustic shock, delay and network echo control.

This standard is available for download free of charge from: http://webapp.etsi.org/pda/queryform.asp

Mobile Digital Communication for Public Safety, Law Enforcement, and Non-Tactical Military

What is the relationship between TETRA, TETRA 2 and the revolutionary step into the future world of Mobile Broadband as taken by the new international standardization partnership known as project MESA?

TETRA represents today one of the most successful standards for mobile digital communication designed to fulfill the needs of professionals in particular within the sectors of Public Safety and Military peacekeeping. TETRA is categorized in the field of narrowband mobile technology and represents as such the most advanced utilization of the radio spectrum by offering the parallel traffic of four full voices on just one single 25 kHz ordinary land mobile radio channel.

The combination of high spectrum efficiency and processing of applications calling for both circuit-switched and well as packet-switched connections is one of the key characteristics of TETRA.

The ETSI Board unanimously approved the new terms of reference for ETSI Project TETRA (EPT) to evolve the TETRA Standard to enhance its already comprehensive suite of services and facilities. The programme to enhance the standard is known as the TETRA Release 2 work programme. Working group activities within TETRA Release 2 are already addressing requirements for high speed packet data, speech coding, air interface enhancements, SIM evolution and interworking with Cellular technologies such as GSM, GPRS and UMTS/3G.

TETRA Release 2 can be best described as an evolutionary enhancement to the existing TETRA standard, providing value added functionality to complement the many services and facilities already provided by TETRA. It is also intended that TETRA networks already deployed can be field upgraded to include the services and facilities from the TETRA Release 2 suite of standards thereby future proofing existing investments and increasing the longevity of TETRA.

Originally, the ideas to develop something that is now known as MESA were created inside the TETRA standardization, but the goals of MESA go much further into the future. Following the completion of the Packet Data Optimized (PDO) narrowband version of TETRA in 1999, the idea to develop and standardize a new mobile broadband technology based on IP Protocols emerged rapidly and gained support from Public Safety and Law Enforcement authorities as well as from public network operators and Industry. Also the European Commission supported this effort through standardization mandates presented to ETSI. This work which was code-named DAWS (Digital Advanced Wireless Services) was also presented to the Military community from where interest in the concept was shown from the very beginning. The basic idea of DAWS was to develop a set of standards enabling support of the fast growing demand for professional mobile applications that require carrier bit-rates in the area from several MBPS and up, an area which today is unknown in a wireless wide-area environment. This work has been transferred as input to a new International Public Safety Partnership (Project MESA) involving ETSI and TIA, DAWS has thus been discontinued as an ETSI-only activity.

The interest in the development of a new Mobile Broadband Standard is driven by the emergence of a still widening capability gap between telecommunications technology in the service of Public Protection Agencies and in the hands of instigators of organized crime and terrorism. Also a growing demand for Mobile Broadband Services within Tele-medicine, Fire-fighting, Mobile Robotics and Military Peacekeeping operations is rapidly emerging.

MESA represents today the first international Standardization Partnership, which directly invites users and their organizations to contribute to its work, whereby the technical committees of PSPP are provided expert guidance in achieving a timely and accurate implementation of the relevant technologies.

First ITU standards approved using the new accelerated approval process

The first two ITU standards using its new fast-track approval process called alternative approval process (AAP) have been successfully approved. This new procedure was adopted by the recently held World Telecommunication Standardization Assembly in a bid to further reduce time-to-market delivery of standards and more closely match the industry's timeframes and operational practices. Under the alternative approval process AAP), an ITU-T standard can now be approved in as little as four weeks after notification of the last call period.

This successful application of AAP marks the beginning of the private sector's formal participation in the approval of ITU-T Recommendations. This is an important demonstration of the ability of ITU-T to change and meets the private sector's requests to participate in the global standards-setting approval process.

The first two standards approved using AAP are:

- ITU-T Recommendation G.964 (03/2001) – V-Interfaces at the Digital Local Exchange (LE) – V5.1-Interface (based on 2048 kbit/s) for the support of Access Network (AN)
- ITU-T Recommendation G.965 (03/2001) – V-Interfaces at the Digital Local Exchange (LE) – V5.2-Interface (based on 2048 kbit/s) for the support of Access Network (AN)

Using this new accelerated process, over 25 texts were announced for last call on 29 January with comments being accepted until 28 February. All comments received for draft ITU-T Recommendations G.964 and G.965 were positive allowing the Study Group 15 management team to declare approval on 1 March.

UWC-136 Update Approved for Inclusion in ITU-R Recommendation

The International Telecommunication Union Radiocommunications Sector (ITU-R) Working Party 8F meeting has approved an update to the Universal Wireless Communications Consortium's option for IMT-2000 wireless services, UWC-136. The update, which includes EDGE technology as a wireless data delivery standard, was officially approved for inclusion in Revision 1 of ITU-R recommendation M.1457 at the Working Party 8F's fourth meeting in Rabat, Morocco, on February 27, 2001. This approval positions the UWC-136 documentation to meet translation and publication goals for ultimate finalization of ITU-R recommendation M.1457 by October 2001 at the Working Party 8F meeting in Japan. The IMT-2000 radio interface specifications for TDMA Single-Carrier technology are developed by TIA TR45.3 with input from the Universal Wireless Communications Consortium (UWCC). This radio interface is called Universal Wireless Communication-136 (UWC-136), which is specified by American National Standard TIA/EIA-136.

Ericsson's Jim Ragsdale, Chairman of the UWC-136 Radio Interface Specifications (RSPC) group, commented, "At this time, of the five radio interfaces in the ITU family, the UWC-136 update, Section 5.4, is the only one to be approved for inclusion in Revision 1 of the ITU-R recommendation." He added, "It was important to capture EDGE classic and EDGE COMPACT as part of this approved documentation to proceed towards full service transparency and the future goal of Revision 2, which includes wireless multimedia and data transmission."

The UWCC is a Bellevue, Washington-based international consortium of more than 100 wireless carriers and vendors promoting the development, evolution and deployment of seamless global wireless solutions based upon TDMA, EDGE, and WIN technologies and their interoperability with GSM and UMTS. For more information, visit the UWCC website at http://www.uwcc.org/.

IEEE 802.16 Working Group

The IEEE 802.16 Working Group on Broadband Wireless Access announced it reached several key milestones during its Session #12, held on 12-15 March 2001 in Hilton Head, South Carolina, USA. During the session, attended by 174 people affiliated with numerous organizations worldwide, the Working Group:

- ✦Finalized a decision to create a unified Working Group air interface document, with a common, flexible medium access control (MAC) platform supporting multiple physical layers (PHYs)
- ✦Approved, pending comment resolution, a draft 10-66 GHz air interface standard (802.16) with the expectation of publication in the fourth quarter of 2001
- ✦Agreed to base a 2-11 GHz air interface standard (802.16a) on both single carrier and OFDM PHY layers

Work also progressed on the 802.16b WirelessHUMAN™ air interface for use at license-exempt frequencies. The 802.16.2 recommended practice on coexistence, following unanimous Working Group Letter Ballot approval, entered Sponsor Ballot phase.

"This meeting consisted of representatives from system vendors, semiconductor suppliers, and service providers all working together to develop an air interface standard based on open public consensus," said Roger Marks, Chair of the IEEE 802.16 Working Group. "Service providers need interoperability through a global standard in order to begin widespread deployment."

IEEE 802.16

The IEEE 802.16 Working Group on Broadband Wireless Access is creating the IEEE 802.16 family of WirelessMAN™ Standards for Wireless Metropolitan Area Networks. With 162 members and over 90 official observers, IEEE 802.16 operates in an open process to develop accredited air interface standards and recommended practices for global use. Meeting bimonthly, 802.16 has a record of rapidly reaching technical consensus. IEEE 802.16's standards set the stage for a revolution in reliable, high-speed network access in the first mile by homes and enterprises. For more information, see http://wirelessman.org/.

IEEE Standards Association

The IEEE Standards Association (IEEE-SA) is an international membership organization serving today's industries with a complete portfolio of standards programs. The IEEE-SA is a major contributor to the IEEE, which is the world's largest technical professional society. IEEE-SA membership, through its IEEE association, promotes the engineering process by creating, developing, integrating, sharing and applying knowledge about electro and information technologies and sciences for the benefit of humanity and the profession. More information is found at http://standards.ieee.org/sa-mem/index.html.

3G Mobile Standards on Target

The review process of the 3GPP third generation digital mobile communications specifications set for the first release, which was functionally frozen in December 1999, has been completed. The announcement follows a high-level meeting of the Partners of the Third Generation Partnership Project (3GPP) at the premises of the European Telecommunications Standards Institute (ETSI) on 10-11 April in Sophia Antipolis, France. ETSI was a founding Partner in 3GPP. The completion of the first release is a major milestone, concluding a concerted effort by experts from all over the world. It allows manufacturers to deliver 3GPP compliant equipment to operators in the confidence that the specifications are comprehensive and stable. The 3GPP Partners are now working on a further release of the 3GPP standard, which will provide additional multimedia features, improved data streaming and other enhancements. In addition, the first all-IP (Internet Protocol) standard for 3GPP is expected to be functionally frozen at the end of this year. The Partners are determined to ensure that 3GPP meets the evolving requirements of all the manufacturers and operators – and users – involved in the successful launch of third generation mobile systems in the global market. This will ensure full multimedia capability, with all the added benefits of using IP – in particular, seamless connection between different networks, facilitating full global roaming for users, whilst allowing them to retain access to services that they enjoy at home.

GEO-Mobile Radio interface specifications

The European Telecommunications Standards Institute (ETSI) has published the first release of a complete set of specifications for a mobile satellite radio interface, known as 'GEO-Mobile Radio interface specifications' (GMR).

This first ever release of ETSI specifications for personal communications systems based on geostationary satellites was jointly developed with the US Telecommunications Industry Association (TIA) and is largely evolved from the popular Global System for Mobile Communications (GSM) standard (which was also developed by ETSI). Publication of parallel GMR specifications by TIA is expected to follow later this year. The GMR specifications include many new features, such as direct terminal-to-terminal calls that adapt and enhance the GSM radio interface technology to make it operate efficiently over geostationary satellites. This first release of specifications includes a full set of circuit mode ser-

vices for voice and fax, as well as a range of data services. All these services are compatible with the services provided by current terrestrial GSM systems. There are two variants of the GMR standards in this first release: GMR-1, led by HNS Hughes and adopted by the Thuraya system; and GMR-2, led by Lockheed Martin Global Telecommunications (LMGT), and developed for the ASIA Cellular Satellite (ACeS) system. The Thuraya system provides services in 99 countries spanning Europe, North & Central Africa, Middle East, Central Asia and the Indian Subcontinent. The ACeS system provides services over an area covering India, China, Indonesia, as well as most of South East Asia. Rupert Goodings, Chairman of the ETSI TC-SES/GMR working group, said: 'Recognizing the value we bring to the satellite industry, ETSI has taken a leadership role in developing these new standards for personal communications systems via satellite. The open standards will increase market competition by driving down the price of user terminals, giving our subscribers choice and providing innovative new features, allowing the industry to stay competitive with GSM user terminals.' Matthew Mohebbi, General Manager of Mobile Satellite System, HNS, said: 'To have these first satellite standards published is a great endorsement of the HNS commitment to open standards. Very early on we realized the importance of the standard radio interface to the success of geomobile satellite systems. The published specifications are the conclusion of several years of tireless work, during which we brought to bear our expertise in satellite communications, cellular telephony and wireless subscriber systems.' Yousuf Al Sayed, Chief Executive of Thuraya, said: Thuraya is pleased to have been part of this initiative, collaborating on a technology that was developed for us and will now be adopted as a standard for the mobile satellite industry. The publication of GMR-1 by ETSI is an important step forward that will regularize the industry, encouraging growth, innovation and competition.' Michael Williams, President and General Manager of LMGT Systems & Technology, added: 'LMGT's continuing commitment to advanced mobile communication via geo-synchronous satellites, of which AceS is the first to achieve operational status, is confirmed by our participation in creating these important standards. LMGT worked diligently to design the GMR specifications that allow the ACeS system to help improve the quality of life of countless people living in South East Asia by greatly expanding the communications potential of many countries previously having only a limited communication infrastructure. The ACeS system and interfaces were specifically designed to ensure robust, high performance communication links while promoting small cellular-size handsets.'

Get IEEE 802™ Program Provides Public Access to Networking Standards

The IEEE Standards Association (IEEE-SA) launched the "Get IEEE 802" pilot program granting public access to view and download individual electronic (PDF) IEEE Local and Metropolitan Area Network (802) standards at no charge. The "Get IEEE 802" pilot marks the first time the IEEE-SA has joined forces with industry to make a series of standards widely available. The program was established to assist potential users for whom the standard itself could be more costly than its actual implementation for network connectivity. For more information see: http://standards.ieee.org/announcements/getieee802.html

Live TV on Cell Phones

Three European telephone service providers are testing a way to stream live TV events including horse races and financial news updates to cell phones.

The companies may debut the service on the tiny screen by year's end. Streaming video to handsets is among the applications being proposed for the next generation, or so-called "3G," phone systems that carriers worldwide are in the midst of launching. These new systems will allow cell phones to have Internet access at broadband speeds. But the 3G marketplace has been rattled as of late. Japan's NTT DoCoMo was supposed to launch the world's first such 3G network in May. Instead, because of problems with the network, it will wait until October. Other carriers in Europe and Asia also announced delays. Many analysts, however, remain optimistic that such sophisticated services can work on a cell phone.

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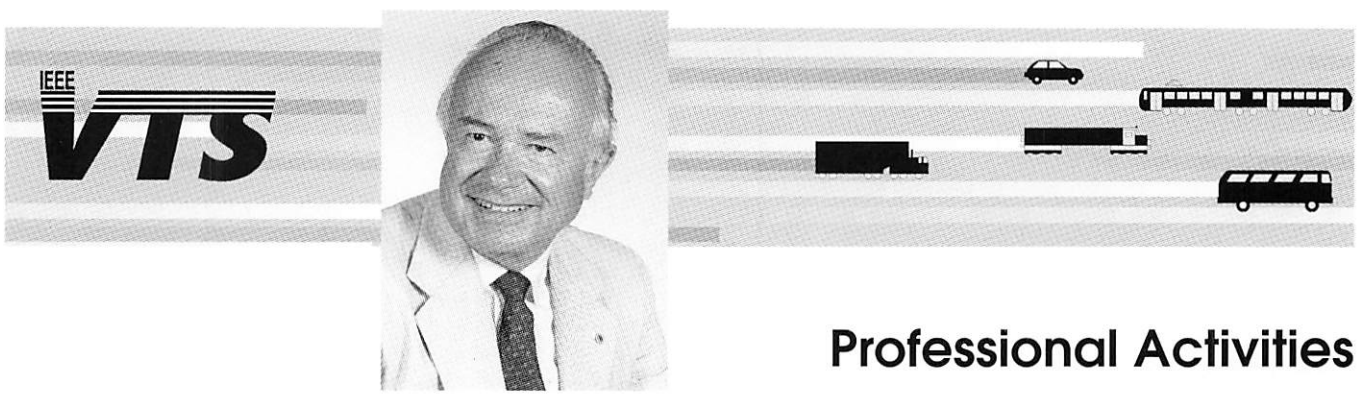


Professional Activities

Frank Lord, Senior Editor

Scoundrels were probably the second professionals in the world. Most people were just providers for their families in terms of food and shelter. Scoundrels survived by taking a share of the valuables of average people. The creative people learned to be paid for their ability to contribute to the common good. Among these were those who would be classified as engineers as civilisation progressed. As law made life more of complicated, scoundrels were able to develop ways to take advantage of others without contributing anything to the common good.

The loss of consideration of the common good increased considerably in the 1990s in the United States. Some of the

reasons for this included the considerable decline in ethics, morality and patriotism at high levels in the government. Prior to this it was surprising in the late eighties when a major federal agency started promulgating misinformation about an engineering shortage. With pressure from the IEEE and AAES a two day conference, *Engineering in America's Future: Shortage or Surplus?*, was held in Washington DC in September 1991. It was concluded that there was neither a present nor projected shortage. Why would a major government agency that had no supporting data generate false information? Self-interest! This agency was administering federal government grants for graduate study. If there were no shortage of engineers there would be fewer grants and less need for administrators. The head of this agency was subsequently called before the involved congressional committee and publicly chastised.

In view of all foregoing it was quite surprising in 1997 when a recently formed association, Information Technology Association of America (ITAA) called a press conference to announce a "crisis" in their industry due to labour shortage. This was contended in the face of market factors that included static salary structure, massive layoffs in the industry, major management turmoil, and student judgement that the computer science field is reasonably attractive (entries were up from the recession induced downturn of the early nineties). It was also surprising that this "report" was merely a collection of pronouncements made without any substantial backup. This purported investigation had no particular methodology or significant response and queried members of the association. This report, in effect, discredited itself. It is difficult for me to comprehend why an officer in this association would want to embarrass himself by having his name on the report.

Given the foregoing I consulted our Robert Rivers, LF, pioneer in Professional Activities, and very knowledgeable in economics, who responded as follows:

"There is much publicity given to shortages of engineers. From an economic point of there can be no such thing as a shortage in the long run in a market economy. A market economy will adjust the price until such time as the supply is called out from a shortage or the supply shifts from those that do not want to pay the price to those that do. Employing organisations that cry shortage are really saying something different. There are saying that they do not want to pay the price that others are willing to pay or that workers are willing to work for in order to obtain benefit of their services. Shortage statements show ignorance of labour market economies or expose attempts to manipulate others to make a lower cost supply available. Allocation of labour in a centrally planned economy does result in real shortage and surplus conditions due to inevitable planning errors. Our economy, however, is thankfully not a centrally planned one.

Overspecification is a technique used to guarantee the obtained obtaining of shortage evidence. It is used frequently to justify special immigration visa requests. Lower than market salary offers are guaranteed to produce evidence of shortages. Further evidence of the absence of any long-term deficiencies in supply is shown by the 30 years of data on the real wages of engineers. From 1965 to 1995 there has been a decrease in real wages.

In summary, the word shortage is a marketing term used to avoid bidding in the marketplace for the available supply of presently employed engineers. It is also used to convince perspective students of a high level of opportunities. It is used to convince government to open the floodgates of immigration."

I recommend that each of our members should be pushing for a high level investigation. In spite of the logical presentations developed by the IEEE and other individual sources, the Immigration subcommittee of the Senate voted to retain the H-1B category and increase the numbers to nearly 200,000 immigrants per year.

Even though our global institute should be concerned about the situation because all members are being exploited, very little as being done. I have pointed out that so many other items are under consideration that our resources are thinly spread. Consequently I have recommended other organisations to which our members might contribute to produce even more action. I repeat one of my previous recommendations which has a membership for over 70,000 and could do more with more support:

FAIR (Federation for American Immigration Reform)
1666 Connecticut Avenue, N.W.
Suite 400
Washington, D. C. 20009

This organisation published following item which includes a reference to one of our dedicated IEEE members:

The slowdown in the high-tech economy has drastically reduced demand for the foreign workers the computing industry was begging for only last year.

In the last few years, the high-tech industry has steadily pressed Congress to allow it to hire more foreign workers. During debate over the issue, FAIR told Congress that the industry's claims of a possible worker shortage were exaggerated and that raising the cap on temporary foreign workers would be a mistake. FAIR's report, *Digital Addiction: Why the Information Technology Industry Doesn't Need More Temporary Foreign Workers*, cited numerous facts and studies that argued strongly against any increase. (This report is available our web site www.fairus.org).

Despite objections from organisations that, like FAIR, were concerned about the effects of foreign labour on American workers, Congress agreed to triple the cap on H-1B temporary visas from 65,000 to 195,000.

But just a few months after Congress acquiesced to the computer industry's pressure, the demand for temporary foreign workers under the H-1B visa programme has dropped 44 percent. Norm Mattloff, computer science professor at the University of California at Davies and a well-known critic of the computer industry's dependence on temporary foreign workers, feels the Congress should have seen this coming. "People like me are saying, 'I told you so'," Matloff said, "I never felt there was a shortage of people in the first place." Prof Matloff's own paper, *Debunking the Myth of the Desperate Software Labour Shortage*, is available online at http://heather.cs.ucdavis.edu/itaa.html

Thousands of H-1B foreign workers have been fired as a result of the high-tech slowdown and are required to leave the country immediately, despite confusing rumours that the INS is not enforcing departure and there that there was a 'grace period' during which H-1B holders could find different jobs in order to remain. The INS has issued a public clarification that fired H-1B holders are expected to leave the country immediately with the assistance of their foreign employers, as required by law.

Member responses are always welcome.

Mobile Radio

Javier Gozalvez, Senior Editor

CTIA Wireless 2001

CTIA Wireless 2001, operated by the Cellular Telecommunications Industry Association (CTIA), was held in Las Vegas (March 20-22). The show had over 700 wireless exhibitors.

The US wireless operator Sprint PCS announced its migration strategy to 3G at the show by building a cdma2000 network. Lucent, Motorola, Nortel and Qualcomm were identified as the main technology partners of the operator. Sprint's strategy has four deployment phases. The first one is due to begin before the end of 2001 and will offer greater capacity for voice traffic and increased data speeds, reaching 144kbps. The second stage will offer data speeds up to 307kbps. The 3rd stage (late 2003) will introduce cdma200 1xEV-Data only with speeds of up to 2.4Mbps. Early in 2004, the fourth stage will implement 1xEV data and voice with speeds of up to 5Mbps.

Spectrum issues were at the centre of discussions during the CTIA show. Some industry leaders criticise the US spectrum policy, which has caused the US to fall behind the rest of the world in the amount of spectrum set aside for the wireless industry. Michael Powell, head of the FCC, said "the country needs to spend time developing a coherent, nationally harmonised spectrum policy". Mr Powell also expressed the limited control of the FCC over spectrum as "ownership is spread throughout the government, defence and aviation".

Qualcomm announced during the CTIA show a series of new products. Among the announcements were the MSM6200 and MSM6300 Mobile Station Modem integrated circuit and system solutions to support 2G and 3G standards. The MSM6200 solution supports the FDD mode of WCDMA and GSM/GPRS. The MSM6300 solution supports 3G cdma2000 1x and GSM/GPRS. Also revealed were the MSM6050 and MSM6100 integrated circuits and system software. The devices will support acceleration of advanced 3G features and services in CDMA product offering and cdma2000 commercial deployments. According to the company, these devices along with their radioOne architecture will reduce the number of radio components by 50%. Other products announced include the MSM6500 and MSM6600. MSM6500 supports cdma2000 1X, cdma2000 1xEV and GSM/GPRS. The MSM6600 solution supports cdma2000 1x, WCDMA and GSM/GPRS. Qualcomm revealed with Korea Telecom Freetel the plans of the Korean operator to commercially launch cdma2000 1xEV in the major cities of Korea during the second calendar quarter of 2002. The technology, an enhancement of cdma2000, supports peak data rates up to 2.4Mbps in a standard 1.25MHz frequency channel. The US company also revealed its licensing agreement with Globalstar USA/Caribbean to sell Globalstar Commercial Data services, two-way data satellite communications using the Globalstar Satellite Data Modem (GSP-1620) by Qualcomm. The agreement will allow Globalstar to offer services for single unit retail rates beginning at a $10 per month for service and usage charge of $0.15 per Kilobyte second. The modem uses CDMA technology and is compatible with Windows 95/98/2000 Dial-up Networking.

Lucent Technologies, Microsoft and Qualcomm revealed at CTIA the results of an independent IDC (International Data Corporation) North American research study. The conclusion of the research is that consumers want mobile multimedia now. The main interests were accessing emails with large attachments, pictures, music and Internet access during drive time. The study also forecasts the market for wireless high-speed data users to grow more than 27million in 2007.

TTPCom announced its solution to include Java capability into GSM phones. According to officials from the company, the software is capable to run on a wide range of baseband processors, can be embedded into the handset at time of manufacture or can be downloaded on demand from a mobile portal.

During the event, Siemens announced it will ship by the fourth quarter of this year the first TDMA/GSM handset. The handset, S47, will support TDMA at frequencies 800 and 1900MHz and GSM at frequencies 900 and 1900MHz. The phone will also be able of using GPRS.

Technology and research news

Tropian, a Silicon Valley company, revealed its TimeStar chipset, a multi-mode RF transmitter that supports various technologies such as AMPS, GSM, TDMA, GPRS and EDGE. The company claims that its chipset performance is as or more efficient than single-mode solutions. TimeStar is enabled by the use of Polar Impact technology, which means that whereas other systems process the signal in an analogue way, TimeStar does it in digital form end to end. According to the company "the various standards are stored as a digital look-up table".

CKW Wireless, a subsidiary of ArrayComm and winner of an unpaired 5MHz frequency in the Australian 3G auction, said it will use the spectrum to supply only data services via its i-Burst technology. The company plans to start the roll-out in October 2002. It also claims that its technology will deliver 40Mbps to each cell and 1Mbps guaranteed to each user.

Lucent Technologies has announced a series of enhancements to its 3G base station platform that will boost performance and capacity for UMTS and cdma2000 networks. Lucent revealed that its 3G-ready Flexent OneBTS base station will incorporate an optional Intelligent Antenna BLAST technology with enhanced amplifier innovations developed by Bell Labs. The OneBTS base station has been designed so that it can integrate multiple antenna and ampli-

fier technology. Depending on how a network is configured intelligent antennas can improve coverage by as much as 70% or data throughput capacity by 100%. Also, Bell Lab researchers have shown that BLAST can improve network capacity by up to 300% in a typical configuration.

The 3rd Generation Partnership Project (3GPP) has accepted a proposal by the SyncML initiative to adopt SyncML as the protocol for future mobile data synchronisation services. SyncML will then replace IrMC as a sole wide area network synchronisation solution in 3GPP release 4.

Idetic has released the Alpha version of Far Reach, the company's network and bandwidth optimisation product. The company claims to be able to provide 3G-like speeds over existing wireless networks using its tool. The product incorporates a collection of intelligent network and bandwidth optimisation technologies that monitor every stage of wireless data delivery and makes adjustments on the fly. The trials have demonstrated a consistent reduction in data traffic by a factor of more than 4 to 1.

Tantivy Communications has announced its I-CDMA wireless protocol. According to the company, I-CDMA is the only technology available today to enable portable, end-to-end, wireless broadband Internet access. The technology can support, per user, access speeds of 368kbps for downloading and 224kbps for uploading data. It can also support 1,000 users per 1.25MHz channel. According to the company the I-CDMA technology can be easily deployed as an overlay to a service provider existing wireless infrastructure and is spectrally compatible with IS-95.

Samsung has launched the first handset to break the one centimetre thickness barrier. The handset includes features such as upgraded SMS, wider animation character selection and a memory capacity that can store up to 1,000 phone numbers. The phone is intended for the South Korean market initially.

J-Phone (Japan) has introduced a 16-bit colour screen cell phone capable of displaying 3D images. Three-dimensional technology for mobile phones is different from the 3D in the movies as it does not require wearing red and blue glasses. Also the images on the cell phones don't appear to leap out at the viewer. Instead, the images are shaded and shaped to give them greater depth. They can also be rotated or viewed at different angles.

A high security cell phone, the TopSec GSM phone based on the Siemens S35i handset, has been launched. The handset has been modified with a so-called "crypto-chip" for a high level of security. The phone uses a combination of asymmetric 1,024 bit and symmetric 128-bit encryption. Both parties of a call must be using the TopSec GSM phone or a similar equipped fixed-line device. Rohde & Schwarz is marketing the devices after acquiring the hardware cryptology segment of Siemens' Information & Communication Mobile division.

Image Sensing System from the US announced the availability of a cellular telephone and pager jamming device that can block the transmission and reception of wireless phone and pager signals within a 40 meter circle. The device emits an encoded signal from a base transmitter at the same frequency of wireless and pager communications. It is compatible with AMPS, D-AMPS, CDMA, GSM, PCS and PHS at frequency bands 800, 900, 1800 and 1900 MHz.

e-tenna Corporation unveiled a new approach to RF design that can significantly improve the performance and lower the cost of antennas for mobile communications. A key element of the technology is the Artificial Magnetic Conductor (AMC), a thin and low-cost printed circuit board that enables wireless antennas to be isolated nearby objects that could degrade the performance. In field-testing AMC technology resulted in performance gains of 2 to 4 dB which could result in an increase in wireless coverage by 15 to 20%. The device also reduces Specific Absorption Rate (SAR).

Photo by Samsung

Samsung's new phone is less than 1cm thick

The KDD Research Institute (Japan) teamed with a research group at the University of Kagoshima (Japan) to use Wireless LAN technology to send and receive 2.4GHz signals between two islands 11.3km apart. The experiment involved KDD's Carrier Frequency Offset-Spread Spectrum (CFO-SS) which can transmit and receive 2.4GHz signals at 10-18Mbps. Conventional wireless LAN system transmitting at 11Mbps have to halve the transmission speed at distances of 2-3km.

Intel has revealed a technology, called "Wireless-Internet-on-a-chip", that provides a microprocessor, computer memory plus wireless functionality onto a single piece of silicon. The resulting core mobile phone chip is expected to provide battery life of up to one month and almost five times the computing power of current handset chips.

M-commerce and location-based services

Gravitate Inc revealed that SigmaOne Communications Corp will be integrating the Gravitate Platform into its Sigma- 5000 TDOA-AOA Location system. The Sigma-5000 is a location determination product that combines two separate network-based methodologies, Time Difference of Arrival and Angle of Arrival. The solution does not require operators to modify existing handsets or infrastructure equipment. The Gravitate software will function as manager and application server of the location data provided by the SigmaOne system.

CellPoint, a wireless location service provider, announced a deal with E-Plus (Germany) to launch its mobile location system in E-Plus's network. The technology, which does not require any network or SIM-card upgrades, will allow to locate phones within around 100 meters in a city. The system is also fully compatible with 2.5G and 3G systems.

Ericsson and Cambridge Positioning Systems (CPS) signed a licensing agreement under the terms of which Ericsson will use CPS's Cursor location technology, based on Enhanced Observed Time Difference (E-OTD), as part of its mobile positioning products.

A report from the Yankee Group Europe suggests location-based services will not be a revenue-spinner as it forecasts that by 2005 they will only provide operator traffic revenues of US$6.4billion in Western Europe. The report recommends operators to pay attention to issues such as privacy, expectation management, roaming and third-party access to data. It also suggests to develop partnerships with content providers, positioning technology vendors, ASPs and handset manufacturers.

A consortium of companies (including E-Plus, GZS, Payitmobile, MATERNA and Accenture) are establishing a new mobile payment system in Germany. The consortium will run a pilot phase during this summer.

Nokia, KPN Mobile and Interpay (a Dutch payment processing specialist), announced they performed the first successful financial transaction via a mobile network using Wireless Identity Module (WIM) technology. WIM is part of

the WAP 1.2 specification. It is installed in the SIM card and provides security for real-time payments.

CeBIT 2001

The CeBIT 2001 convention took place between the 22nd and 28th of March in Hanover (Germany). There were 8106 companies from 60 different countries participating as exhibitors. During the show, manufacturers such as Nokia, Samsung, Ericsson, Siemens and Motorola unveiled their new GPRS handsets. Motorola displayed the largest range with five models, Nokia only unveiled two models (one of them incorporating GPRS, HSCSD, Bluetooth and WAP technologies) and Ericsson showed its T68 phone, which is supposed to be the industry's first GPRS phone with a colour screen. Samsung presented its SGH-Q100 model, which combines WAP and GPRS. Samsung's handset is a multi-slot class 8 device with four receive channels and a single transmit channel.

Columbitech demonstrated during the show in partnership with Axis Communications how mobile users can move freely between a GSM network and Bluetooth without losing their secure connections with the Internet or their corporate data. The company uses Wireless Transport Layer Security (WTLS) Class 3 to ensure that privacy, integrity and authentication are maintained from application-to-application. Hewlett-Packard also announced during the show its first integrated Bluetooth printer.

An alliance between Symbian and IBM for the smartphone software was announced at the CeBIT show. The first product to use the complete package will be Nokia's 9210 Communicator.

ACCESS Co demonstrated during the show a new micro browser, the Compact NetFront Plus, with native support for the three most important standards for mobile phone Internet access: WML used in WAP, Compact HTML used in i-mode and XHTML Basic. The tool allows to display content in any of these three formats.

Baltimore Technologies, AU-System and Gemplus announced the launch of their new wireless security solution which uses a combination of Subscriber Wireless Identity Module, a wireless application layer and a Wireless PKI. The solution conformed to the Standard Security Interface (SSI) and is suitable for GPRS.

Initiatives and Forums

The DECT Forum has launched an interoperability initiative. The DECT interoperability certification programme will require suppliers and manufacturers of DECT Packet Radio Service products to demonstrate the smooth interoperability of their products with other supplier's devices.

Ericsson, Motorola and Nokia announced the establishment of the Wireless Village, the Mobile Instant Messaging and Presence (IMPS) initiative to define and promote a set of universal specifications for mobile instant messaging and presence services and create a community of supporters. The initiative will deliver an architectural specification, protocol specifications, as well as test specifications and tools for IMPS. The initiative will also define procedures and tools for testing conformance and interoperability of mobile instant messaging and presence services. The instant messaging specification will be based on prevalent bearer protocols and other well-adapted standards such as SMS, MMS, WAP, SIP and XML. More information can be found at http://www.wireless-village.org/

Alcatel, Ericsson, Motorola and Siemens also announced they will implement Enhanced Messaging Service (EMS), a standard defined by 3GPP. EMS allows to send text messages in the form of images, melodies and animations. The standard is seen as an evolutionary step between SMS and Multimedia Messaging Service (MMS).

A new consortium, named COR Consortium, of so-called Mobile Virtual Network Enablers (MVNEs) has been created to lower market entry barriers for brand owners to become virtual operators. The aim of the consortium is to make MVNOs viable with a smaller subscriber base. The consortium will have four core competencies: payment infrastructure, network access, content provision, and management and consultancy.

The Wireless Advertising Association has launched a global initiative to provide business standards in wireless marketing, equivalent to the audit standards already established in the print and broadcasting advertising media.

The Wireless Multimedia Forum (WMF) joined the 3rd Generation Partnership Project as a Market Representation Partner.

Ericsson, Motorola and Siemens Information and Communication Mobile announced plans to develop an industry initiative to define a universal mobile games platform using existing and emerging standards. The initiative will focus initial efforts on agreeing upon open Applications Programming Interfaces (APIs) and a Software Development Kit, which once developed will be available to software developers subject to license.

FCC & US mobile market

The Federal Communications Commission (FCC) released a Final Report on a spectrum study of the 2500-2690MHz band for 3G wireless systems. This frequency band was identified by the WRC-2000 conference as one of the candidate spectrum for 3G systems. In the US, the 2500-2690 MHz band is currently used by the Instructional Television Fixed Service (ITFS) and Multipoint Distribution Service (MDS). This report is a companion to a study done by the NTIA on the 1755-1850MHz band. The report highlighted the difficulty of sharing or segmenting the 2500-2690MHz band for a nation-wide footprint as the use of the band varies across the country. Also, sharing would require large separation distances between the video and 3G providers to ensure there is no interference. According to the report, relocation could cost between $10.2billion and $30.4billion. The NTIA report says the Department of Defence uses the 1710-1850MHz band and that the spectrum could not be fully released before 2017 or 2030. The report suggests three options for sharing or relocating government operations. The reports are available at http://www.fcc.gov/Bureaus/Engineering_Technology/Public_ Notices/2001/da010786.html

A study from the Johns Hopkins University concluded that the Ultra-Wideband technology can operate so that the signals have characteristics similar to white noise. The study comes after concern from the aviation community about possible interference from UWB to the GPS system.

The FCC has delayed the auction of upper and lower paging channels until October 30.

The FCC approved the transfer of the control of licenses and authorisations held by VoiceStream and Powertel to Deutsche Telekom in connection to their merger.

The FCC proposed to revise its rules for spread spectrum systems to reduce the amount of spectrum that must be used for frequency hoping spread spectrum systems operating in the 2.4GHz band and to eliminate the processing gain requirement for direct spread spectrum systems.

The CTIA submitted a filing requesting the FCC to re-allocate spectrum allocated for mobile satellite services to wireless networks. The spectrum, on the 2GHz band, is currently unused and unlicensed.

The FCC has said that wireless carriers are responsible for the costs of delivering enhanced 911 information to the 911 system maintained by the wireline phone companies. Both Nextel and AT&T have filled waiver requests regarding the FCC's October deadline for meeting enhanced accuracy and reliability standards to locate wireless callers in emergencies. In its waiver request, Nextel states it has chosen A-GPS technology. The CTIA released the official figures regarding wireless emergency service calls. A total of over 51million calls were done in 2000, nearly 140,000 a day.

Verizon Wireless signed an agreement to acquire 10 MHz PCS licenses from Carolina PCS I L.P and its subsidiaries.

3G trials and roll-out

Motorola successfully transmitted what it claims is the world's first live video transmission over its 3G CDMA 1xEV-DV solution. Sprint PCS and Lucent announced the successful completion of a 3G over-the-air data call at speeds of up to 2.4Mbps using cdma2000 1xEV-DO. Lucent's Flexent CDMA base stations and Qualcomm's 1xEV-DO test equipment was used in the trial. Nokia and BT Wireless have completed a successful 3G All-IP multimedia rich call over BT's trial network in the UK. The applications tested include Voice over IP and video telephony. The system was based on IPv6. Vodafone UK and Ericsson announced the successful completion of what they claim is the first WCDMA live voice call over a commercial network. KDDI (Japan) and Qualcomm announced the successful completion of a 3G cdma2000 1xEV-DO trial in co-operation with Hitachi, Sony and Kyocera. The tests were performed in the 800MHz band.

NTT DoCoMo delayed the launch of its 3G services for full commercial use to October 1, four months later than planned. The causes of the delay were software bugs in the switches, radio network control and handsets, and changes in the specifications. However, the company has introduced its FOMA 3G service for a limited number of users between May 30 and September 30, 2001. The "Introductory service" will be used to assess system performance and provide customer feedback for the full-scale launch. The company has already completed the installation of 200 base stations. The service was launched in Tokyo and limited areas in Yokohama and Kawasaki. DoCoMo received more than 147,000 applications for the trial while it was only offering 4,500 phones.

BT had also to delay, at least for three months, the launch of its 3G service in the Isle of Man. According to BT, the reasons for the delay were software bugs in the handsets when handover was performed.

The German regulator said that current UMTS licenses will permit UMTS infrastructure sharing under certain conditions. Only the sites, masts, antennas, cables and combiners can be shared but not the core network. The operators must also have independent control of its own logical Node B. It has been estimated that this sharing could save 40% of network build costs. BT and Deutsche Telekom have then agreed to share their 3G infrastructure costs in Germany and UK. Spain is also expected to allow infrastructure sharing amongst its 3G operators. Spain had also to delay the start date of its 3G services from August 2001 to June 2002. In Sweden, Orange has signed a letter of intent with 3G Infrastructure Services AB, a joint venture of Hi3G Access AB and Europolitan Vodafone, to cooperate on the construction and operation of a joint 3G network in Sweden.

The European Union released a discussion paper, "The Introduction of Third Generation Mobile Communications in the European Union: State of Play and the Way Forward", where it calls for a unified approach for the development of 3G networks and services in EU countries. The paper criticises the "very heavy front-end expenses" as a result of 3G license auctions and indicates the EC wants to discuss with Member States the conditions to permit infrastructure sharing.

Mobile satellite communications

New ICO submitted a proposal to the US Federal Communications Commission requesting to be allowed to use satellite spectrum in the 2GHz range for terrestrial and satellite services. This move highlights the question of whether satellite spectrum should be opened for terrestrial services. New ICO and ICO-Teledesic Global Ltd announced they have abandoned their plans to merge New ICO and Teledesic Corp into the holding company. However, ICO-Teledesic Global Ltd has signed collaboration agreements with two other satellite companies, CCI International and Ellipso Inc. The agreement with CCI, a company established to develop a low-orbit satellite system, covers technical, financial, regulatory and business issues. The deal with Ellipso includes the collaboration on the deployment of voice and data services via satellite. Ellipso was planning to deploy its services in 2002 or 2003. Its system consists of 18 satellites moving in elliptical orbits over densely populated areas.

Iridium, now run by the Boeing Company, has unveiled an Internet service. However, its best service will only reach 10 kilobytes per second. The company also signed a commercial deal, adding to its existing 13 service providers, with SAIT Communications. This company provides satellite services for maritime, government and military users and was recently acquired by Telenor. The first mobile satellite phone system in Philippines was launched by Iridium. The service will include voice telephony, paging and Short Message Service (SMS). Iridium's phones can also offer 2.4kbps data transmissions.

Telenor, Norway's state telecoms group, has acquired Lockheed Martin Global Telecommunication's COMSAT mobile communications operations for $116.5million. The acquisition also includes two earth station facilities in Southbury, Connecticut, and Santa Paula, California. COMSAT provides global mobile communications solutions to the maritime, land, mobile and aeronautical communities and offers data, voice, fax, telex and video services over the Inmarsat satellite constellation.

Mobile phones and health

Researchers at the University of Sidney and the Australian National University have started a study into the effects of mobile phone use. The study will monitor more than 2000 long-term users. According to one of the researchers, while most studies concentrate on cancer effects, there are many studies that have in fact shown an improvement on people's ability to perform certain tasks.

The Committee of Senior Officials for Scientific and Technical Research (COST) of the European Union has launched nine new projects, two of them targeting the telecoms industry, to study the effect of electromagnetic fields in human health. The aim of the project "Electromagnetic Fields and Health: Emerging Information and Communication Technologies" is to obtain a better understanding of possible health impacts of emerging technologies, especially related to communication and information technologies, that may result in exposure to electromagnetic fields. The second project "Channel Modelling and Propagation Impairment Mitigation for Millimetre Wave Radio Systems" aims to improve the design and planning of present and future millimetre wave broadband telecommunications systems.

New research results from Dr Henry Lai, research Professor at the University of Washington, were presented at a conference held in London. The research concentrated into the influence of mobile phones on single and double-strand DNA breakage. According to the presenter, Dr Magnussen (Chief Executive Officer of EMX Corp), "each of our body's cells has the ability to repair itself each day. However, with exposure to cellular phone radiation, over time its ability to fix itself is decreased". EMX has developed an electromagnetic noise field that "regularly pulses electromagnetic fields" and "the repair mechanism [of our body's cells] function at top speed again".

Research from Swedish scientists, lead by Professor Hardell from the Orebro Medical Centre, has suggested that certain benign tumours are more likely to occur on the side of the head against which mobile telephones are held. The study compared 1,617 patients diagnosed with brain tumours with a group of healthy people.

The UK House of Commons Trade and Industry Committee highlighted concerns over the health effects of the TETRA system in a report on the sitting of mobile phone masts. The problem comes from the fact that a burst of energy at a rate of 17.6 times per second is produced in the TETRA system. The Stewart report, published last year, recorded studies showing that calcium loss from brain tissue was greatest at 16Hz. The report suggested that amplitude modulation around 16Hz should be avoided.

A report released by the United States General Accounting Office stated the current research does not show radio-frequency emissions from cellular phones have adverse health effects. However, the report says although the FCC has set limits for RF exposure, there are no standardised testing procedures for assessing how much radiation a phone emits.

The CTIA announced contracts, estimated at $1.5million, with various laboratories in the US, Germany and Italy to study the health effect of mobile phone use. The research is part of a Cooperative Research and Development Agreement with the US Food and Drug Administration. The research, which will be conducted independently of the CTIA and wireless industry, is expected to take two years to complete.

Wireless industry forecasts and surveys

The 2001 Multimedia Telecommunications Market Review and Forecast, a publication produced by the Telecommunications Industry Association, predicts that wireless messaging and mobile workforce requirements for wireless Internet access will boost wireless services spending at 17.3% compound annual growth rate through 2004. The overall US wireless market is expected to grow at a 14.7% compound annual rate. The report also claims that 3G wireless technology will not be a principal driver for the 2000-2004 period.

Cahners In-Stat Group predicted in a report a considerable increase in mobile phone subscribers in the next five years. According to the report, the worldwide penetration rate will reach 24% in 2005. Also, the research firm said 3G service providers will not see a return to profitability until after 2005. Strategy Analytics Inc predicts in its report "Worldwide Cellular User Forecasts (2001-2006)", that the wireless market will reach 1.7billion subscribers by 2006, with North America and Western Europe only accounting for 20% of this increase. Latin America and Central Europe will mainly drive the growth. In another report Strategy Analytics suggests the US cellular market will reach saturation by 2006 with a penetration rate of 84%. The research firm also predicts that handset shipments will reach 500million in 2001 and more than a billion in 2006, with replacement rather than new handsets accounting for the majority of the growth.

One 2 One, a mobile phone operator in the UK, released a survey showing there is a growing interest in using the mobile phone to vote. The interest was particularly strong amongst people aged between 18 and 24 years old, with 62% of them wanting to use the mobile phone to vote. The percentage decreased to 46% when considering people under the age of 55.

Northstream AB, a Swedish consultancy firm, reported on the viability of the business case for 3G mobile operators. The report "3G Business Case: Bid book versus reality" estimates that an incumbent operator in a country like Germany with a market share of at least 20% will require an Average Revenue Per User per month of 44.9 euros (only 10% more than current levels) by 2010 to achieve a positive net present value by 2015. The figure is increased by 37% for a new entrant. Population density plays a key role as the figure is increased by 125% in a country like Sweden. The report also suggest that site sharing will not provide considerable benefits except in sparsely populated countries.

Merrill Lynch has identified 2.5G systems and the wireless LAN standard 802.11b as strong challengers for 3G. According to the firm 2.5G provides the always-on capability at a cost, in Europe, of $3billion compared to $250billion for 3G. Wireless LAN strengths include the price, its interoperability, security and speeds offered.

Nokia's 3G Business Consultancy released the results of a survey conducted over 8,000 mobile phone users. The survey suggests that users will be willing to pay on average US$67 per month for services such as multimedia, personalised information services and m-commerce. The survey also concludes that users would generally be willing to part with over 50% more per month for 3G services that they usually paid.

Spectrum licenses

An official from the Telecommunications Ministry of Tunisia said the second GSM mobile phone license in the country will be awarded in July at the latest. Algeria also opened its tender for the second GSM license with the view to offer a third one in December 2003. The list of candidates was later shortlisted to four companies: Orange, Telefonica, Portugal Telecom and Orascom Telecoms from Egypt.

The Russian Communications Ministry has granted Moscow Cellular Communications a license to build a CDMA400 based network. The license is for the 453MHz to 457.5MHz and 463 to 467.5 MHz bands. Association-800, which represents Russian AMPS networks, announced an agreement with the Russian Communications Ministry to award the AMPS networks spectrum in the GSM1800MHz band and corresponding GSM licenses. At least half of the AMPS networks are committed to upgrading their networks to GSM. Russia plans to discontinue AMPS services by 2010. Slovenia's first tender for three UMTS licenses failed after receiving just one application. Regulations stipulate that there have to be at least two applications. The high cost of the licenses (US$109.2million) was seen as the reason for the lack of applications. However, the country has opened a second tender that will expire in September. The price has been decreased and regulations modified to allow for a single application. Slovakia awarded three Fixed Wireless Access (FWA) licenses in the 26GHz band.

Colombia will admit bids for C-band wireless licenses from August to September and expects to award the licenses in the fourth quarter of this year. Existing operators will not be allowed to apply for the licenses that will operate on the 1900MHz band. Venezuela is said to restage this summer an auction of radio frequencies for high-speed telecommuni-

cations services previously cancelled. The country will auction 11 licenses for Local Multipoint Distribution Systems (LMDS). Ecuador is intending to offer a further 1900MHz license by the end of the year, plus several other fixed wireless licenses. Telecom Italia Mobile completed its Brazilian nation-wide network by acquiring a mobile license covering 16 states. However, Brazil failed to sell, for the second time, two regional licenses as it received no bids. The licenses, known as band E, were to operate in Sao Paulo state and in Brazil's central-south region.

France awarded two UMTS licenses to France Telecom Mobiles and SFR. The French regulator has also proposed to carry out a second round for the two outstanding licenses as soon as possible. Greece has decided to award four UMTS licenses by auction on July 2001. The starting price will be $130million. The payment conditions will depend on the number of winning bidders.

Jamaica has announced it will auction two licenses for 3G services by early 2002. Despite the auction, no new mobile phone operators can begin operating until March 2003 when full market liberalisation occurs.

The Australian auction for 3G spectrum ended raising a total of US$577million, half the expected amount by the Australian government. The licenses will be allocated for a 15 year term. Telstra, Vodafone, CKW Wireless, Optus Mobile, 3G Investments (Qualcomm) and Hutchison were the winners. Singapore awarded three 3G licenses. The planned auction was cancelled as the bidders applied for different segments of the spectrum. The winners are MobileOne, Singapore Telecom Mobile and StarHub Mobile. Singapore is also planning to auction five 2G spectrum right lots in the GSM1800MHz band.

Mobile Data

Numerous industry leaders in the mobile communications and content industries (among which AOL, CNN, Ericsson, Motorola, Nokia, Orange, Siemens, Sun Microsystems, T-Mobil, TIM and Vodafone) announced their support for the XHTML markup language (Extensible Hyper Text Markup Language) as the format for the future evolution of mobile services. XHTML is seen as the natural evolution of WAP which will allow the convergence of WAP with the fixed Internet. Nokia then demonstrated the first XHTML microbrowser on mobile phones (the modified Nokia 6210 and Nokia 7190 handsets).

Telstra (Australia) has made available WAP on its CDMA network. The Kyocera QCP 3035 is the first WAP-enable CDMA handset available. It includes two-way SMS, data capabilities and a car kit with an external antenna.

A report from Cahners In-Stat Group suggest the WAP market in Western Europe will grow from 5.8million in 2000 to 200million in 2004. The adoption of the GPRS technology will be a key factor in this increase. Also, the adoption of the XHTML standard will be an important factor.

NTT DoCoMo has announced it expects the market for i-mode to saturate soon as the penetration rate reaches 80%. A Japanese newspaper reported the company will sell new dual-band cell phones from 2002 to tackle the saturation. The phones will switch between the 1.5GHz and 800MHz bands automatically depending on the band's traffic. NTT DoCoMo has also announced it will open its Japanese i-mode network to competitors in 2003. The company has also been forced to recall again more than 420,000 Java-enabled i-mode phones due to a software bug.

Hutchison Telecommunications, partially owned by NTT DoCoMo, will launch its own version of i-mode this summer in Hong Kong. Hutchison will use a 2.5G packet switched technology to launch the service.

Bluetooth news

The Bluetooth Congress took place in Monte Carlo at the beginning of June. Several announcements were made during the event. Cambridge Silicon Radio (CSR) introduced its MicroSira and CompactSira development tools for integrating Bluetooth functionality into personal computers and PDAs. CSR's Bluetooth chips were also selected by 3Com for its Bluetooth modules (PC card, USB device and USB printer module). Palm released during the Congress its Bluetooth card which can plug into its Palm m500 and m505 handhelds. Certicom partnered with Classwave, Socket and Widcomm to provide security via a wireless virtual private network for Bluetooth solutions.

Philips Semiconductors and Tality announced their strategic partnership to provide customers with complete embedded Bluetooth system solutions. The solutions consist of a family of Tality-developed Bluetooth reference modules that utilise baseband and RF ICs from Philips, together with Tality's protocol stack and application profiles.

Ericsson presented Mobile@Home, a fixed-mobile convergence concept. It combines Bluetooth and the speed of fixed IP access and reaches rates of up to 700kbit/s. The concept requires a Bluetooth enabled handset and a Bluetooth Home Base Station (HBS). Through fast IP access the HBS connects into the standard Mobile Core Network through a Home Base Station Controller.

KDDI announced it will launch a wireless phone (C413S) that will be the first cdmaOne Bluetooth-enabled phone in Japan.

Transilica introduced OneChip, what it claims is the world's smallest fully integrated Bluetooth system-on-chip solution. The solution combines all Bluetooth components including the RF Transceiver, baseband modem, microprocessor, SRAM and flash memory into an eight-millimetre square BGA chip.

Murata Electronics introduced a Bluetooth module developed using Low Temperature Co-Fired Ceramics technology. The chip integrates both active devices (IC's) and passive components onto a single chip that supports USB, UART and PCM interfaces.

Microsoft has announced it will not support Bluetooth in the next major version of Windows. Windows XP will instead support 802.11.

Other news

The City and County of San Francisco has accepted a new Motorola 800MHz trunked SmartZone communications system that will enable all City and County public-safety departments to talk directly with each other. Motorola has also applied for a TETRA license in Denmark.

China will wait until 2002 to decide on a 3G standard. In the meantime, tests of TD-SCDMA, developed by the Chinese Academy of Telecommunications and Siemens, have already started in Beijing. The technology is expected to be commercially available next year. Seventeen Chinese handset manufacturers signed an alliance to work together in research and development, supply chains and distribution networks to boost their market share. At the moment, Chinese companies only control 10% of the local handset market. China Unicom has started building its CDMA network. The company has awarded contracts to Lucent Technologies, Motorola, Nortel Networks, Ericsson Huawei Technologies, Shanghai Bell, Datang Telecom, Jinpeng Group and Eastern Communications. The network is not expected to be operational until the end of 2001. China Mobile will launch soon mobile data services based on SMS and WAP under a scheme named "Monternet". According to newspapers, the company will follow DoCoMo's revenue generation model for i-mode.

The Spanish Association of Electronics and Telecoms Industries (ANIEL) has launched a national initiative to recycle mobile phones. The main operators and manufacturers established in Spain participate in the program.

Ericsson and Sony signed a Memorandum Of Understanding to create a new company that will incorporate their respective mobile phone businesses worldwide.

A survey of 69 mobile portals in 17 countries has been produced by the Global Mobile Suppliers Association. The survey can be downloaded at www.gsacom.com

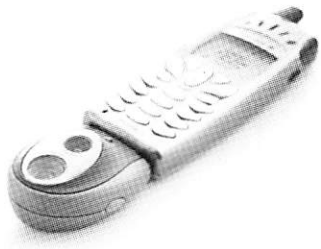


Photo by Ericsson

World's first mobile camera for GSM

According to the CDMA Development Group the number of CDMA mobile subscribers has reached 90million, growing 58% in the last year. The number of GSM subscribers reached the 500 million mark according to the GSM Association and EMC World Cellular Database. The Universal Wireless Communications Consortium (UWCC) announced an increase of 67% over the last year in the number of TDMA subscribers to reach a total of 68.3million.

Ericsson unveiled the world's first mobile camera for GSM. The product allows to send instant pictures from a mobile phone to an email address or store them in a virtual photo album.

Book Reviews

Dirk Pesch, Senior Editor

Dear VTS members

I am delighted to introduce the first book review since I joined VTS News as senior editor for book reviews. I hope that readers will find this section of the News interesting and informative. I would also like to take the opportunity to encourage all VTS News readers to participate in the book review section by suggesting new and interesting books for review or to contribute a review themselves. The review in this issue looks at a book about transportation engineering, "Intelligent Transportation Systems: New principles and architectures", by Ghosh and Lee, published by CRC Press in 2000. The subject of transportation engineering is at the heart of Vehicular Technology. Transportation is key to mobility, which has impacts on not only vehicular traffic and systems but also on mobile and wireless communications. We would hope to follow on from this review with a review of a book covering the area of mobile communications in order to span the interest of our readers.

The reviewer of this issue is Dr. Hubert Rehborn, who is a senior research scientist with DaimlerChrysler research center in Stuttgart, Germany. Hubert works primarily on modelling and control of vehicular traffic on highways and has published widely in this field. Hubert can be reached as follows: Dr. Hubert Rehborn, DaimlerChrysler Research, Dept. FT3/T Telematics Research, HPC: E224, D-70546 Stuttgart, Germany. E-mail: hubert.rehborn@daimlerchrysler.com

Sincerely,
Dirk Pesch

Dirk Pesch was born in Krefeld, Germany in 1966. He received a Dipl. Ing. (MSc) degree from Aachen University of Technology, Germany, in 1993 and a PhD from the University of Strathclyde, Glasgow, Scotland, in 1999, both in Electrical and Electronics Engineering. Dirk was a software systems design engineer with Nokia Mobile Phones from 1993 to 1995, working on wireless protocol specification and standardisation. From 1996 to 1998, he was a research fellow with the Mobile Communications Group at Strathclyde University. Since February 1999 he has been a lecturer in the Department of Electronic Engineering at Cork Institute of Technology, where he is also co-director of the Adaptive Wireless Systems research group. His research interests are in the area of wireless network and protocol design, wireless and mobile network management and performance evaluation.

Intelligent Transportation Systems: New principles and architectures

Sumit Ghosh and Tony Lee
Published 2000 by
CRC Press
ISBN 0 849 3 00673
192 pages
Price $89.95 (US), £59.99 (Europe)

Reviewed by Hubert Rehborn

In transportation the necessary flow of information has to be much faster and more efficient than the physical flow of goods or people in the transportation network. The demand for flexibility and the wish for the freedom of choice in transportation is increasing today, while the physical transport networks cannot be expanded anymore as required. Therefore, there is a strong need for efficient co-ordination, control and routing in transportation networks, which should be supported by a software architecture and algorithms.

This book presents distributed algorithms and software architectures for computer-based control of intelligent transportation systems (ITS). Two algorithms, a distributed control algorithm, DARYN, and a scheduling and congestion mitigation algorithm RYNSORD for railway networks are introduced by the authors. Software implementations are including on a CD-ROM.

Traditional approaches are presented first (chap. 2), which are based on centralized control algorithms for railway networks with strong limitations regarding large networks and train numbers. In DARYN, based on an absolute centralized clock, station computers at each node and distributed physical entities of the railway networks (e.g. trains) act as decision makers; this leads to less communication time and less computation. Limitations of DARYN are (i) no assignment of train priorities, (ii) no congestion and bottlenecks in the network.

In the RYNSORD approach (chap. 3), the look-ahead of trains, i.e. reserving N tracks ahead of the current position includes predictions of the train's trip. The concept of "soft reservation" means the monotonically increasing requests for future tracks with flexibility in time in contrast to the rigid and binary decision of current station nodes. Tracks are characterized by length and owned by one specific station node to guarantee safety. Then the dynamic routing of trains is performed. The approach is presented and evaluated for larger train networks, i.e. the eastern US Railroad Network with 50 stations. The software example (chap. 8) needs some time to become familiar with; an automatic demonstration with more explanation and graphic would have been helpful. A comprehensive stability analysis for RYNSORD (chap. 5) is performed including many test results: strong stability is shown with respect to perturbations of finite duration to the input traffic and track failures.

For intelligent vehicle highway systems (IVHS) a distributed architecture analogously to DARYN and RYNSORD is proposed for dynamic route guidance and intelligent congestion mitigation (chap. 4). The concept of a distributed scalable traffic management center's architecture (DICAF) is presented. The authors demonstrate the scalability and performance of DICAF based on a congestion measure which is a very simple engineering approximation of the reality. In the future the dynamic routing of a large number of vehicles under changing traffic conditions will require new architectures and concepts.

Two different simulation techniques for ITS designs are introduced with pseudo-code and simulation examples (chap. 6): in Virtual Process Migration (VPM) each stationary entity is assigned to the processors on a one-on-one-basis and the mobile entities of the transportation network are modeled as virtual processes. In the Physical Process Migration (PPM) all entities are allocated on separate processors. Both approaches are compared with simulation results: VPM is more feasible for larger networks while PPM for more realistic modeling.

Transportation research is interdisciplinary and transportation engineers need knowledge in civil and electrical engineering and more and more in computer science and engineering. The authors have a broad computer science and engineering background; for transportation related issues the authors use more or less rules of thumbs and do not take the real underlying highway traffic processes (which are not determined by waiting queues) into consideration. The book does not contain real-life examples for highway transportation. Key issue here is the demonstration and simulation of an asynchronous and distributed computational approach. The book is valuable for graduate students in transportation engineering as it introduces possible approaches in the application of computer science to transportation problems. Intelligent and efficient software solutions will become more and more necessary in transportation in times of increasing global exchange of goods and people. However, practitioners and policy makers in transportation would miss the connection to real-life examples and the advantages of the proposed concepts in comparison to market competition and other approaches.

VTS Bylaw Change

The Vehicular Technology Society Board of Governors, at their meeting on May 8, 2001, approved the following change to their Bylaws:

Bylaw IV, Section 2.0, delete the word "elected" in the second line.

As a result of the change, the bylaw will read as follows:

'The President and Executive Vice President must be members of the Board of Governors at the time they assume office. The balance of the officers, if they are not elected members of the Board shall become appointed members of the Board and have all the privileges and responsibilites of Board members with the exception of the right to vote. This includes entitlement to reimbursement for travel expenses when authorized'.

The full VTS constitution and bylaws can be found on the VTS web site, www.vtsociety.org, by following the 'Administrative' link. They were last published in the VTS News in the February 1997 issue.

VTS Board Member runs for Division IX Director

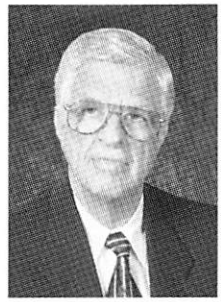
Every two years society members have an opportunity to vote for a director to represent the society's technical division on the Technical Activities Board and in the IEEE Board of Directors. VTS is in Division IX, the Signals and Applications division, with five other societies: Aerospace & Electronic Systems, Geoscience & Remote Sensing, Oceanic Engineering, Signal Processing, and Ultrasonics, Ferroelectrics & Frequency Control.

The ballot members will receive in September will offer three candidates for Division IX director: George F. McClure, John Vig, and Glen N. Williams. Their principal societies are, respectively, VTS, UFFC, and OE. George McClure will be known to VTS members as a past VTS president and current elected board member.

The last time VTS had a member of its board on the IEEE Board of Directors was in 1989-1990. That was Art Goldsmith, but because of a different arrangement of soci-

eties in divisions at that time, he represented the Engineering Management Society rather than VTS. George's current VTS assignments include the conference board, long-range planning committee, publicity and public relations, and assisting in member recruiting and retention, as well as in strengthening chapter relations, a priority recommendation from the 1999 Sections Congress.

George McClure's view is that technical societies should focus their activities to provide the greatest benefit to the members. This includes, besides the purely technical information dissemination role in publications and conferences, promoting education opportunities, newsletter content, and better chapter support. Working with other boards, such as Education Activities, societies can assist in the development of member mid-career education opportunities and strengthen their relations with their chapters.



George McClure

A constraint to this development is the levy on society assets by IEEE to finance growing administrative costs. At the current rate, some societies will be totally stripped of assets in five or six years. George believes that problem-solving to reduce the levies will work to allow societies more autonomy in serving their members. Healthy growing societies translate into a healthy IEEE as well, making the resolution of the financial problems the first priority.

George McClure has been nominated to serve on the IEEE Audit Committee, contingent on his election as Division IX director, so will be well-positioned to begin his budget problem-solving.

Convergence 2002

Dates for Convergence 2002 have been set at 21-23 October 2002. Due to the continued growth of the conference, it will again be held at the Cobo Center in Detroit.

VTC2001-Fall in Atlantic City

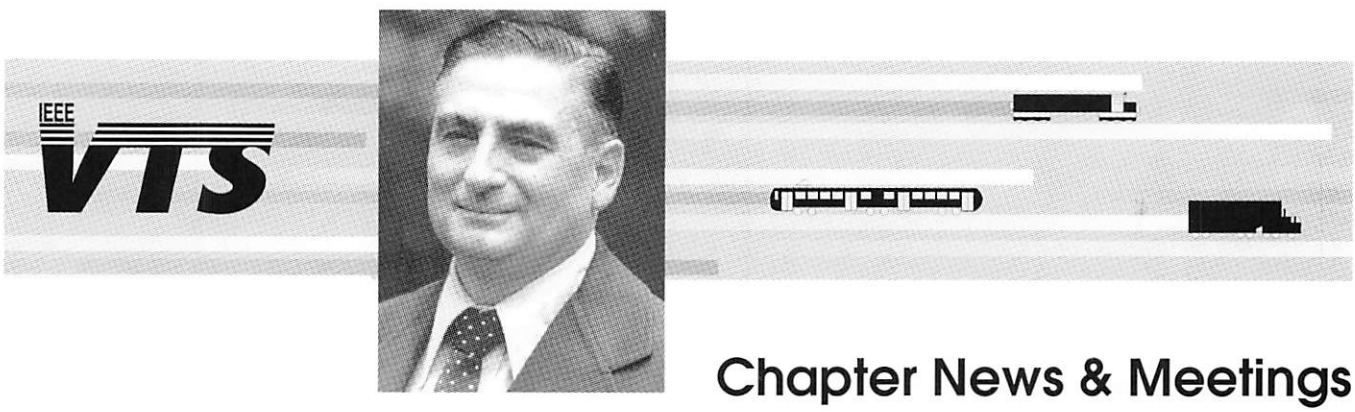
Last call for VTC2001-Fall in Atlantic City, which will take place from the 7th to the 11th of October in the Atlantic City Convention Center. **Advance registration closes on the 30th of August.** Advance registration gives a saving of about 15% so is worth taking advantage of.

Approximately 650 papers have been accepted to form part of the technical programme. In addition, the first day of the conference on Sunday 7th October will feature 11 tutorials on a wide range of current topics on mobile radio.

In a new development, three workshops will be presented by industry on the last day (Thursday 11th). Delegates are welcome to attend free of charge. The workshops are:

- ✦Maximising capacity in 2G and 3G networks with smart antennas (by Metawave Communications Corp.)
- ✦Automated Design, Synthesis and Optimisation of High Frequency Circuits and Structures (by Ansoft Corp)
- ✦Communications System Design using Advanced Integrated EDA Tools (also by Ansoft Corp.)

Abstracts of each of these workshops can be found on the web site, along with other details of the conference and the tutorials can be found on the conference web site, http://www.fallvtc2001.com



Chapter News & Meetings

Gaspar Messina, Senior Editor

New York Section

At their April 24, 2001 forum, two papers were presented. Mr. Ramdane Benferhat, of the New York City Transit Authority, presented the first paper entitled, "R-143 Propulsion and Signs"; and Mr. Edwin Mortlock, of Parsons Transportation Group, presented the second paper entitled, "New Technologies Used On NYCT's R-143 Cars". A total of 56 IEEE Members and Guests attended.

Rail Communications Innovations Forum

The IEEE NY Section Vehicular Technology and Communication Society Chapters will co-sponsor a technology-sharing forum on **Fiber Optic Communication Networks for Rail Vehicle Control**. Panelists will describe and answer questions on the Broadband Communication system being implemented by MTA - New York City Transit. The forum, hosted by Nortel Networks, will take place on October 30, 2001, 6:00 to 8:00 PM at 320 Park Avenue, (50th ST) New York City. Lead panelists **are Morris Schwartz, P.E., PhD.**, and **Edward J. Willner**. Mr. Schwartz is a Senior IEEE Member, and Chief Communications Engineer with MTA-New York City Transit. Mr. Willner is President of E.A. Technologies Inc., Transit Communications Systems.

Engineers, suppliers, installers, and operators are invited to raise questions and share insights. Future IEEE

NY Section, VTS Technology Sharing forums are being planned for:

- ✦JFK Airport Transit System, and
- ✦Public Address Systems on Subways and/or Commuter Rail

There is a $35.00 charge for the forum and refreshments commencing 5:30 PM.

Advance registration is required for admission. IEEE Members and non-members may register for the October 30, 2001 forum by sending $35.00 checks payable to IEEE NY Section to Brad Craig, Louis T. Klauder and Associates, 317 Madison Avenue, Suite 1621, New York, New York 10017. If you are an IEEE member, please provide your membership number and indicate if you are interested in participating in one or more of the planned forums.

Additional information regarding program specifics can be obtained by contacting Mr. David Horn of Fluor Daniel Infrastructure, at (212) 947-7110, or by e-mail at david.horn@fluor.com.

Note to VTS Chapters

VTS Chapters world-wide are eligible to receive $100.00 U.S. at the end of the calendar year for submitting L-31 Meeting Attendance Forms reflecting their Chapter's periodic meeting to VTS Chapter Activities Chairman.

Gaspar Messina,
9800 Marquette Drive,
Bethesda, Maryland 20817, U.S.A.

Calls for Papers

VTC2002-Spring in Birmingham, Alabama

4-9 May 2002

The VTC2002-Spring Conference will be held in Birmingham, Alabama from 4-9 May 2002.

The objective of the conference is to provide the opportunity to present technical papers and posters, tutorials and exhibits that represent technical innovation and applications associated with an ever-expanding mobile wireless industry. Although the main focus of the conference is voice and data wireless mobile communications, papers addressing rail and automotive transportation topics are invited. The program committee issues the Call for Papers and invites your participation in the conference.

Please see the VTC2002 web site at www.ieee.org/vtc02spring for technical subject areas, as well as details of how to submit a paper. A short abstract and an extended abstract of up to two pages, including text and figures, must be submitted at the same time. Important dates are:

September 30, 2001:	Deadline for Submission of Abstracts (Short and Extended)
December 15, 2001:	Notification of Accepted Papers
February 15, 2002:	Deadline for Submission of Full Paper

Birmingham is located in North Central Alabama and early May is the peak of spring time in the "Magic City". Attractions include NASA's Marshall Space Flight Center at Redstone Arsenal in nearby Huntsville, AL; the Robert Trent Jones Golf Trail; Alabama Sports Hall of Fame; the McWane Center, an interactive hands-on science adventure that also includes an IMAX Dome Theatre; and Mercedes Benz, manufacturer of the M-Class ATV, who offer tours of the facility.

Further details of registration, the conference program and activities will be forthcoming on the VTC2002 Spring web site.

VTC2002-Fall in Vancouver, British Columbia, Canada

24-29 September 2002

The VTC-2002 Fall Conference, to be held in Vancouver, Canada, aims to capture and present the current state of the innovative and highly active mobile wireless industry. We seek to present the changing face of wireless technology and a glimpse in the future of this exciting field. Over 400 full technical papers and posters are expected to be presented, along with tutorials, business application/panel sessions and exhibits. Authors are invited to submit extended abstracts describing original research results, innovative applications, and experimental or field trial/test results in the following mentioned fields of wireless communication : Antennas and Propagation; Wireless Access; Transmission Technology; Multimedia, Networks and Systems; Wireless Personal Communication Systems; Mobile Satellite; and Transportation.

Authors MUST submit an extended abstract (up to 2 pages) in MS Word, PDF or PS file formats at the SAME time as their short abstract submission (approx. 150 words).

Proposals for Tutorials and Panel sessions are also accepted in the VTC-2002-Fall. Tutorials (half-day or full-day sessions) that are intended to provide in-depth learning on a specific topic of interest to the participants. Panel sessions are 90 minutes long. They present leaders in a particular area discussing a topic of interest to the attendees of VTC-2002-Fall. There is usually significant audience participation in Panel sessions. Proposals for Tutorials and Panel sessions should consist of a 250 word summary, a 100 word abstract, and a cover page listing the details of the author(s) as given above. Summaries should be submitted electronically by February 15, 2002. Submissions should be made at the website "http://www.fallvtc2002.org"

The first date for submission of abstracts is **1 November 2001**. Abstracts must be submitted by **Feb 15, 2002**

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Conferences of Interest

The following table shows VT-06 sponsored and co-sponsored conferences as well as related conferences not sponsored by the Society. While every attempt was made to ensure accuracy, you should contact the respective conference committee to confirm date and location.

DATE	CONFERENCE	LOCATION	WEB PAGE	
15-18 August 2001	3rd Int. Workshop on Mobile Wireless Comms Networks	Recife, Brazil	http://www.cin.ufpe.br/~mwcn2001/	
19-22 August 2001	RAWCON 2001 Radio and Wireless Conference	Boston, MA	http://www.rawcon.org	
25-29 August 2001	ITSC 2001	Oakland, CA	http://www.ewh.ieee.org/tc/its/2001/	
9-12 September 2001	WPMC'01	Aalborg, Denmark	http://www.wpmc01.org	
24-28 September 2001	European Wireless Week	London, UK	http://www.eumw.com	
25-28 September 2001	IVEC2001 Veh. Electronics Conf.	Tottori City, Japan	http://www.kankyo-u.gr.jp/ivec2001	
26-28 September 2001	3rd Int. Workshop on Multi-Carrier Spead Spectrum	Oberpfaffenhofen, Germany	http://www.dlr.de/KN/KN-S/mcss2001	
30 September - 3 October 2001	PIMRC 2001	San Diego, CA	http://www.pimrc2001.org	
7-11 October 2001	VTC 2001-Fall	Atlantic City, NJ	http://www.fallvtc2001.org	
28-31 October 2001	MILCOM 2001	Washington, DC	http://www.milcom.org/2001	
30 October 2001	Rail Comms Innovations Forum	New York, NY	See page 42	
30 October - 2 November 2001	CIC 2001 6th Int CDMA Conf.	Seoul, Korea	http://www.kics.or.kr/cic.html	
14-16 November 2001	ISCIT 2001	Chiang Mai, Thailand	http://www.kmitl.ac.th/~iscit/	
25-29 November 2001	Globecom 2001	San Antonio, TX	http://www.globecom2001.com	
20-24 January 2002	Int. Conf. On Micro Electro Mechanical Systems (MEMS)	Las Vegas, NV	mailto:kkcline@pmmiconferences.com	
26-28 February 2002	European Wireless 2002	Florence, Italy	http://www.ing.unipi.it/ew2002	✓
28 April - 2 May 2002	ICC2002	New York, NY	http://www.icc2002.com	✓
6-10 May 2002	VTC 2002-Spring	Birmingham, AL	http://www.ewh.ieee.org/soc/vtc02spring/	✓
28-31 May 2002	3G Wireless 2002	San Francisco, CA	http://delson.org/3gwireless02/	✓
16-21 June 2002	APS International Symposium / URSI Radio Science Meeting	San Antonio, TX	http://www.ieeeaps.org/2002APSURSI/	✓
16-21 June 2002	IST Mobile Summit	Thessaloniki, Greece	http://www.iti.gr/summit2002	✓
2-5 September 2002	ISSSTA 2002	Prague, Czech Republic	http://www.ure.cas.cz/isssta2002	✓
24-29 September 2002	VTC 2002-Fall	Vancouver, BC	http://www.fallvtc2002.org	
21-23 October 2002	Convergence 2002	Detroit, MI	http://www.convergence2002.org	
27-30 October 2002	WPMC '02	Honolulu, Hawaii	mailto:M.Clemente@ieee.org	
21-24 April 2003	VTC 2003-Spring	Seoul, Korea	mailto:jhlee@gong.snu.ac.kr	
Fall 2003	VTC 2003-Fall	Lake Buena Vista, FL	mailto:mguizani@cs.uwf.edu	
Spring 2004	VTC 2004-Spring	Genoa, Italy	mailto:vatalaro@ing.uniroma2.it	

Conferences marked '✓' have open calls for papers as of 31 August 2001. This list is based upon the conference calendar at our web site, which is updated more frequently than this list can be. To access it go to the following URL: http://www.vtsociety.org/, then click on "Conference List" in the left frame.

Corrections and additions to this list are most welcome. We are particularly interested in adding listings for Automotive and Transportation conferences. Please send corrections and additions to Tom Rubinstein at t.rubinstein@ieee.org.