IEEE MULTIMEDIA COMMUNICATIONS TECHNICAL COMMITTEE

# *E-LETTER*

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## CONTENTS



IEEE COMMUNICATIONS SOCIETY

## Message from MMTC Chair

Greetings to our MMTC members,

Multimedia Communication Technical Committee (MMTC) has been providing a forum for technical advancement of Multimedia Communications. The MMTC meets twice a year during ICC and GLOBECOM conferences, and this TC meeting is a very good opportunity for all the related people from academia and industry with the interest in research and development in multimedia communications to get together. The next TC meeting will be held in Berlin during the ICC 2009 conference in June, 2009. All conference attendees are welcome to attend. The meeting agenda and other information about MMTC activities and operation can be found at the TC web page:
http://www.comsoc.org/~mmc/index.asp

We also have an e-mail mailing list to inform you various MMTC related activities through multicomm@comsoc.org.

Thank for the great efforts from Haohong (EIC) and all the editors (Philippe, Chonggang, Guan-Ming, Shiguo, and Antonios), we have continued our E-Letter. You can check all the E-Letters from http://www.comsoc.org/~mmc/index.asp.

The primary goal of the E-Letter is to disseminate issues that share ideas, opinions, and perspectives in various areas of multimedia communications related technologies. I would like to take this opportunity to encourage all of you to contribute short articles to share with all the TC members about your research achievements and your perspectives on specific research topics.

See you all in Berlin.

Sincerely yours,

Qian Zhang

## Message from Editor-in-Chief

At the beginning of this Issue, I would like to encourage every members and friends that are working in the multimedia communications related areas to attend the MMTC meeting to be held in Berlin during the ICC 2009 conference in June, 2009. In the TC meetings, we can meet with each other, find new opportunities to collaborate, or strengthen the current connections with face-to-face communications.

In this issue, we have 7 scientific articles published in the technology session and half of them are concerning about the high reality 3D visual communications. This group of papers with special interest begins with a Distinguished Position paper, 3D media delivery over IP, delivered by Dr. A. Murat Tekalp (Koc University, Turkey). In this article, Dr. Tekalp shares his vision and perspective of the 3D media Internet services and enabling technologies, and throws lights on the future trends and promising research and development areas for 3D media delivery.

The second paper by Dr. Ghassan Alregib (Georgia Institute of Technology) is focused on the immersive communications, where the key factors for its success, such as multi-camera imaging, user's behavior modeling, coding, and displays, are discussed.

The third paper by Drs. C.T.E.R Hewage and S. Worrall (University of Surrey, UK) concerns about the error robustness of 3D video data coding and transmissions, where the error resilient 3D video coding, error concealment and cross-layer optimizations for 3D video are discussed in details.

In this issue, the selected paper for recommendations by our Column Editor, Dr. Guan-Ming Su (Marvell Semiconductors) is a paper published in *IEEE Trans. Wireless Communication* in 2007, on the topic of cross-layer design for video communication over wireless ad-hoc networks.

In the fourth paper, Drs. Gene Cheung and Wai-tian Tan (HP Labs) overviews the current research achievements in the topic of community media from both perspectives of networking and applications and services. In addition, a few challenges are highlighted at the end to encourage audiences to investigate further.

In the last 2 papers, Drs. Zhu Li (Hong Kong Polytechnic University, China), Minoru Etoh (NTT Docomo Labs, Japan), and Hong-Shik Park (Information and Communications University, Korea) highlight a few latest advanced multimedia communications technologies and services that have been deployed in Asian market, such as TD-SCDMA, BcN, mixi, and mobage-town. Dr. K.P. Subbalakshmi (Stevens Institute of Technology) discussed about the general scope of multimedia security and introduced the special interest group of security inside MMTC.

At the end, I would like to strongly encourage everyone to support MMTC by attending MMTC meeting at Berlin this June.

As always, I thank all Editors of the E-Letter, and our authors to make this issue successful.

Thank you very much.

Haohong Wang

## HIGHLIGHT NEWS & INFORMATION

# *Call for Participations: MMTC Meeting @ ICC'09*

June 14-18, 2009
Dresden, Germany

The regular MMTC meeting is to be held at Dresden, Germany during IEEE ICC 2009 conference, June 14-18, 2009. The specific meeting time and location would be determined very soon and would be notified in our next Issue.

All members of MMTC and friends that are working or interested in multimedia communications related areas are encouraged and invited to attend this meeting.

This year, IEEE ICC (International Conference on Communications) is hosted first time by Germany. As one of the flagship conference of the IEEE Communications Society, ICC typically bring together around 1500 world's leading scientists from academia and industry to participate this event. Around 1000 papers selected from 3000+ submissions would be presented in the conference.

The host city, Dresden, has recently converted into one of the most famous silicon site with booming high-tech semiconductor businesses. Many companies (see below the Volkswagen's Transparent Factory) and R&D institutes located there make Dresden a modern city full of civilization and advanced technologies.

Volkswagen's "Transparent Factory"

The Dresden Zwinger - a baroque complex of pavilions and galleries

On the other hand, Dresden has a long history in which it has experienced both splendid eras and times of tragedy. It was above all during the 18th century a magnificent centre of European politics, culture and economic development, only to become a synonym for apocalyptic destruction just two centuries later

The Frauenkirche Church

Dresden offers many attractions including the Dresden Zwinger, the Frauenkirche Church, Semper Opera House and Royal Palace as well as many other historical monuments and ensembles determine the image of the city.

Dresden is the fourth largest city in Germany after Berlin, Hamburg and Cologne, in terms of area. It is on the border of Germony, Czech Republic and Poland. The city lies in a marked widening of the Elbe valley. The foothills of the Eastern Erzgebirge Mountains, the Lusatian Granite Uplands and the Elbe Sandstone Mountains characterize its delightful surroundings.

## TECHNOLOGY ADVANCES

### *Distinguished Position Paper Series*

# 3D Media Delivery over IP

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With higher speed access network becoming widely available and affordable, services such as "Voice over IP," "video over IP," and "IPTV" are now commonly deployed and part of everyday life. 3D media services over IP are clearly the next big step forward in the evolution of digital media, entertainment, education, gaming and visual communication technologies. Consider watching your favorite football game in 3D at home, or your 3D avatar attending a business meeting at some remote location. Our vision of 3D media services over IP and its enabling technologies are depicted in Figure 1.

Significant accomplishments have been made over the last few years towards this goal; however, there are still some short-term and long-term fundamental research challenges that need to be addressed. It is the goal of this article to summarize what has been achieved so far, and what still needs to be done in order to realize this vision.

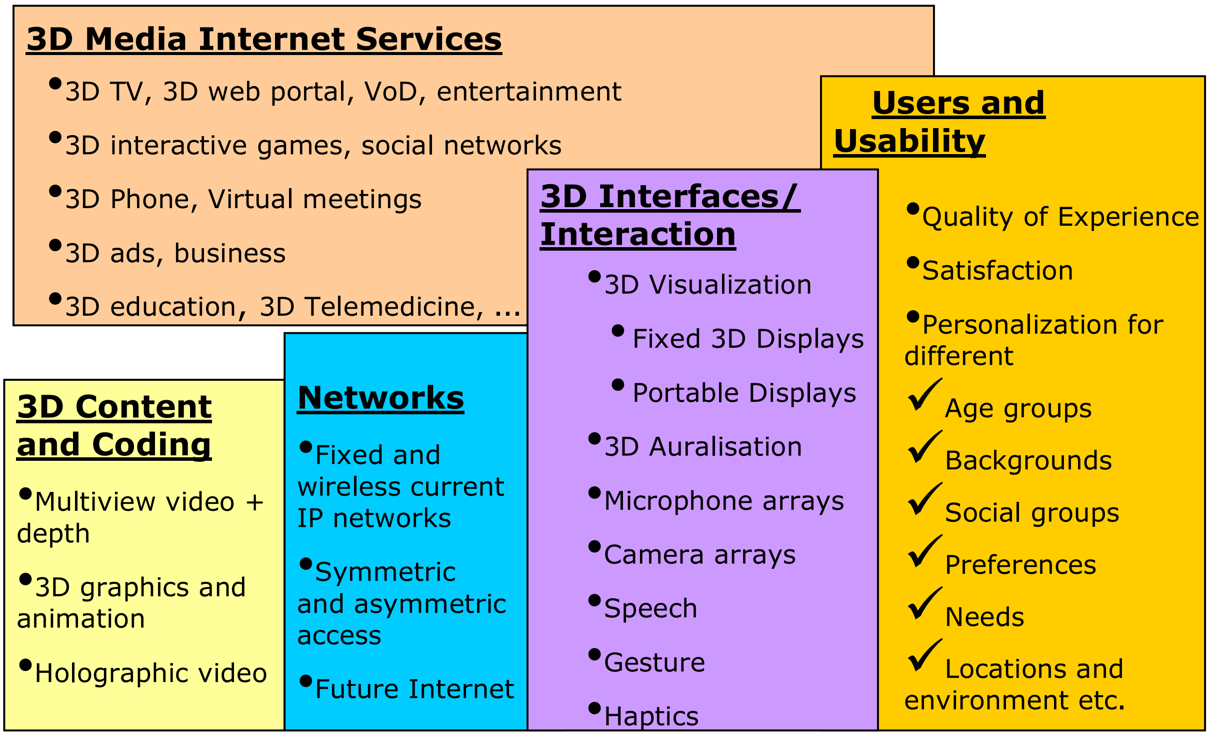


Figure 1: 3D Media Internet Services and enabling technologies

**Recent Accomplishments**

End-to-end 3DTV services theme was the focus of the European Framework Program 6 Network of Excellence 3DTV [1]. The main results of this project have been published in a series of articles in a special issue [2]. More specific results on 3DTV transport over IP have been presented in [3]. The most important recent advances in this area are:

- Auto-stereoscopic (multi-view) Displays: Current 3D video applications employ stereo or multi-view 3D video format, which is based on fooling the human eye by showing slightly shifted views to the right and left eyes. Auto-stereoscopic displays, using technologies such as parallax-barrier or lenticular lenses, achieve this without requiring the user to wear glasses. A typical multi-view 3D display device shows 8 or 9 views simultaneously to allow a limited free-viewing angle.
- Multi-view Video Compression: Methods for efficient compression of multi-view video have been standardized under Joint Video Team (JVT) MVC international standard [4].
- Streaming stereo videos: Stereo video provides more flexibility in congestion control methods, such as video rate adaptation to the available network rate, methods for packet loss handling, and post-processing for error concealment. These issues are addressed in [3], [5].

**Future Research**

New 3D video signal formats, capture technologies, and new-generation 3D displays: Multi-view video may cause eye strain and headache if not properly displayed. New 3D video capture and display technologies such as holoscopic and holographic video provides more natural 3D experience. However, these technologies are not mature enough for commercialization and more research is needed. Some of the European projects supported in Framework Program 7 are addressing these technologies [6]. Compression of these new video formats, such as holographic video (dynamic holography), is also an active research topic.

Future media networking technologies supporting different levels of end-to-end qualiy of service (QoS) and application-level quality of experience (QoE): We foresee that future media Internet services must rely on highly efficient and cost-effective mechanisms that can support different levels of end-to-end QoS in a fair manner in order to provide desired user QoE in proportion to each user's resources. This is a key future Research area [7], [8].

3D Media Internet Services will be a key future research and development area including 3D IPTV and immersive telecommunications services. Human factors such as usability of 3D video, interaction of 3D video and 3D spatial audio, and user satisfaction with such services as well as new means of 3D user interaction in immersive environments must also be studied.

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**A. Murat Tekalp** is a Professor at Koc University, Istanbul, Turkey since 2001. He received Ph.D. degree in Electrical, Computer, and Systems Engineering from Rensselaer Polytechnic Institute (RPI), Troy, New York, in 1984. He has been with Eastman Kodak Company, Rochester, New York, from December 1984 to June 1987, and with the University of Rochester, Rochester, New York, from July 1987 to June 2005, where he was promoted to Distinguished University Professor. His research interests are in the area of digital image and video processing, including 3D video compression and streaming, multimodal human-computer interaction, motion-compensated video filtering for high-resolution, video object tracking, content-based video analysis and summarization, multi-camera surveillance video processing, and protection of digital content.

Prof. Tekalp is a Fellow of IEEE and member of Turkish Academy of Sciences (TUBA). He was named as Distinguished Lecturer by IEEE Signal Processing Society in 1998. He chaired the IEEE Technical Committee on Image and Multidimensional Signal Processing (1996 - 1998), and was a founding member of the IEEE Technical Committee on Multimedia Signal Processing. He served as an Associate Editor for the IEEE Trans. on Signal Processing (1990-1992), IEEE Trans. on Image Processing (1994-1996), and the Kluwer Journal Multidimensional Systems and Signal Processing (1994-2002). He was an area editor for the Academic Press Journal Graphical Models and Image Processing (1995-1998). He was also on the editorial board of the Academic Press Journal Visual Communication and Image Representation (1995-2002). He was the Special Sessions Chair for the 1995 IEEE International Conference on Image Processing, the Technical Program Co-Chair for IEEE ICASSP 2000 in Istanbul, Turkey, the General Chair of IEEE International Conference on Image Processing (ICIP) at Rochester, NY in 2002, and Technical Program Co-Chair of EUSIPCO 2005 in Antalya, Turkey. He is the founder and first Chairman of the Rochester Chapter of the IEEE Signal Processing Society. He was elected as Chair of the Rochester Section of IEEE in 1994-1995.

He is the Editor-in-Chief of the EURASIP journal Signal Processing: Image Communication published by Elsevier since 1999. He authored the Prentice Hall book Digital Video Processing (1995). Dr. Tekalp holds seven US patents. His group contributed technology to the ISO/IEC MPEG-4 and MPEG-7 standards. He is a project evaluator for the European Commission and European Science Foundation.

## Immersive Communications: Why Now?

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The term Immersive Telecommunications consists of *immersive*, *tele*-, and *communications*. *Immersive* refers to the act of immersing a human or an object in an environment that is usually digitally constructed. *Tele*- means distant and *communications* refers to the act of transmission. If you combine these meanings, the term immersive telecommunications refers to the process of transmitting objects and their status over a distance to a remote entity. This definition leaves the door open to what the remote entity might be; it can be a digital world, a real world, or a combination of the two. In comparison, *telepresence* refers to the process of interacting with a remote *real* world while *immersive virtual reality* refers to the process of interacting with a *digital* world. In this article, I would like to share with the readers my views on immersive telecommunications and why we as a multimedia telecommunications community can impact the future of immersive technologies.

An example of an immersive telecommunications system is an enriched video conferencing system where participants are collaborating together in designing a new building or a new device. These participants have both a virtual or a digital design and a realistic design; all participants interact with both designs. Such vision is not new but nowadays we are closer than ever in realizing such vision. This is motivated by the recent advances in a number of related areas such as pervasive computing, imaging technologies, video and 3D coding and transmission, displays, wireless sensor networks, broadband access, graphics processing units (GPUs), and processors and hardware in general. There are several applications that will benefit from immersive communications. A surgical training system will benefit from immersive telecommunications technologies where existing virtual reality-based surgery training systems can be combined with remote access technologies for remote supervision and instructions by experienced surgeons. In the education field, there are several underrepresented regions lacking enough support for science laboratories and existing video conferencing systems are not capable of providing the students with hands-on experience that is crucial in the learning process; a remote instructor may teach a science lab and interact with the students who are located in various geographical locations. The examples of applications that may use immersive telecommunications are many and all of them fit the twenty first century; immersive telecommunications is a green technology.

There are a number of key areas that will be crucial to the success of immersive telecommunications in fulfilling their promise of serving our societies. These areas are: multi-camera imaging, modeling of user's behavior, efficient coding, and displays.

*Multi-camera imaging*: Multi-camera imaging has experienced several key advances over the years with applications in reconstructing 3D models of objects. Over the past a few years, new systems have been introduced into the market where a multi-camera system is used for telepresence. Although these systems are a step forward from the single-camera systems, these new systems do not fully utilize the opportunities a multi-camera system brings compared to single-camera systems. As an evidence of the importance of multi-cameras, one could review the latest efforts in multi-view coding and in 3DTV. I truly believe there is a large room for innovations in this arena with how multi cameras are becoming cheaper and they give us new tools and new problems to innovate.

*Modeling of user's behavior:* Not only Immersive environments depict real-life scenarios but they also bring more details that provide users with a detailed view of objects and the environment in ways that cannot be realized in real life. In order to achieve this goal, immersive environments have rich media beyond image, audio, and video. The data generated from interactivity between users or between a user and objects has features and characteristics that are different from other typical media data. Such new type of data requires different analysis and modeling. Processing images and video sequences require understanding of how such data is captured, i.e., understanding how cameras work. Moreover, the human visual system (HVS) was helpful in understanding how we see images and watch videos. That knowledge proved useful in compressing image and video sequences and in designing displays and processing algorithms. Similarly, thorough understanding of interactivity data requires us to understand how it is generated, how it is processed at various parts in the system, and how it is viewed by the human user.

*Efficient coding:* The multi-view coding showed us that there are still unanswered questions in coding multimedia sequences that are captured using untraditional devices. In immersive telecommunications, coding is required to all data including actions and multimedia sequences.

*Displays:* Display technology has been advancing at an unprecedented rate over the last a few years. As we improve the processing and the communications of the data that is captured and exchanged in an immersive environment, we will witness more innovations in how to display such data for more natural interaction.

In conclusion, over the past years and since we started the conference series on Immersive Telecommunications in 2007 (IMMERSCOM), we have witnessed various efforts by various groups in bringing researchers, industry leaders, and entrepreneurs from related communities under one umbrella to exchange knowledge and define the future of immersive telecommunications. The Multmiedia Signal Processing Workshop has immersive communications as the theme of the workshop in 2009. IMMERSCOM II is held in Berkeley in May 2009 and is attracting very interesting contributions with a solid technical program. I take this opportunity to invite the readers to contribute to this emerging area and to help us define this 21st-century green technology.

**Useful Links:**

1. IMMERSCOM Conference: www.immercom.org
2. MMSP Workshop: www.mmsp09.org
3. ICST Journal on Immersive Telecommunications: http://www.icst.org/publications/transactions_immersive_telecommunications/

**Ghassan AlRegib** received the Ph.D. degree in electrical and computer engineering from the Georgia Institute of Technology in 2003. He joined the Faculty of the Georgia Institute of Technology in 2003 and is currently an Associate Professor in the School of Electrical and Computer Engineering (ECE). His research group is working on projects related to multimedia processing and communications, distributed processing, immersive telecommunications, and gestural-based interaction. Dr. AlRegib received the Georgia Tech-ECE Outstanding Junior Faculty Member Award in 2008. Dr. AlRegib was the General Co-Chair and Co-Founder of the First International Conference on Immersive Telecommunication (IMMERSCOM) that was held in Italy in November 2007. He is the Steering Committee Co-Chair for the Second International Conference on Immersive Telecommunications to be held in California in May 2009. He was the Chair of the Special Sessions Program at the IEEE International Conference on Image Processing (ICIP), 2006. He also served as an Associate Editor of the IEEE Signal Processing Magazine and he is currently the Area Editor for the magazine.

## Robust 3D Video Communications

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**Abstract:** 3D multimedia applications are receiving increasing attention from researchers in academia and in industry. This is in part due to new developments in display technologies, which are providing high quality immersive experiences for prices within the range of consumers. 3D video has become a strong candidate for the next upgrade to multimedia applications, following the introduction of High Definition (HD) video. This letter discusses approaches for error robust transmission of 3D video. It looks at some of the similarities and some of the differences between the approaches that can be applied to 2D and 3D video, and recommends some future directions for research. The focus is mainly on 3D video in the color plus depth format.

### Introduction

The effects of transmission errors on the perceived quality of 3D video could not be less than for the equivalent 2D video applications, because the errors will influence several perceptual attributes (e.g. naturalness, presence, depth perception, eye-strain, viewing experience, etc), associated with 3D viewing. Therefore, 3D video content needs to be protected when transmitted over unreliable communication channels.

Before considering how 3D video is made error robust, it is necessary to discuss the format of video that will be used. A plethora of formats have been developed to represent 3D video. The two representations currently featured in published standards are:

- Color plus depth – where a depth map is sent alongside a color frame. The depth map represents the distance from the camera [1];
- Multi-view Video Coding (MVC) – a new standard developed by the Joint Video Team (JVT), which is capable of exploiting the correlation between the multiple views that are required to represent 3D video [2]. Work is being carried out combining the depth map with MVC [2].

A single view color plus depth video is sufficient to represent stereoscopic video, which is suitable for most of the 3D displays currently available. MVC can be used for holographic displays, and for Free-Viewpoint Video (FVV). In FVV, it is possible for the user to interactively select their viewpoint, and the view is then synthesized from the closest spatially located captured views [3].

This letter focuses on the color plus depth representation, due to its efficiency for the compression of 3D video, and its use in standards, such as MPEG-C.

An important point to note is that the compressed quality of the depth map is not a significant factor in the final rendered quality of the stereoscopic 3D video [4]. This is because the depth map is not directly viewed, but is instead used to warp the 2D color image to two stereoscopic views. Furthermore, the human vision system obtains many depth cues from the structure of the 2D image. However, for FVV, the depth map quality becomes more important, as it is used to render virtual views that are further apart than with the stereoscopic case. When the views are further apart, then the distortion in the depth map has a greater effect on the final rendered quality.

The rest of this letter considers the potential for 3D error robustness research. It splits up potential research areas into robust source coding, cross layer robustness, and error concealment.

### Robust Source Coding

Many standard source coding approaches are available to provide robust source coding for 2D video, and many of these can be used for 3D color plus depth video. Features such as slice coding, redundant pictures, Flexible Macroblock Ordering (FMO), Intra refresh and Multiple Description Coding (MDC) [5] will all be useful. Perhaps the main outstanding issue is in deciding how to optimize their application.

Loss aware rate-distortion optimization is often used for 2D video to optimize the application of robust source coding techniques. However, the models used have not been validated for use with 3D video. Although the importance of color compared to depth [4] would seem to indicate that existing 2D techniques will provide benefit, further work is needed to establish how the models can be better adapted. This is particularly true for FVV, where it would be beneficial to be able to model the effects of packet loss on synthesized free-viewpoints.

**Cross Layer Error Robustness**

Considerable attention has been paid to cross layer optimization of 2D video quality in recent years. This has resulted in algorithms that have optimized channel coding, and that have prioritized the video data using techniques such as Unequal Error Protection (UEP), and prioritized resource allocation.

Work has been carried out looking at a methods to transport 3D video across networks [6]. The study carried out in [7] proposes a JSCC scheme for color plus depth video.

Prioritization of color over the depth information is also possible, as the color information has been shown to be more important than the depth map for subjective quality [4]. However, as the depth map can typically be compressed to 10-20% of the color information, the gains from this approach are limited.

**Error Concealment**

Most 2D error concealment algorithms can be exploited for 3D video. However, there is additional information that can be used in 3D video to enhance the concealed quality. For example, information, such as motion vectors can be shared between the color and depth video. If color information is lost, then depth motion vectors can be used to carry out concealment.

However, there are many more opportunities with MVC, where adjacent views can be used to conceal a view that is lost. This can be through more simple disparity compensation techniques, or from more advanced warping using the 3D geometry of the scene.

**Summary**

This letter has described some of the issues associated with robust 3D video communications. Existing 2D error robustness techniques should offer improvements to the quality of 3D video transmitted over lossy networks. However, to obtain the best possible quality it is necessary to consider human perception issues (e.g. how perceived quality can be estimated), and the additional data present in a 3D video bitstream compared to its 2D equivalent.

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**S. Worrall** received the MEng Electronic Engineering degree from the University of Nottingham in 1998. He joined the Centre for Communication Systems Research (CCSR), at the University of Surrey, in 1998 as a research student, and obtained his PhD in 2001. From 2001-2003, he continued to work within CCSR as a research fellow, and was appointed as a lecturer in multimedia communications in 2003. His research interests include error robust video coding, multiple description coding, video compression, transmission of video over wireless networks, and multi-view video coding. He is a member of the IEEE and the IET.

## Editor's Selected Paper Recommendation

S. Mao, X. Cheng, Y.T. Hou, H.D. Sherali, and J.H. Reed, "On Joint Routing and Server Selection for Multiple Description Video in Wireless Ad Hoc Networks," *IEEE Transactions on Wireless Communications*, vol.6, no.1, pp.338-347, January 2007.

Ad hoc networks are infrastructureless wireless networks with mobile users. These two characteristics make them excellent match for important military and civilian applications, all of which demand simplicity and flexibility in deployment and operations. However, the direct consequences of infrastructure independence and mobility are dynamic network topology and multi-hop, fragile wireless paths, posing great challenges for provisioning of content-rich multimedia streaming services.

A basic requirement of a streaming service is continuous delivery of media data, which translates to continuous connectivity between media server and client. Furthermore, it would be highly desirable to have graceful degradation of received media quality as network environment changes over time. The traditional approach of accessing a single server through a single path could hardly be adequate, since the server could crash or be unavailable due to high workload or network partition, and the single path could be broken or congested [1]. An effective solution to these issues is *service replication*, as widely used in the Internet to make service closer to clients and for load balancing.

Recent advances in Multiple Description (MD) coding have made it highly suitable for wireless multimedia communications [2]. MD coding generates multiple *equally* important descriptions, each giving a low, but acceptable video quality. The decoding independence among the descriptions permits a reconstruction of video from any subset of received descriptions, achieving a quality commensurate with the number of received descriptions. MD coding is highly suited for media streaming over ad hoc networks, where links and servers are unstable, and reliable paths are hard to maintain [1,2].

In this paper, the authors investigate the problem of joint routing and server selection for double description (DD) video in ad hoc networks. In addition to selecting a pair of servers, they also explore optimal routing strategies to find high quality paths. Such a joint routing and server selection scheme opens a new dimension of freedom for improving the DD video quality, since it explores a much larger solution space than existing server selection schemes.

Joint routing and server selection is first formulated as a combinatorial optimization problem. This approach is application-centric and cross-layer in nature since the application layer performance is optimized via network layer operations. Due to the high complexity, exact solutions are hard to find. Rather, the authors present schemes to compute a *lower bound* and an *upper bound* on the achievable video distortion based on the monotone properties of the objective function. The upper bound produces a near-optimal pair of servers and a pair of corresponding paths, while the lower bound provides a benchmark for evaluating the optimality of the upper bounding solution. The proposed approach is computationally efficient and can be easily incorporated into existing routing protocols for ad hoc networks.

Extensive numerical results are provided to show that the upper and lower bounds are very close to each other for all the cases studied, indicating their closeness to the global optimum. Significant gains in received video quality over existing server selection schemes are also observed, which justify the importance of jointly considering routing and server selection for MD video streaming in wireless ad hoc networks.

The idea of cross-layer optimized MD video streaming has been extended in [3]. The authors develop a *branch-and-bound* based framework, embedded with the *Reformulation-Linearization Technique* (RLT), which can produce $(1-\varepsilon)$-optimal solutions for any small value $0 \le \varepsilon < 1$.

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** The Column Editor recommending this paper is Dr. Guan-Ming Su, Marvell Semiconductors.*

# New Paradigms in Community Media: Transport and Interactivity

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**Abstract:** *Recent proliferation of online social networking sites like facebook and mixi has garnered unprecedented attention on the power of community. In the context of media communication, by harnessing the power of community one can construct new and interesting paradigms for media transport and interactivity, beyond the traditional point-to-point unicast and point-to-multipoint multicast communication models for simple piecemeal media. We review existing research in community media and discuss future technical challenges, both from a network and an application perspective.*

## Introduction

Recent proliferation of online social networking sites (SNS) like facebook [1] in US and mixi [2] in Japan has attracted an exploding number of add-on applications and user-generated contents created by members, and has garnered tremendous attention and showcased the *power of community*. In hindsight, it is little surprise that when people gather their resources and efforts together, even when they are physically apart and only connected via computer networks, they can enrich traditional modes of interaction (e.g., populate video clips en masse in YouTube [3] for individual downloads), or create entirely new modes of interaction (e.g., chat in discussion groups formed around selected YouTube content). In the context of media communication, harnessing the power of community can also enable construction of new and interesting paradigms for media transport and interactivity; we loosely term this leveraging of community for media communication *community media*. These new paradigms provide new ways of looking at how media should be optimally transported and how users interact via media, much beyond standard distribution of simple piecemeal media via traditional point-to-point unicast (e.g., phone call, email) or point-to-multipoint broadcast/multicast (radio, TV distribution) delivery models. In this paper we review some examples of these paradigms, both from a network and an application perspective. We conclude with a discussion on future technical challenges for community media.

## Community Media: Transport

In the past few years, networking research has been extremely active in exploiting the power of community for wireless media transport. Similar to multiple-input, multiple-output (MIMO), *cooperation communication* exploits spatial diversity at the physical layer among multiple cooperative wireless clients, by employing relay node(s) to forward overheard copies of signals to intended receiver for combining [4-6]. A related development at the network layer, orthogonal to these cooperative communication systems that rely on the same physical channel for transmission, is the forming of *communities of multi-homed devices*, each equipped with both a Wireless Wide Area Network (WWAN) interface like 3G and a Wireless Local Area Network (WLAN) interface like 802.11, for the purpose of community-optimized media delivery [7-11]. In each case, multi-homed devices form an ad-hoc WLAN community for improved packet delivery, leveraging the group's collective WWAN connections. Focusing on network metrics, [7] proposed to first select proxy clients with good WWAN channel quality to the base station, then relay WWAN unicast packets via ad-hoc WLAN networks to non-proxy clients with poor WWAN channel quality for improved overall throughput. Similarly, towards the goal of increasing WWAN multicast group throughput, [8] proposed to elect proxy devices in an ad-hoc group to forward common multicast packets to non-proxy devices with poor WWAN channel quality.

Community of multi-homed devices was studied from a more media-driven angle in [9-11]. In [9], the community's collective WWAN links were aggregated to form a virtual link to speed up individual device's infrequent but bursty large content download like web access. [10] showed that smart striping of FEC-protected delay-constrained media packets across community's WWAN links could alleviate single-channel burst losses, while avoiding interleaving delay experienced in a typical single-channel FEC interleaver. To improve video quality, [11] proposed a *Cooperative Peer-to-peer Repair* (CPR) framework, where heterogeneous WWAN broadcast/multicast losses like MBMS [12] experienced by individual devices can be alleviated by cooperatively exchanging received

WWAN packets via the group's WLAN ad-hoc network. It is worth noting that network coding [13] is ideal for this CPR community scenario: if received WWAN packets were first coded with network coding in a rate-distortion optimized manner before peer exchange, resulting expected distortion can be greatly reduced.

## Community Media: Interactivity

By leveraging the power of community, users can also creates new media interactions where they interact in complex and interesting ways. In Japan, Nico nico douga [14] invites viewers to *collectively* overlay personal textual comments on uploaded video clips, enriching the original media in a cooperative yet unpredictable manner. (jimaku [15] is a different variant where users are encouraged to overlay Japanese subtitles to foreign-language video clips.) In Europe, SMS is used for voting of broadcast TV program, and [16] described a study of an Italian system where interactive SMS messages are visually overlaid on broadcast TV. One finding in [16] is that users are primarily interested in inter-personal communications, even if that is irrelevant to the TV program. In yet another example, [17] discussed a system for online game observers where users can observe online game action in real-time, *and* chat with fellow spectators via conferencing audio at the same time. Beyond simple text or audio exchange, [18] proposed to paint visual representations of observers called *interactive visual overlays* (IVO), like personalized avatars or real-time captured talking heads of observers, on top of the common video stream before distributing the shared view to the observer group. Unlike text and audio, IVO visually conveys the observers' presence, moods or expressions to the group in a non-verbal manner.

Of course, however complex the community media interaction is, one can divide the involved complex media into individual simple pieces, and subsequently treat each media piece separately for coding and transport from media producer to media consumer. For example, one can treat the streaming video and IVOs in [18] as separate streams for coding and transport. However, the media pieces are inherently semantically related in the complex interaction, exposing grounds for optimization. In [18], while the passively observed video in the background and the interactively controlled IVOs obviously have different delay constraints, [18] proposed a *same-stream* approach where both components are encoded into the same stream but scheduled and buffered differently to meet heterogeneous delay requirements. Same-stream approach avoids high decoding complexity and bandwidth-inefficiency inherent in the aforementioned multi-stream approach.

## Future Challenges

Like online SNS, research in community media is in its early development and much growth is expected. From the network perspective, much of the cited works are focused on leveraging the power of community to optimize transport for simple piecemeal media. For newer and more intricate media interaction in community as described earlier, how can one optimize transport of complex media? For example, can transport mechanisms like aforementioned network coding [13] be designed to optimize for related media sub-streams of the same complex interaction with different delay constraints?

For application, new paradigms for community interactivity will likely continue to grow. For example, automatic video advertisement insertion [19] can be performed in a personalized fashion while an observer community consumes the same broadcast/multicast media content. Higher dimension media types beyond single-view video, like multiview video [20] or Free Viewpoint TV [21] are active research topics and operational systems are on the horizon. The challenge is then to identify the desired media interactions for these new media types in a community setting and to provide the appropriate coding and transport advances to support these interactions.

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*Focused Technology Advances Series*

## Latest Multimedia Advances in Asia

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*Minoru Etoh, NTT DoCoMo Labs, Japan*
*Hong-Shik Park, Information and Communications University, Korea*
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The financial implosion in USA seems to have quite an impact on Asian economy as a whole. But the telecommunication sector is still expanding at a healthy rate, with interesting developments on the technology front. Below are some highlights.

**Chinese 3G wireless standard TD-SCDMA** developed by the Datang Communication has been adopted by the 3GPP and will see commercial deployment in China soon. The 3G radio licenses was issued by the Chinese government to Network Operators like China Mobile, China Telecom, China NetCom, at the start of 2009, and planned deployment of TD-SCDMA base stations and equipments will exceed US$41 billion in total, covering 20+ major cities in the first phase of deployment.

TD-SCDMA is a wireless access technology that is targeting web and multimedia applications with asymmetric traffic patterns. The solution utilizes both CDMA and Time Division techniques in achieving better network efficiency. Extensive testing and teething problems in the technology has repeatedly delayed the deployment of the solution in China, and now all the hard work and effort eventually payed off. Major TD-SCDMA equipment makers include Datang, Siemens, Huawei, ZTE and others. The technology will fuel the next round of mobile multimedia applications in China.

**Broadband service expansion and convergence in Korea**. In 2004 Korean government decided 'Broadband Convergence Network (BcN) Development Plan' which consists of three phases: 1st phase (2004~2005), 2nd phase (2006~2007), 3rd phase (2008~2010). The plan entails an investment by the South Korean government of 2.25 trillion won, and seeks to induce more than 74 trillion won by private sectors from 2004 to 2010. BcN is being implemented as a national project for developing the next generation convergence network and taking a bold step to breakthrough market depression and leading the future communications market.

BcN aims to provide new converged services, end-to-end high quality services and open service architecture on the IP-based unified network. In BcN, support of a connection over heterogeneous networks both on horizontal and vertical structures, interaction between network-dependent elements of these networks, and security and quality of service policies including scheduling and admission control have been carefully designed. In order to efficiently converge wire and wireless communication, telecommunication and broadcasting, voice and data, broadband convergence, BcN is divided vertically into the service and control layer and the transport layer.

The former Ministry of Information and Communication (MIC) set the goal of supporting wired broadband convergence services with 50~100Mbps transmission speed per subscriber through BcN. To develop the broadband wired access network, the country's major telecom operators widely installed optical cables into the access networks and applied new technologies such as xPON-based FTTH (Fiber to the Home), 100Mbits/s HFC (Hybrid Fiber Coax) and 100Mbits/s optical LAN. KT (Korea Telecom) and SK Broadband rushed to change their access networks from the ADSL infrastructure to VDSL and FTTH. LG Dacom which owns mostly HFC infrastructure expects to build the 50Mbits/s subscriber access network through the DOCIS 3.0. For the wired and wireless integration, SK telecom and KT have expanded their investment to the IMS and 3G/Wibro.

Through this works, the government had already completed the 2nd phase, providing 50~100Mbits/s broadband services to 7,009,783 fixed line subscribers which are almost half of high speed internet subscribers and 1Mbits/s broadband services to 560,000 wireless subscribers as shown in the table. from Korea Communication Commission [Dec. 2008/ Unit: thousand]

| Wired Subscribers | | | |
|---|---|---|---|
| xDSL | HFC | LAN | FTTH |
| 3,718 | 5,085 | 4,933 | 1,737 |

| Wireless Subscribers | | |
|---|---|---|
| HSDPA | WLAN | WiBro |
| 5,010 | 510 | 110 |

Through the promotion of the 2nd phase, the struggling BcN trial services have been renewed, including the IPTV trial service. KT is the most active player pioneering the IPTV market and launched Mega-TV commercial services in Dec. 2008. KT`s IPTV service, dubbed Mega TV, has 800,000 subscribers, while SK Broadband currently has 780,000 subscribers for the broad&tv video-on-demand services and LG Dacom`s myLGtv has 65,000. And voice over Internet protocol (VoIP) service is being enlarged over BcN instead of PSTN. KT, LG Dacom and SK Broadband are also fully committed to push VoIP, hoping to snatch fixed-line telephone customers by pitching cheaper IP-based phone services. In addition to these services, new business and service models for QPS (Quadruple Play Service) including, Interactive communication, video conferencing, ubiquitous services, etc will be served in BcN.

**Meizu M8 – the iPhone Killer?**

*Figure 1 Meizu M8*

Meizu is a less known company established 5 years ago in Zhuhai, a southern city on pearl river delta. The company makes music player and in the fiercely competing mp3 player market. Yet it is not one of yet another company offering cheap devices with lousy functions and qualities. The company has some unique vision about the mobile device design and with the success of its Meizu Mini series media players, M4 and M6, the company is getting into the high-end mobile phone sector with the debut of Meizu M8 phone.

With much hype and delay, the phone is officially on sale now world wide for about US$400 for the 8G memory version. The phone has a similar form factor as Apple iPhone, and the features a 3.4" 720x480 touch screen. Inside it is powered by an ARM11 677MHz processor, running a self-developed Meizu OS that is basically a WinCE OS with a GUI and Application framework that supports multi-touch and other advanced features. The OS seems to be quite stable, and responsive. It also has lighting and motion sensors that can support applications like shake to select a different song in the playlist.

What is most attractive about Meizu M8 is that it offers an open SDK/API (http://download.meizu.com/m8/sdk/M8SDK.zip) for third party developers and fans to write their own applications. At the Meizu store we noticed that the popular mobile portal application QQ has already been developed by fans to run on Meizu M8.

The key strength of Meizu M8 is its own GUI and Application architecture that was based on the success of its media player series. The Meizu OS can be retro-fit to other hardware abstraction layers like Linux kernel, or even proprietary solutions.

Will this be an iPhone killer? We will wait and see how eventual users receive and perceive the new Meizu M8 phone.

**Broadband Mobile Network Outlook in Japan**

2001 is the first year in which NTT docomo launched its W-CDMA service in Japan firstly of the world. In the following several years, mobile broadband networks (i.e., services offering a minimum speed equal to, or greater than, 256kbit/s in one or both direction) were deployed over the world. The next figure shows top 10 economies by the number of mobile broadband subscribers, in millions, as of the end of 2005. The two far east countries have been leading on the cutting edge of mobile broadband. Note that those countries have well-established mobile multimedia ecosystems which are independent from PCs'. As i-phone differentiates itself from PC not only in its innovative user interface but also in its mobile application ecosystem, broadband cell-phones in the far east countries have been a kind of premature i-phones for general population from the aspect of the mobile application uniqueness.

In 2009, the commercial deployment of the W-CDMA system is still progressing steadily not only in Europe but in North America and Asia as well, and at present, more than 180 mobile network operators have commenced 3rd Generation technologies. For example in Japan, the maximum downlink transmission data rate provided by NTT docomo in its packet services via High Speed Downlink Packet Access (HSDPA)[1] is 7.2 Mbit/s, but the technical specifications of HSDPA and High Speed Uplink Packet Access (HSUPA)[2] support maximum transmission data rates between a base station and mobile terminal of 14 Mbit/s in the downlink and 5.7 Mbit/s in the uplink.

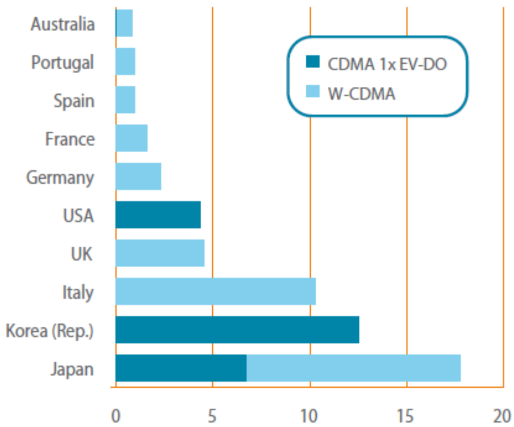


*Figure 2 Top ten mobile broadband economics (source: ITU Internet Report 2006)*

Those HSPA and EVDO technologies are categorized into "3.5G" mobile broadband. Roughly speaking, at this point, Japan's market has 100miilion subscribers, of which 90% are using 3G cell-phones, and half of them are taking benefits of 3.5G technologies. Mega-bps cell-phones are now majority there. That is the key killer application enabler in the mobile application space. The music and video clip download is quite common among younger generations, and web accesses to a wide variety of services are common practice of 70% of our general population.

What we can see beyond the HSPA technologies is 3G-LTE (Long Term Evolution) that is planned to be launched late 2010 in Japan. 3G-LTE will be required to provide short delays in addition to a dramatic leap in data rates and improved spectrum efficiency. Achieving short delays means that the time required for call setup (connection delay) and the time involved in data transfer during a call (transmission delay) will be reduced enabling the high-speed data transmission by a protocol like TCP/IP.

LTE's downlink uses the Orthogonal Frequency Division Multiple Access (OFDMA) radio access providing high resistance to multipath interference and flexible support for a wide range of frequency bandwidths by changing the number of subcarriers. That highlights 3G LTE from the existing 3G technologies. The uplink, meanwhile, uses Single Carrier - Frequency Division Multiple Access (SC-FDMA)[3] that can achieve low power consumption by decreasing the Peak-to-Average Power Ratio (PAPR) of cell-phones and reduce interference from other users. It is said 3G-LTE will be provided, at the beginning, to lap-top PCs as the cellular correspondent to WiMAX. Eventually, however, we will see 10~100 Mbps applications for ordinarily people with popular cell-phones in five years. The point is not the bandwidth, but the improved user experience, by the fact that the fairly improved low-latency and high-capacity mobile broadband environment will emerge soon, and it will accommodate new killer application environments in the sense of mobile Internet beyond the cellular networks.

**Mobile Social Network Services in Japan**

As the far east has very unique mobile ecosystems based on mobile broadband networks, VGA size display cell-phones, mobile contents (i.e., exclusive to PC users) and "smart mob" culture, SNS is also different from the other regions. Let us see its uniqueness in two SNSs: mixi and mobage-town in Japan. Those use only one language, Japanese and therefore don't have a global reach to the rest of the world, unlike MySpace and FaceBook. Those business models are similar mainly in on-line advertisement (banner and click), and slightly different in

[1] HSDPA: A high-speed downlink packet transmission technolog standardized by 3GPP. It optimizes the modulation method and coding rate according to reception conditions at the mobile terminal.

[2] HSUPA: A high-speed uplink packet transmission technology standardized by 3GPP. It optimizes the coding rate, spread factor, and transmission power according to reception conditions at the base station.

[3] SC-FDMA: A scheme that allows multiple user access by allocating consecutive frequency bandwidths for each user within the same frequency band.

several side businesses such as job-brokering, e-commerce, auction, and so on.
Mixi launched their business in early 2004, and has reached at having 16 million subscribes as of early 2009. A half of the age group early 20s are using this SNS, and around 15% of the nation at ages from 18 to late 50s have subscribed. The active visit rate within three days is about 52%. That is the king of SNS in Japan. Unlike MySpace, most of mixi users are using nicknames and meeting in a small group space, so as to get community entertainments, for which they write diary, read and comment each other in their daily lives. It seems that mixi provides semi-real communities that overlay real ones. Nicknames are used to keep them anonymous though, they know each other in real names within a community to which they belong.

A very interesting observation is that mixi users are becoming mobile. In late 2006, a survey on mixi access method among respondents said that it was 78.6% mainly from PC, mobile supplemental, 15.4% mainly from mobile, PC supplemental, and 6.0% solely from mobile.

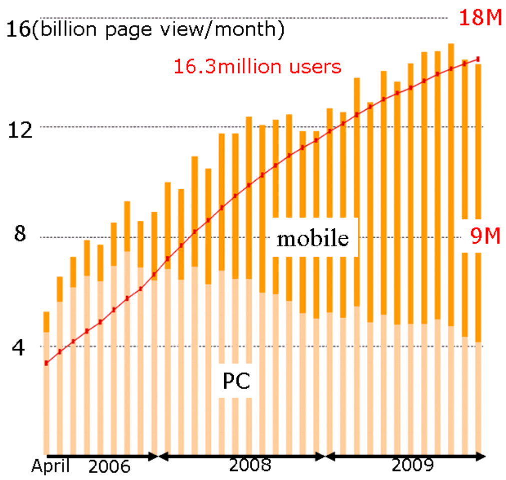


*Figure 3. mixi's growth (source: mixi's IR report)*

The above figure summarizes the current growth of subscribers and page views. The figure shows that the number of page views from PCs is declining. On the other hand, the number of page views from mobile is getting significant. The page sizes of mobile contents is almost 1/10 of PC contents though, it seems the communication structure of mixi is changing from PC-oriented to mobile-oriented. There are several implications: 1. new subscribers are mainly from mobile users, 2. 3G mobile broadband has technically fostered the transition from PC to mobile, and 3. A way of community entertainment by its nature is required to be casual, instant, and personal.

Mobage-town is the queen of SNS in Japan. The name comes from a Japanese abbreviation of English term "mobile game town." That has 12.3 Million subscribers and 15 billion page views per month as of late 2008. They started the SNS in 2006, and have sharply attracted teens to join them. This SNS can be conceptually summarized as an extension of Second Life in a mobile space plus their unique attractive services. The SNS has similarity with Korean game-site "Han game." There must be nonlinear synergy effects in combination of games, SNS, content share, and e-commerce. Especially, gaming is so poplar enough to lure the teens that they have attains more than 50% penetration to Japanese teens. Interestingly, mobage-town only allows cell-phones to access. That is mobile-only SNS and requires their subscribers to use high-end cell-phones equipped with adobe flash players, since all the contents are provided in the flash format, and thus (on-line) gaming has become possible for millions of cell-phone users. We can summarize the technical enablers. Those are always-on-anywhere, flat rate pricing broadband networks, VGA-size display, and graphic processors tolerant to manipulate adobe flash contents. Without those enablers, mobage-town has not emerged.

Recent five years, the term "convergence" has been a buzz word in communication industries. Especially, the convergence between fixed and mobile networks is getting attracted in a wide range of mobile services that utilize fixed communications infrastructure to complement the mobile service. That convergence remains just at network economics in providing less-redundant functionality and less-payment. What we see here, on the other hand, is mobile unique evolution of multimedia applications, where application-layer convergence has occurred as "mainly mobile, complementary PC". As mobile broadband technologies evolve, a higher layer convergence will be essential. Mixi shows a good example, which is not from the single invention.

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## IG Corner: Multimedia Security and the MMTC Security Interest Group

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**Multimedia Security** With the advent of the Internet and the popularity of multimedia applications on hand-held and other portable devices, security in the context of multimedia data has taken on several flavors and nuances. For example digital rights management (DRM) issues typically deal with protecting the multimedia content from being illegitimately accessed, altered, used and/or disseminated. Techniques used for DRM include watermarking and cryptography [1,2].

Due to the sheer bulk of multimedia data one can argue that there is an inherent need for reduced per-unit processing to protect multimedia data. Several researchers have suggested that the two important functionalities of compressing and encrypting the multimedia data be done in one step. In principle this should work since both processes have compatible goals. For example, compression, in broad terms, intends to decrease the redundancy in the data which in turn makes it difficult to infer information about one part of the data from another. This is in line with the goals of cryptographic security. However if this joint encryption-compression scheme is not designed well, it can be shown [3] that the resulting scheme is either not very secure or is too inefficient computationally.

The flip side of the increasing interest in data-hiding technologies is that it has also been used for criminal and/or anti-social deeds. For example U.K.'s National Hi-Tech Crime Unit broke a pedophile network (called Shadowz Brotherhood) on the Internet that was using steganography. The availability of several easy-to-use data-hiding software on the Internet has also led to some reported use of steganography in criminal activities including planning for terrorist attacks. Thus steganalysis, the science of determining the presence/absence of hidden data in innocuous looking host media, has also gained significant attention as an important aspect of multimedia security [4]. Steganalysis can be classified into active or passive depending on whether the algorithm can extract/tamper with the hidden data or merely detect the presence or absence of hidden data. Several research challenges in steganography are presented in [5].

Another form of security issue arises in the social networking sites, chat rooms, blogs etc., where multimedia data – including text, voice clips, videos etc are posted. Several reports have surfaced recently about popular sites like Craig list being used to post advertisements to deceive users. Hence another aspect to multimedia security is to analyze multimedia data on the Internet to detect deception. Interested readers are invited to try out the tool developed at Stevens Institute of Technology (available at http://www.stevens.edu/stealth) to detect deception from text.

**The Sec-IG and how to join it** The security special interest group (Sec-IG) is a group of researchers and practitioners from academia and the industry interested in all aspects of multimedia communications security. In order to increase the ease of discussing matters of interest to the Sec-IG community we have created a group in **LinkedIn for the Sec-IG**. We invite researchers and practitioners interested in this area to join our group. This can be done easily via the LinkedIn group that has been set up for this purpose. The title of the group in LinkedIn is: "*Special Interest Group in Multimedia Security, IEEE Multimedia Technical Committee, IEEECOMSOC*".

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