SATELLITE AND SPACE COMMUNICATIONS **SSC**
http://committees.comsoc.org/ssc/

IEEE COMMUNICATIONS SOCIETY

SSC Newsletter **Vol. 22, No. 1, June 2012**

CONTENTS

The Satellite and Space Communications (SSC) Committee is a volunteer group actively involved in advancing satellite and space communication technologies within the IEEE. This committee is approved by the IEEE Communications Society and is governed by the constitution and bylaws of the IEEE as well as the other twenty-three Technical Committees in the Society. The committee belongs to the Technical Committee Clusters of Communication/Signal Processing (C/SP).

SATELLITE & SPACE

- JOIN US -

All conference attendees are welcome to join us in the SSC Committee meeting.

Location: Room "Les Saisons"

Date: Tue 12th June 2012

Time: 18:30 - 19:30

Future SSC Meetings

Dec. 2012, Anaheim, CA, USA.
June 2013, Budapest, Hungary.
Dec. 2013, Atlanta, GA, USA.

ICC2012 SSC Committee Activities:

Symposium on Selected Areas in Communications:

- *Tue, 12 June 2012 • 16:15 – 18:00*

Location: GRB 342 C.
SA-SSC1 Satellite & Space Communications
Chair: Hiromitsu Wakana, NICT, Japan.

- *Tue, 12 June 2012 • 10:45 – 12:30*

Location: GRB 342 C.
SA-SSC-P1 Satellite & Space Communications Systems I
Chair: Ming-Chuan Yang, Harbin Institute of Technology, China.

- *Tue, 12 June 2012 • 14:00 – 15:45*

Location: GRB 342 C.
SA-SSC-P2 Satellite & Space Communications Systems II
Chair: Daniel E. Lucani, University of Porto, Portugal.

- *Wed, 13 June 2012 • 08:00 – 09:45*

Location: GRB 342 C.
SA-SSC2 Satellite & Space Networking
Chair: Hiromitsu Wakana, NICT, Japan.

HOW TO JOIN SSC COMMITTEE AND MAILING LIST

If you like to join SSC Technical Committee: Please send your name and e-mail address to the SSC Secretary, optionally include your mail address, telephone and fax numbers.
If you like to join SSC Mailing List: Instructions on how to subscribe/unsubscribe are available at http://lists.scnl.dist.unige.it/listinfo/ssc.

SSC COMMITTEE OFFICERS

CHAIR
Prof. Nei Kato
Graduate School of Information Sciences
Tohoku University
Aoba 09, Aramaki, Aoba-ku,
Sendai, 980-8579, Japan.
Tel: +81+22-795-6161
Fax: +81+22-795-6162
e-mail:
kato@it.ecei.tohoku.ac.jp

VICE CHAIR / EDITOR
Dr. Igor Bisio
Department of Communications, Computer and System Science
University of Genoa
Via Opera Pia 13,
16145, Genoa, Italy
Tel: +39-010-3532803
Fax: +39-010-3532154
e-mail: igor@dist.unige.it

SECRETARY
Dr. Hiromitsu Wakana
National Institute of Information and Communications Technology
4-2-1 Nukui-Kita, Koganei,
Tokyo, 184-8795, Japan
Tel: +81-42-327-6026
Fax: +81-42-327-7605
e-mail: hwakana@nict.go.jp

PAST CHAIR
Prof. Takaya Yamazato
Department of Electrical Engineering and Computer Science
Nagoya University
Nagoya, 464-8603, Japan
Tel: +81-52-789-2743
Fax: +81-52-789-3173
e-mail: yamazato@ieee.org

COMMITTEE HISTORIAN
Mr. Louis Pollack
c/o Pollack Associates
15321 Delphinium Lane
Rockville, MD, USA 20853
Tel: +1 301 929 1295

COMMITTEE ADVISOR
Prof. Desmond P. Taylor
Dept. of Electrical & Electronic Engineering
University of Canterbury
Private Bag 4800
Christchurch, New Zealand
Tel: +64 3 364 2213
Fax: +64 3 364 2761
e-mail:
taylor@elec.canterbury.ac.nz

MESSAGE FROM THE CHAIR

Prof. Nei Kato

Time flies. This is my last message as Satellite and Space Communications (SSC) Technical Committee Chair. First, I would like thank our SSC Members from the bottom of my heart for your kind support during my term.

I would also like to thank Dr. Igor Bisio and Dr. Hiromitsu Wakana for their dedicated services for our TC.

These two years, our TC received increasing submissions to ICC/GC, this shows the great needs and potential as well the importance of satellite communications. After Japan's *3.11 Earthquake and Tsunami*, the significance of satellite technologies have been reaffirmed, not only inside Japan but also around the Globe.

In Japan, the Government has taken action to introduce new satellite technologies to respond to disasters. Also the cooperation with the terrestrial networks like cellular, *ad hoc* and mesh networks will be strengthened. Our University, Tohoku University, is deeply

involved in the development of those new technologies.

Finally, I wish the continued outstanding success with the leadership and efforts of our new officers.

Prof. Nei Kato, Chair
IEEE ComSoc
Satellite and Space Communications
Technical Committee

SCANNING THE WORLD

Dr. Igor Bisio

This is my last "*Scanning the World*" article. This is also the last number of the *SSC Newsletter* edited by me. For this reason, I would deeply thank all colleagues that have contributed with their *Perspective Articles*, suggestions and revisions. Obviously, I would deeply thank all readers. It has been an honor to serve as Editor of this simple but important editorial product. I am convinced that our *Newsletter* is a consolidated initiative and, after 22 years, could be also seen as the "prototype" for future developments of the *Newsletter* itself towards a wider editorial initiative for the SSC scientific community. Moreover, being arrived my term as SSC Vice-Chair, I would spend few words about the Officers that have shared with me the last two years. In particular, I would deeply thank Prof. Nei Kato, our Chair, for the determinate guidance of our Technical Committee and Dr. Hiromitsu Wakana, our Secretary, for his precious support to all the Technical Committee activities. After the due greetings to the readers of the *SSC Newsletter*, I would propose a brief analysis of the Journals and/or Magazines where Authors coming from the SSC community prefer to submit their research works.

First of all, our Chair, in his "*Message*" has highlighted again the importance of Satellite and Space Communications: they play a crucial role in the emergency situations caused by the earthquake and the consequent tsunami. It demonstrates, on one hand, the necessity to develop the satellite communications and networking technologies, and on the other hand, the necessity to spend further efforts in the scientific research in that field. It would justify a significant scientific production, in terms of papers, on the more important Journals and Magazines in the field. This brief "*Scanning the World*" article presents the results obtained starting from the *IEEE Xplore* database (*ieeexplore.ieee.org*). In particular, all papers containing the keyword *satellite* has been searched. Obviously, it may include papers about natural satellite (not only artificial) and not all papers are related to disciplines related to our Technical Committee. As a consequence the presented numbers are not precise but just indicate a trend.

Journal and/or Magazine	2011	2010	2009
Aerospace and Electronic Systems Magazine, IEEE	13	6	18
Aerospace and Electronic Systems, IEEE Transactions on	36	20	27
Antennas and Propagation Magazine, IEEE	14	9	16
Antennas and Propagation, IEEE Transactions on	14	15	23
Antennas and Wireless Propagation Letters, IEEE	11	16	17
Applied Physics Letters	6	0	5
Biomedical Engineering, IEEE Transactions on	0	0	5
Broadcasting, IEEE Transactions on	0	0	10
Communications and Networks, Journal of	5	0	0
Communications Letters, IEEE	6	5	0
Communications Magazine, IEEE	0	7	6
Communications, IEEE Transactions on	4	6	7
Communications, IET	0	14	0
Consumer Electronics, IEEE Transactions on	0	6	11
Electronics Letters	10	9	7
Engineering & Technology	0	0	8
Geoscience and Remote Sensing Letters, IEEE	49	53	39
Geoscience and Remote Sensing, IEEE Transactions on	131	106	109
Image Processing, IEEE Transactions on	5	0	0
Information Theory, IEEE Transactions on	0	5	0
Instrumentation and Measurement, IEEE Transactions on	8	0	5
Journal of Applied Physics	9	0	7
Microwave Magazine, IEEE	0	0	5
Microwave Theory and Techniques, IEEE Transactions on	5	0	5
Nuclear Science, IEEE Transactions on	11	8	14
Plasma Science, IEEE Transactions on	8	0	0
Proceedings of the IEEE	16	15	0
Radar, Sonar & Navigation, IET	9	6	0
Review of Scientific Instruments	5	0	0
Selected Areas in Communications, IEEE Journal on	4	0	0
Selected Topics in Applied Earth Observations and Remote Sensing, IEEE Journal of	47	39	20
Selected Topics in Signal Processing, IEEE Journal of	0	0	25
Signal Processing, IEEE Transactions on	0	5	0
Spectrum, IEEE	0	6	8
Systems Engineering and Electronics, Journal of	7	7	0
Ultrasonics, Ferroelectrics and Frequency Control, IEEE Transactions on	0	8	0
Vehicular Technology, IEEE Transactions on	7	6	8
Wireless Communications, IEEE Transactions on	0	6	16
Total	**440**	**383**	**421**

Table 1 Published Papers on Satellite Topics in the IEEE Journals and Magazines (period 2009-2011).

Table I reports the number of papers published in IEEE Journals and Magazines in the period

2009-2011. Fortunately, the table shows that the SSC community is very active. In average, around 400 papers for each year are published on satellite related topics. It represents a good number and seems coherent with the necessity of a good level of research in the SSC field due to its importance.

Nevertheless, Fig. 1 and Fig. 2 show that the scientific community is very fragmented. Indeed, Fig 1 shows the percentage of papers, in the mentioned period, distributed among IEEE Societies. It has been obtained considering what IEEE Society is sponsoring a given Journal or Magazine. In the pie-chart, just the Information and Communications Technologies (ICTs) related societies have been explicitly reported.

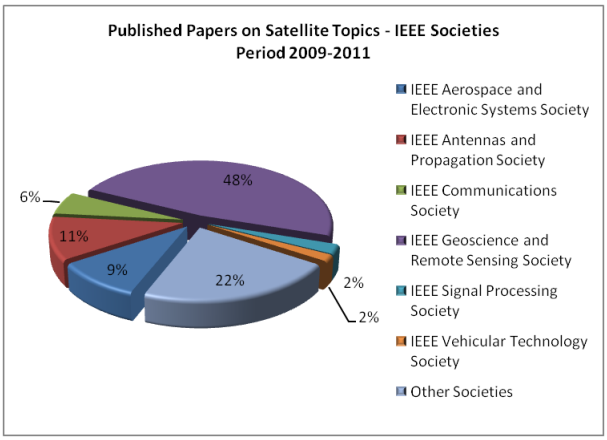

Fig. 1 Published Papers on Satellite Topics in the IEEE Societies (2009-2011).

From my view point the distribution among societies provides limited information. Indeed, it should be more interesting considering the number of Journals and Magazines produced by IEEE societies. In more detail, Fig 2 proposes the same data but averaged over the number of Journals and Magazines sponsored by each society.

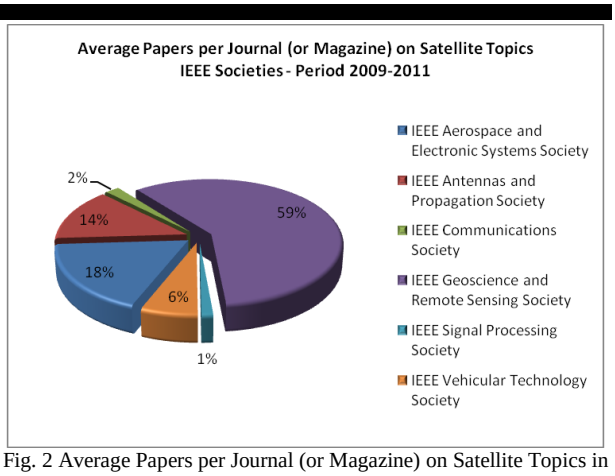

Fig. 2 Average Papers per Journal (or Magazine) on Satellite Topics in the IEEE Societies (2009-2011).

Unfortunately, the IEEE Communications Society, where our Technical Committee is active, is considered by a very limited number of Authors that produce paper in the field.

Considering the analysis really far from a rigorous study of the real trends, it gives an idea of the authors' choice. Considering the crucial role of the research in that field, to find an aggregation point from the editorial viewpoint for the efforts of the community is very important. In such a way, fragmentation could be avoided and our important research results will be easy to be found and exploited from industrial actors and users.

The research of an aggregation point for the community represents, in my humble opinion, one of the more important objectives that our Technical Committee, within the IEEE Communication Society and in cooperation with other societies, should consider in the imminent future.

Dr. Igor Bisio, Vice Chair
IEEE ComSoc
Satellite and Space Communications
Technical Committee

.

FORTHCOMING GLOBECOM AND ICC CONFERENCES

COSPONSORING / RELATED CONFERENCES AND WORKSHOPS

MILCOM 2012

Oct. 29 – Nov. 1, 2012, Orlando,FL, USA

http://www.milcom.org/

MILCOM 2012 is soliciting unclassified and classified (up to DoD Secret) technical papers as well as proposals for tutorials and panels on current topics of interest such as communications and information processing systems, social networking for military applications, weapons, and battle-space technologies. Professionals in industry, academic, and government organizations from the U.S. and countries worldwide are encouraged to contribute and participate in addressing the latest technology in trusted communications, situational awareness, and decisive action.

GLOBECOM 2012

December 3-7, 2012, Anaheim, CA, USA

http://www.ieee-globecom.org/2012

IEEE GLOBECOM 2012 will feature a comprehensive technical program including 12 Symposia and a number of Tutorials and Workshops. IEEE GLOBECOM 2012 will also include an attractive industrial and forum program featuring keynote speakers, various Business, Technology and Industry fora, and vendor exhibits. Prospective authors are invited to submit original technical papers for presentation at the conference and publication in the Proceedings. Proposals for Tutorials, Workshops, and Fora are also invited. Visit the IEEE GLOBECOM 2012 website, http://www.ieee-globecom.org/2012, for details and submission information.

ICC 2013

June 9-13, 2013, Budapest, Hungary.

http://www.ieee-icc.org/2013

The international Conference on Communications (ICC) is one of the two flagship conferences of the IEEE Communications Society, together with IEEE Globecom. Each year the ICC conference attracts about 2-3.000 submitted scientific papers, a technical program committee involving about 1.500 experts provides more than 10.000 reviews, the conference being finally attended by 1.500 - 2.000 professionals from all around the world. IEEE ICC is therefore one of the most significant scientific events of the networking and communications community, a must-attend forum for both industrials and academics working in this area. In 2013 the IEEE ICC conference will be held for the first time in Eastern Europe.

CONFERENCES CALENDAR

CONFERENCE	DATE & LOCATION	INFORMATION
6th ASMS 6th Advanced Satellite Multimedia Systems Conference & 12th Signal Processing for Space Communications Workshop	Sept 5 - 7, 2012 Baiona, Spain	http://www.asms2012.org/
International Conference on Localization and GNSS	June 25-27, 2012, Starnberg, (Munich), Germany	http://www.icl-gnss.org/2012
SPECTS 2012 International Symposium on Performance Evaluation of Computer and Telecommunication Systems	July 8-11, 2012, Genoa, Italy	http://atc.udg.edu/SPECTS2012
18th Ka and Broadband Communications Conference 2012	Sept. 24-27, 2012, Ottawa, Canada	http://www.kaconf.org
ICSSC 2012 International Conference on Satellite and Space Communications	Sept. 26-28, 2011 Rome, Italy	http://www.waset.org/conferences/2012/rome/icssc/
ITST-2012 11th International Conference on Telecommunications for Intelligent Transport Systems	Nov.5-8, 2012, Taipei, Taiwan	http://www.itst2012.org
IEEE Aerospace Conference 2013	Mar. 2-9, 2013 Big Sky, MT, USA	http://www.aeroconf.org
WCNC 2013 IEEE Wireless Communications & Networking Conference	April 7-10, 2013 Shanghai, China	http://www.ieee-wcnc.org/2013

To all SSC members: If your postal address, telephone or fax numbers have changed, please update them with the committee secretary. You can review our current records on our web page at http://committees.comsoc.org/ssc/.

Satellite and Space Communications on the Evolutionary Path of the Train Control and Management Systems

Francesco Rispoli

Ansaldo STS, Genoa, Italy
francesco.rispoli@ansaldo-sts.com

***Abstract* — Communication based train control systems adopt reliable and safe train positioning systems and dedicated Telecommunications (TLC) networks. Most of these technologies are relatively outdated since railways life cycle is rather long respect to innovations rate on electronics, satellite positioning and TLC. This paper gives an overview on the role of satellite geo-localization and TLC for the signaling systems roadmap to meet emerging market opportunities.**

I. Market Perspective

Signalling market (Fig.1) is large & still growing but more competitive, volatile and changing in geo mix with core technologies becoming global solutions to be integrated with a package of satellite technology to serve global and local needs.

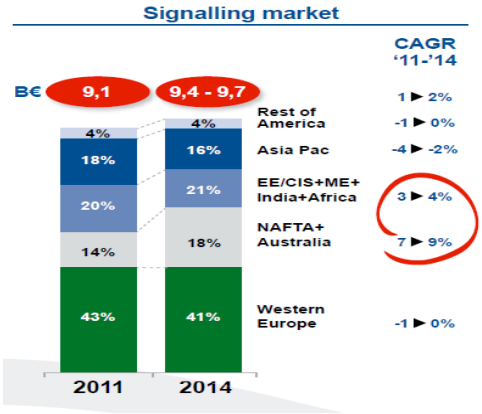

Fig.1 Market forecast.

According to UIC (Union International des Chemin des Fer) an important share of this market is targetable by satellite-based train control systems [1]. Over the past decade Global Navigation Satellite Systems (GNSS) technologies have been widely tested first in Europe, but also in USA and Russia as a cost-effective alternative to safely localize the train. The European ERTMS system, de facto the railways standard, and adopted in most of new lines and major upgrades [2] is pursuing a roadmap to make use of satellite-based localization systems and IP communications for the local and regional lines where the cost of the investment and operation is preventing railways operator from adopting communication based train control systems. Nevertheless, Europe appears a step behind the USA, Russia and Australia in the race for the adoption of GNSS for train control systems. In the USA, the Positive Train Control (PTC) Government Act of 2008 is requiring a system of monitoring and controlling train movements to provide increased safety and will likely be implemented on more than 70-90% of main line trackage within the United States. In Russia, the Master plan for the modernization programme of the train operator RZD, endorsed by the Government, largely relies on satellite technology and GNSS. In particular, the plan is on the highest priority with the theme of GPS-GALILEO-GLONASS interoperability given the dimension of their network and the need for "seamless" train operations on the international corridors that involve also the CIS countries. In Australia the adoption of satellite technology is accelerating with the recent awarding of the Roy Hill Iron Ore Project Mine's 342km heavy haul rail Line, in the Pilbara region [3].

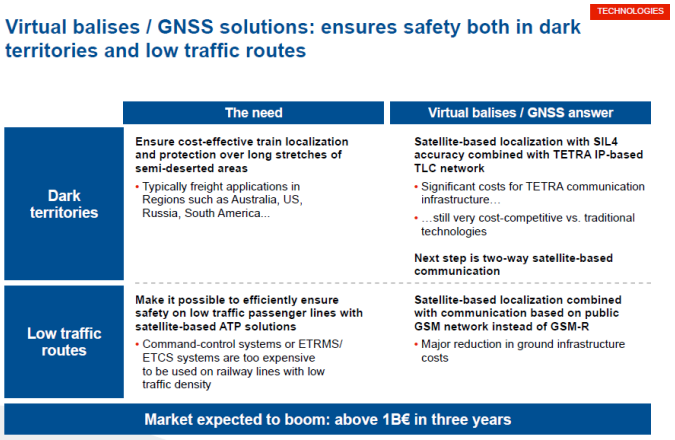

Fig.2 Market opportunity for GNSS applications.

The adoption criteria for such new technologies takes into account different and somehow conflicting needs for the various scenarios. The scenario "green-field" with private owned and operated railway networks rank first on exploiting GNSS systems. The rationale is the higher efficiency and lower costs when compared to traditional train control system technologies that need track side circuits to localize the train. Given the fact that GNSS is less costly and introduces a cost-shift from the infrastructure to the operating train, low traffic lines will become more sustainable from the economical pint of view. To reinforce this concept also TLC should evolve from a pure infrastructure model (as the GSM-R) to a service model by using public networks where the costs are related to their usage. On the opposite direction there is the scenario of the main lines where some form of signaling systems are already in place but interoperability and backward compatibility with existing rolling stocks equipments have to be traded-off against a lower operational cost and increase of efficiency.

In between the two scenarios there is the "brown field" scenario where the new technologies can also improve the safety level because most of the line's infrastructures are significantly outdated with operational safety relying either on very old safety systems (mechanical and electro-mechanical circuitry) or fully manual procedures carried out by drivers and traffic dispatchers/ground agents . In this category there are the regional lines that in Europe represents about 50% of the whole rail networks.

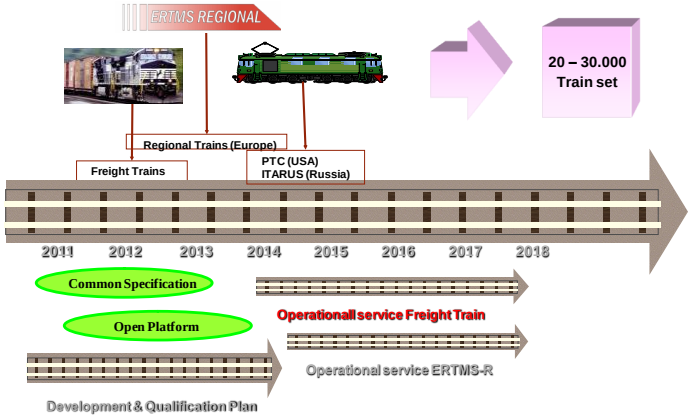

Fig.3 Roadmap for GNSS adoption.

The potential benefits brought by the combined GNSS and TLC technologies are enormous not only for the rail sector but also for the environment with a CO2 lower emission in the order of 1.5 to 3 kg/km per day due to the rail infrastructure. EGNOS that is the European GNSS Overlay System certified for the CAT-1 landing phase of the airplanes would be used by the regional railways lines up to 20 times more than what would be the cumulative usage of all airplanes.

II. GNSS Technology

In the railway, GNSS solutions and/or coupled with independent speed sensors, have been validated with the significant redundancy of GPS data and processing techniques. Respect to single constellation traditional 3D positioning high integrity requirements can be satisfied with a pre-selected triplet of satellites. Multi constellation (GPS, GLONASS and in the future GALILEO) integrated with other measurements to mitigate the effects of GNSS signal obstruction lead to the availability currently achieved by traditional train control systems.

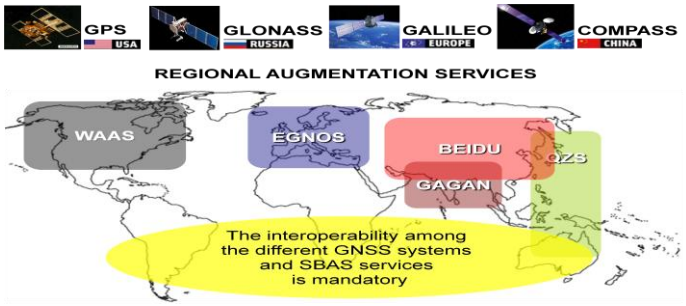

Fig. 4 GNSS Infrastructures.

The GNSS performance can be improved on the availability of geo-referenced tracks, which reduces the number of unknown coordinates. Under these assumptions the average precision of a safely calculated position can be set as low as 10 [m] associated to a wrong side failure rate of 10^{-9}/Hr., which makes this approach adequate for the highest integrity level of the Cenelec norms (SIL 4). The GNSS is also an efficient way to increase the traffic capacity of the network by implementing the "moving bloc" foreseen by the ERTMS L3 standard as shown on the Figures 5-6.

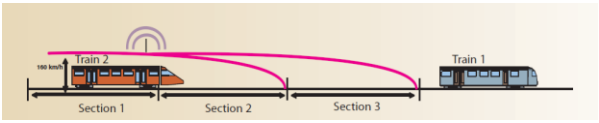

Fig. 5 Principle of operation with fixed blocks.

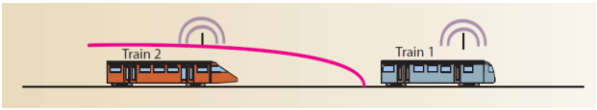

Fig.6 Principle of operation with moving block.

The solution based on moving blocks have a minimum wayside equipments and thus low operational costs. The train spacing is based on the braking distance of each train and is not dependent on infrastructure constraints. The size of the moving block is variable and can be altered according to traffic needs. Fig. 7 is an example of capacity increase estimation with the moving block as foreseen by the ERTMS L3 standard.

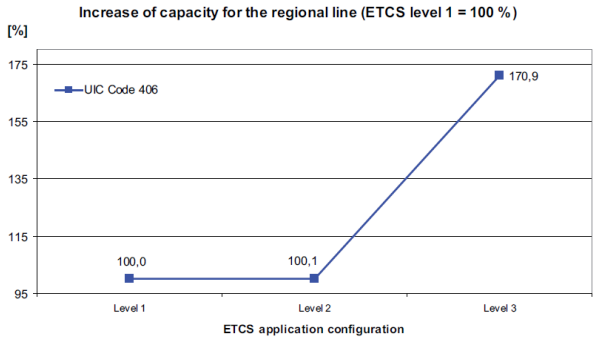

Fig. 7 Efficiency increase with moving blocks [4].

III. TLC Network

The TLC network represents a key pillar of the Train Control System because its performance impacts on the overall cost and quality of the service. As known the GSM-R standard was developed specifically for the rail market following a decision in Europe back in 1993 to agree the correct solution for European railways. A GSM-R network is a private separate network infrastructure and can be integrated with public networks. GSM-R has success across Europe, Asia and Africa.

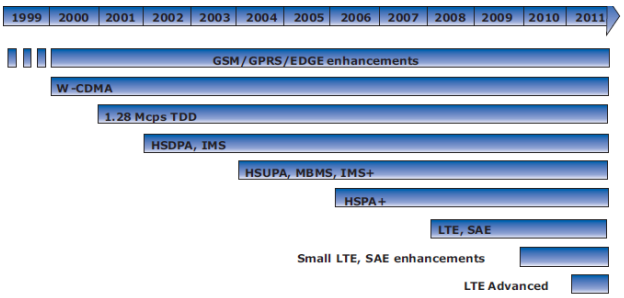

Fig. 8 Mobile network evolution.

The main limitation of GSM-R is the rather old conception based on circuit switching principle while the mobile networks have evolved dramatically in the last years with the ultimate objective to lower the cost and expand the bandwidth. Fig. 8 shows such evolution and it is possible to draw two conclusions: a) mobile networks are even more dominated by the transmission of data and, since GSM standard has been conceived, up to four new technologies were launched on the market. Public mobile operators have already started in some countries to use UMTS (3G) services in GSM900 band close to the GSM-R band as well as LTE (4G).

The railway community is gaining its own knowledge through lab and field tests. These reports and measurement campaigns have shown that wideband systems such as UMTS and LTE in GSM900 band create interferences to the GSM-R services. Since communication based train control systems are not bandwidth hungry (about 200 bytes msg is exchanged at a rate of 3 to 7 s) alternative network solutions are emerging to the GSM-R.

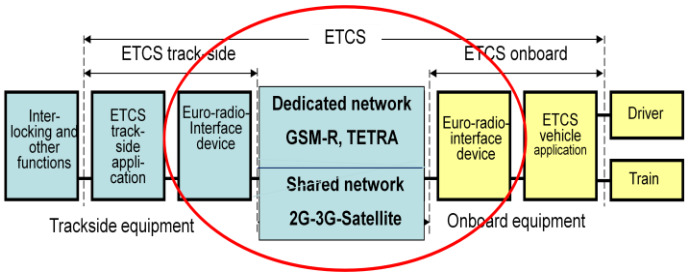

Fig.9 Protocol definition with alternative TLC.

A promising alternative applicable to the rail sector, is the TETRA that is having a large consensus thanks to its characteristics (lower frequency band, higher spectral efficiency and full IP compatibility) that can reduce the overall operational costs. With reference to Fig.9 the challenge is now two-fold: from one way to identify alternative networks (ie TETRA, LTE) and from the other way to validate a solution based on the use of public mobile networks including satellites as indicated in Fig.10.

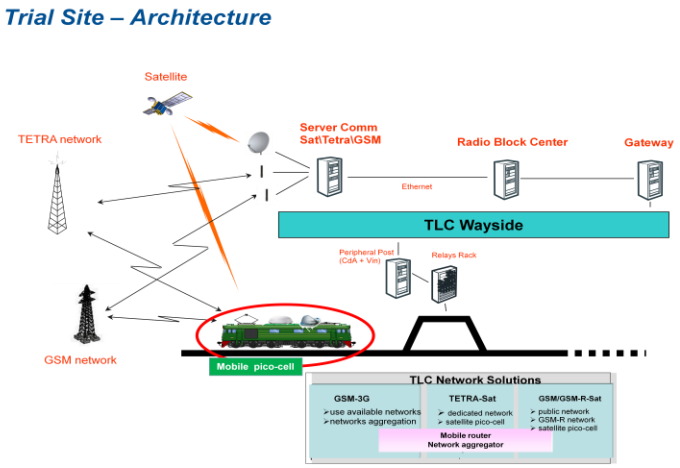

Fig.10 Alternative network solution.

IV. Conclusions

GNSS and TLC networks are strategic assets for cutting edge train control systems solutions. Higher efficiency and cost optimization are key market drivers for the adoption strategy.

References

[1] UIC: GNSS Application in the rail domain 8.04. 2011
[2] www.ansaldo-sts.com (Roy Hills Press Release
[3] S.De Luca, Pres. Board Brussels, 01. 25. 2012
[4] UIC: Influence of ETCS on the line capacity