ETSI TR 102 662 V1.1.1 (2010-03)

Technical Report

Satellite Earth Stations and Systems (SES); Advanced satellite based scenarios and architectures for beyond 3G systems

Reference
DTR/SES-00288

Keywords
3G, architecture, MSS, satellite

ETSI

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - NAF 742 C
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° 7803/88

Important notice

Individual copies of the present document can be downloaded from:
http://www.etsi.org

The present document may be made available in more than one electronic version or in print. In any case of existing or perceived difference in contents between such versions, the reference version is the Portable Document Format (PDF). In case of dispute, the reference shall be the printing on ETSI printers of the PDF version kept on a specific network drive within ETSI Secretariat.

Users of the present document should be aware that the document may be subject to revision or change of status. Information on the current status of this and other ETSI documents is available at
http://portal.etsi.org/tb/status/status.asp

If you find errors in the present document, please send your comment to one of the following services:
http://portal.etsi.org/chaircor/ETSI_support.asp

Contents

Intellectual Property Rights

IPRs essential or potentially essential to the present document may have been declared to ETSI. The information pertaining to these essential IPRs, if any, is publicly available for **ETSI members and non-members**, and can be found in ETSI SR 000 314: *"Intellectual Property Rights (IPRs); Essential, or potentially Essential, IPRs notified to ETSI in respect of ETSI standards"*, which is available from the ETSI Secretariat. Latest updates are available on the ETSI Web server (http://webapp.etsi.org/IPR/home.asp).

Pursuant to the ETSI IPR Policy, no investigation, including IPR searches, has been carried out by ETSI. No guarantee can be given as to the existence of other IPRs not referenced in ETSI SR 000 314 (or the updates on the ETSI Web server) which are, or may be, or may become, essential to the present document.

Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Satellite Earth Stations and Systems (SES).

Introduction

The analysis contained in this Technical Report is intended to assist ETSI in defining future standardisation activities; specifically standardisation for the medium-term evolution of current SatCom "2G" and "3G" standards, and for the long-term definition of future "4G" SatCom standards.

The material presented in this Technical Report represents the efforts of many research facilities which include ETRI, University of Surrey, University of Bologna, ESA and CNES.

1 Scope

The present document addresses the role of satellite communications as terrestrial communication systems begin to evolve towards beyond 3G and 4G architectures.

The present document identifies the possible roles of satellites in beyond 3G and 4G networks and how to make the best use of innovative technologies in order to achieve these roles. The present document makes a contribution in these directions, by identifying possible future system architectures and roles for satellites in this evolving context. It reviews and analyzes some of the latest communication technologies that would enable satellite systems to realize cost-effectively these architectures and claim these roles.

2 References

References are either specific (identified by date of publication and/or edition number or version number) or non-specific.

- For a specific reference, subsequent revisions do not apply.
- Non-specific reference may be made only to a complete document or a part thereof and only in the following cases:
  - if it is accepted that it will be possible to use all future changes of the referenced document for the purposes of the referring document;
  - for informative references.

Referenced documents which are not found to be publicly available in the expected location might be found at http://docbox.etsi.org/Reference.

NOTE: While any hyperlinks included in this clause were valid at the time of publication ETSI cannot guarantee their long term validity.

2.1 Normative references

The following referenced documents are indispensable for the application of the present document. For dated references, only the edition cited applies. For non-specific references, the latest edition of the referenced document (including any amendments) applies.

Not applicable.

2.2 Informative references

The following referenced documents are not essential to the use of the present document but they assist the user with regard to a particular subject area. For non-specific references, the latest version of the referenced document (including any amendments) applies.

[i.1] ETSI EN 302 583: "Digital Video Broadcasting (DVB); Framing Structure, channel coding and modulation for Satellite Services to Handheld devices (SH) below 3 GHz".

[i.2] ETSI TS 101 851: "Satellite Earth Stations and Systems (SES); Satellite Component of UMTS/IMT-2000; Part 1: Physical channels and mapping of transport channels into physical channels; Sub-part 1: G-family (S-UMTS-G 25.211)".

[i.3] Kanatas et al, "Land Mobile Satellite Channel Measurements in Athens City Center at 1 800 MHz", IMSC'97, Pasadena, CA, June 1997.

[i.4] J. V. Evans, "Satellite systems for personal communications", Proc. of the IEEE, vol. 86, no.7, 1998, pp. 1325-1341.

[i.5] J. Goldhirsh, W. J. Vogel, "Earth-satellite tree attenuation at 20 GHz: foliage effects", IEE Electr. Letters, vol. 29, no. 18, pp. 1640-1641, September 1993.

[i.6] W. J. Vogel, U. Hong, "Measurement and modeling of land mobile satellite propagation at UHF and L-band", IEEE Trans. on Antennas and Propagation, vol. 36, no. 5, pp. 707-719, May 1988.

[i.7] W. J. Vogel, J. Goldhirsh, "Mobile satellite propagation measurements at L-band using MARECS-B2", IEEE Trans. on Ant. and Prop., vol. 38, no. 2, pp. 259-264, February 1990.

[i.8] W. J. Vogel, J. Goldhirsh, "Multipath Fading at L Band and Low Elevation Angle, Land Mobile Satellite Scenarios", IEEE Journ. on Sel. Areas in Comm., vol. 13, no. 2, pp. 259-264, February 1995.

[i.9] International Telecommunication Union, ITU-R Recommendation P.681, "Propagation data required for the design of earth-space land mobile telecommunication systems", Geneva, 1997.

[i.10] S. R. Saunders, A.A. Zavala. "Antennas and Propagation for Wireless Communication Systems", 2nd edition, Wiley&Sons, 2007.

[i.11] G. E. Corazza, F. Vatalaro, "A statistical model for land mobile satellite channels and its applications to nongeostationary orbit systems", IEEE Trans. on Veh. Tech., vol. 43, no. 3, pp. 738-742, August 1994.

[i.12] C. Loo, "A statistical model for land mobile satellite link", IEEE Trans. on Veh. Tech. vol. 34, no. 3, pp. 122-127, August 1985.

[i.13] S-H Hwang, K-J Kim, J-Y Ahn, K-C Whang, "A channel model for nongeostationary orbiting satellite system", 47th IEEE Veh. Tech. Conf., Vol. 1, Issue 4-7, pp. 41-45, May 1997.

[i.14] M. J. Gans, "A Power-Spectral Theory of Propagation in the Mobile-Radio Environment", IEEE Trans. on Veh. Technology, Vo. 21, No. 1, February 1972.

[i.15] C.Q. Xu, C. L. Law, S. Yoshida, "On the Doppler Power Spectrum at the Mobile Unit Employing a Directional Antenna", IEEE Comm. Letters, Vol. 5, No. 1, January 2001.

[i.16] W. T Ng, V.K. Dubey, "Comments on "On the Doppler Spectrum at the Mobile Unit Employing a Directional Antenna", IEEE Comm. Letters, Vol. 6, No. 11, November 2002.

[i.17] R. H. Clarke, "A statistical theory of mobile radio reception", Bell Syst. Tech. J., vol. 43, pp. 957-1000, July 1968.

[i.18] T. Aulin, "A Modified Model for the Fading Signal at a Mobile Radio Channel", IEEE Trans. on Veh. Tech., VT-28, No. 3, August 1979.

[i.19] J. Goldhirsh, W. J. Vogel, "Fade-durations derived from the land mobile satellite measurements in Australia", IEEE. Trans. on Comm., vol. 39, no. 5, pp. 664-668, May 1999.

[i.20] R. Tafazolli, P. Taaghol, "Correlation model for shadow fading in land mobile satellite systems", IEE Electr. Letters, vol. 33, no. 15, pp. 1287-1289, July 1997.

[i.21] M. Patzold, Y, Li, F. Laue, "A study of a Land Mobile Satellite Channel Model with Asymmetrical Dopller Spectrum and Lognormally Distributed Line-of Sight", IEEE Trans. on Veh. Tech., Vol. 47, No. 1, February 1998.

[i.22] B. Vucetic, J. Du, "Channel modeling and simulation in satellite mobile communication systems", IEEE J. Select. Areas Commun., vol. 10, no. 8, pp. 1209-1218, 1992.

[i.23] E. Lutz, et al., "The land mobile satellite communication channel - recording statistics and channel model", IEEE Trans. on Veh. Technologu, vol. 40, no. 2, pp. 375-386, May 1991.

[i.24] E. Lutz, "A Markov Model for Correlated Land Mobile Satellite Channels", Int. Jour. Of Sat. Comm., vol. 14, pp. 333-339, 1996.

[i.25] E. Lutz, "Issues in satellite personal communication systems", Wireless Networks, vol. 4, pp. 109-124, 1998.

[i.26] E. Lutz, M. Werner, A. Jahn, "Satellite Systems for personal and broadband communications", Springer 2000.

[i.27] F. Perez-Fontan, et al. "A versatile framework for narrow- and wide-band statistical propagation model for the LMS channel", IEEE Trans. on Broadcasting, vol. 43, no. 4, pp. 431-458, December 1997.

[i.28] F. Perez-Fontan, et al. "Complex envelope threestate Markov model based simulator for the narrow-band LMS channel", Int. J. on Sat. Comm., vol. 15, pp. 1-15, 1997.

[i.29] F. Perez-Fontan, et al. "S-Band LMS propagation channel behavior for different environments, degrees of shadowing and elevation angles", IEEE Trans. On Broadcasting, vol. 44, no. 1, pp. 40-76, March 1998.

[i.30] F. Perez-Fontan, et al. "Statistical modeling of the LMS channel", IEEE Trans. on Veh. Tech., vol. 50, no. 6, pp.1549-1567, November 2001.

[i.31] B. Vucetic, J. Du, "Channel modeling and simulation in satellite mobile communication systems", in Proc. Int. Conf. Satel. Mobile Commun., Adelaide, Australia, pp. 1-6. August 1990.

[i.32] B. Belloul, S. Saunders, M.A.N. Parks, B. G. Evans, "Measurement and modeling of the wideband propagation at L and S band applicable to the LMS channel", IEEE Proc. Microwaves, Antennas and Prop., vol. 147, no. 2, pp. 116-121, April 2000.

[i.33] A. Jahn, H. Bischl, G. Heiss, "Channel characterization for spread spectrum satellite communications", IEEE 4th Inter. Symp., on Spread Spectrum Techniques and Applications, vol. 3, 22-25, pp. 1221-1226, September 1996.

[i.34] A Jahn, "Propagation considerations and fading countermeasures for mobile multimedia services", Inter. Journal of Satel. Comm., vol. 19, pp. 223-250, 2001.

[i.35] M. Dottling, A. Jahn, D. Didascalou, W. Wiesbeck, "Two- and three- dimensional ray tracing applied to the land mobile satellite (LMS) propagation channel", IEEE Antennas and Propagation Magazine, vol. 43, no. 6, pp. 27-37, December 2001.

[i.36] S. R. Saunders, C. Tzaras, B. G. Evans, "Physical-statistical methods for determining state transition probabilities in mobile-satellite channel models", Int. Jour. Of Satellite Communications, vol. 19, pp. 207-222, 2001.

[i.37] C. Oestges, D. Vanhoenacker-Janvier, "Physical-statistical predication of performance for land mobile satellite communications systems", IEEE Proc. on Microwaves and Prop., vol. 146, issue 5, pp. 362-368, October 1999.

[i.38] C. Oestges, S. R. Saunders, D. Vanhoenacker-Janvier, "Physical-statistical modeling of the land mobile satellite channel based on ray tracing", IEE Proc. Microwave Antennas and Propagation, vol. 146, no. 1, pp. 45-49, February 1999.

[i.39] C. Tzaras, B. G. Evans, S. R. Saunders, "Physical-statistical analysis of land mobile-satellite channel", IEE Electronics Letters, vo. 34, no. 13, pp. 1355-1357, June 1998.

[i.40] P.R. King, B. G. Evans, S. Savrou, "Physical-statistical model for the land mobile-satellite channel applied to satellite/HAP-MIMO", 11th European Wireless Conference, vol. 1, April 2005.

[i.41] P.R. King, S. Savrou, "Land mobile-satellite MIMO capacity predictions", IEE Electr. Letters, vol. 41, no. 13, pp. 749-751, June 2005.

[i.42] P.R. King, S. Savrou, "Low Elevation Wideband Land Mobile Satellite MIMO Channel Characteristics", IEEE Trans. Wireless Comm., vol. 6, no. 7, pp.2712-2720, July 2007.

[i.43] P.R. King, S. Savrou, "Capacity improvements for a land mobile single satellite MIMO system", IEEE Antennas and Wireless Prop. Letters, vol. 5, pp. 98-100, December 2006.

[i.44] D2-1.3-Part1-ASC-MAESTRO-V3.3.pdf.

[i.45] D8-3-SPH-MAESTRO-V3.1.pdf.

[i.46] A. J. Viterbi, CDMA: "Principles of Spread Spectrum Communications", Addison-Weley.

[i.47] S. Verdu, "Multiuser Detection", Cambridge University Press, New York 1998.

[i.48] A. Nordio, M. Hernandez, G.Caire, "Low-Complexity Turbo Equalization and Multiuser Decoding for TD-CDMA", IEEE Trans. on Wireless Comm., Vol. 3, No. 2, pp. 454-465, March 2004.

[i.49] R. Lupas and S. Verdu, "Linear multiuser detectors for synchronous code-devision multiple-access channels", IEEE Trans. on Info. Theory, Vol. 35, pp. 123-136, January 1989.

[i.50] C. SanKaran, A. Ephremides, "Solving a Class of Optimum Multiuser Detection Problems with Polynomial Complexity", IEEE Trans. on Info. Theory, Vol. 44, pp. 1958-1961, September 1998.

[i.51] S. Ulukus, R. Yates, "Optimum Multiuser Detection Is Tractable for Synchronous CDMA Systems Using M-sequences", IEEE Comm. Lett. Vol. 2, pp. 89-91, 1998.

[i.52] M. X. Goemans and D. P. Williamson, "Improved approximation algorithms for maximum cut and satisfiability problem using semi-definite programming", J. ACM, vol. 42, pp. 1115-1145, 1995.

[i.53] W. Ma, T.N. Davidson, K.M. Wong, Z.Q. Luo, P.C. Ching, "Quasi-Maximum-Likelihood Multiuser Detection using Semi-Definite Relaxation with Application to Synchronous CDMA", IEEE Trans. Signal Processing, Vol. 50, No. 4, pp. 912-922, April 2002.

[i.54] Y. Nesterov and A. Nemirovskii, "Interior-Point Polynomial Algorithms in Convex Programming", Philadelphia, USA: SIAM, 1994.

[i.55] E.S. Levitin and B. T. Polyak, "Constrained minimization methods", USSR Computational Mathematics and Mathematical Physics, vol. 6, pp. 1-50, 1966.

[i.56] P.H. Tan, L.K. Rasmussen, T.J. Lim, "Constraint Maximum-Likelihood Detection in CDMA", IEEE Trans. on Comm., vol. 49, no. 1, pp. 142-153, January 2001.

[i.57] A. Yener, R.D. Yates, S. Ulukus, "A nonlinear programming approach to CDMA multiuser detection", in Proc. Asilomar Conf. Signals, Systems and Computers, Pacific Grove, CA, October 1999, pp/ 1579-1583.

[i.58] B. H. Ahn, "Iterative methods for linear complementary problems with upper bounds on primary variables", Math. Program., vol. 26, no. 3, pp. 295-315, 1983.

[i.59] L. Brunel, J.J. Boutros, "Lattice Decoding for Joint Detection in Direct-Sequence CDMA Systems", IEEE Trans on Inf. Th., Vol. 49, No. 4, April 2003.

[i.60] E. Viterbi, J. Boutros, "A Universal Lattice Code Decoder for Fading Channels", IEEE Trans on Inf. Th., Vol. 45, No. 5, July 1999.

[i.61] J.R. Shewchuck (1994): "An Introduction to the Conjugate Direction Method Without the Agonizing Pain".

NOTE: See http://www.icos.ethz.ch/.

[i.62] M.J.Juntii, B.Aazhang, J.O.Lilleberg, "Iterative Implementation of Linear Multiuser Detection for Dynamic Asynchronous CDMA systems", IEEE Trans. On Comm., Vol. 46, No. 4, pp. 503-508, April 1998.

[i.63] R.I. Hernadez, R. Baghaie, K. Kettunen, "Implementation of Gram-Schmidt Conjugate Direction and Conjugate Gradient Algorithms", in Proceedings IEEE Finnish Signal Processing Symposium, FINSIG'99, Oulu, Finland, pp. 165-169, May 1999.

[i.64] R. Lupas and S. Verdu, "Near-Far Resistance of Multiuser Dectors in Asynchronous Channels", IEEE Trans. on Comm., Vol. 38, No. 4, pp. 496-508, April 1990.

[i.65] M. Honig, U. Madhow and S. Verdu, "Blind adaptive multiuser detection", IEEE Trans. Inform. Theory, vol. 41, pp. 944-960, July 1995.