รายงานผลการประชุมคณะทำงาน 5A ครั้งที่ ๑๑
ของภาควิทยุคมนาคม สหภาพโทรคมนาคมระหว่างประเทศ
(ITU-R the 11th Meeting of Working Party 5A)
ณ นครเจนีวา ประเทศสวิตเซอร์แลนด์

๒๐ – ๓๐ พฤษภาคม ๒๕๕๖

ภารกิจภูมิภาค และบูรณการ
กลุ่มงานบริหารความถี่วิทยุ
สำนักงานคณะกรรมการกิจการกระจายเสียง กิจการโทรทัศน์ และกิจการโทรคมนาคมแห่งชาติ
เลขที่ ๘๗ ถนนพหลโยธิน ซอย ๘ แขวงสามเสนใน เขตพญาไท กรุงเทพมหานคร ๑๐๔๐๐

รายงานผลการประชุมคณะทำงาน 5A ครั้งที่ ๑๑

ITU-R the 11th Meeting of Working Party 5A
(Land mobile service above 30 MHz (excluding IMT); wireless access in the fixed service; amateur and amateur satellite service)

๑. รายละเอียดการประชุม

การประชุมคณะทำงาน 5A ครั้งที่ ๑๑ ของภาควิทยุคมนาคม จัดขึ้นโดยสหภาพโทรคมนาคมระหว่างประเทศ ระหว่างวันที่ ๒๐ – ๓๐ พฤษภาคม ๒๕๕๖ ณ นครเจนีวา ประเทศสวิตเซอร์แลนด์ โดยมีหน้าที่รับผิดชอบครอบคลุม เรื่อง กิจการเคลื่อนที่ทางบกที่ใช้ความถี่วิทยุสูงกว่า ๓๐ MHz (ยกเว้น IMT) การเชื่อมต่อไร้สายในกิจการประจำที่ กิจการวิทยุสมัครเล่นและกิจการวิทยุสมัครเล่นผ่านดาวเทียม

๒. ผู้เข้าร่วมประชุม

ผู้เข้าร่วมประชุมประกอบด้วยผู้แทนจากรัฐสมาชิก (Member States) สมาชิกสมทบ (Associates) องค์การระหว่างประเทศและองค์กรภูมิภาค (Regional and Other International Organizations) ผู้ประกอบกิจการโทรคมนาคมที่เป็นที่รู้จัก (Recognized Operating Agencies) สหภาพโทรคมนาคมระหว่างประเทศInternational Telecommunication Union: ITU) และหน่วยงานด้านวิทยาศาสตร์หรืออุตสาหกรรม (Scientific or Industrial Organizations) รวมทั้งสิ้นจำนวน ๑๕๓ คน โดย Mr. Jose Costa จากประเทศแคนนาดา ทำหน้าที่ประธานที่ประชุม

๓. หน้าที่ความรับผิดชอบของคณะทำงานที่เกี่ยวข้องภายใต้กลุ่มศึกษาที่ ๕

๓.๑ กลุ่มศึกษาที่ ๕ (Study Group 5) ของภาควิทยุคมนาคม จัดตั้งขึ้นตามมติของที่ประชุมสมัชชาว่าด้วยการวิทยุคมนาคม ค.ศ. ๒๐๐๗ (Radio Assembly 2007: RA-07) ของสหภาพโทรคมนาคมระหว่างประเทศ โดยให้มีหน้าที่รับผิดชอบการศึกษาเกี่ยวกับระบบและโครงข่ายสำหรับกิจการประจำที่ กิจการเคลื่อนที่ กิจการวิทยุตรวจการณ์และตรวจค้นหา กิจการวิทยุสมัครเล่น และกิจการวิทยุสมัครเล่นผ่านดาวเทียม

๓.๒ เพื่อให้ครอบคลุมหน้าที่ความรับผิดชอบตามข้อ ๓.๑ กลุ่มศึกษาที่ ๕ จึงได้จัดตั้งคณะทำงานขึ้นอีก ๕ คณะทำงาน ประกอบด้วย

๓.๒.๑ <u>คณะทำงาน 5A (Working Party 5A)</u> มีหน้าที่ รับผิดชอบการจัดทำคู่มือ (Handbook) และข้อเสนอแนะต่างๆที่เกี่ยวข้องกับกิจการเคลื่อนที่ทางบกที่ใช้ความถี่วิทยุสูงกว่า ๓๐ MHz (ยกเว้น IMT) การเข้าถึงแบบไร้สายในกิจการประจำที่ กิจการวิทยุสมัครเล่นและกิจการวิทยุสมัครเล่นผ่านดาวเทียม

๓.๒.๒ <u>คณะทำงาน 5B (Working Party 5B)</u> มีหน้าที่ รับผิดชอบการจัดทำคู่มือ (Handbook) และข้อเสนอแนะต่างๆที่เกี่ยวข้องกับกิจการเคลื่อนที่ทางน้ำ รวมถึง GMDSS กิจการเคลื่อนที่ทางการบินและกิจการวิทยุตรวจการณ์และตรวจค้นหา

๓.๒.๓ <u>คณะทำงาน 5C (Working Party 5C)</u> มีหน้าที่ รับผิดชอบการจัดทำข้อเสนอแนะและรายงานเกี่ยวกับระบบเชื่อมโยงแบบไร้สาย ย่าน HF และระบบอื่นๆที่มีความถี่วิทยุต่ำกว่า ๓๐ MHz ในกิจการประจำที่และกิจการเคลื่อนที่ทางบก

๓.๒.๔ <u>คณะทำงาน 5D (Working Party 5D)</u> มีหน้าที่ รับผิดชอบการจัดทำข้อเสนอแนะและรายงานเกี่ยวกับระบบ IMT

๓.๒.๕ <u>คณะทำงาน JTG 5-6 (Working Party JTG 4-5-6-7)</u> มีหน้าที่ ศึกษาการใช้งานของ Mobile Applications และระบบอื่นๆ ในย่านความถี่วิทยุ ๗๙๐ – ๘๖๒ MHz

๓.๓ วัตถุประสงค์ของการจัดตั้งคณะทำงาน 5A (Working Party 5A) ตามข้อ ๓.๒.๑ เพื่อ

๓.๓.๑ สนับสนุน การเข้าถึงการใช้ความถี่วิทยุอย่างเท่าเทียมกัน เพื่อให้เกิดประโยชน์สูงสุด

๓.๓.๒ พัฒนาและสร้างมาตรฐานเทคโนโลยีให้กับกิจการเคลื่อนที่ทางบก

๓.๓.๓ ให้ความสำคัญลักษณะและเทคนิคของกิจการวิทยุสมัครเล่น และเพื่อเตรียมความพร้อมในประเด็นที่เกี่ยวข้องกับระเบียบวาระของ WRC

๓.๓.๔ เผยแพร่ความรู้ที่เกี่ยวข้องกับการวางแผนทางวิศวกรรมและการพัฒนากิจการเคลื่อนที่ทางบกในรูปแบบของ Handbook

และเพื่อให้ครอบคลุมหน้าที่ความรับผิดชอบของคณะทำงาน 5A ที่ประชุมคณะทำงาน 5A เห็นชอบให้กำหนดโครงสร้างของคณะทำงาน 5A ซึ่งแบ่งได้เป็น ๕ กลุ่มทำงานหลัก ดังนี้

Group	Chairman
WG 5A-1: *พิจารณาประเด็นต่างๆที่เกี่ยวข้องกับกิจการวิทยุสมัครเล่น*	Dale Hughes : ประเทศ ออสเตรเลีย
WG 5A-2 : *พิจารณาประเด็นต่างๆที่เกี่ยวข้องกับระบบและมาตรฐาน*	Lang Baozhen: ประเทศจีน
WG 5A-3 : *พิจารณาประเด็นต่างๆที่เกี่ยวข้องกับ PPDR*	Amy Sanders: ประเทศ สหรัฐอเมริกา
WG 5A-4 : *พิจารณาประเด็นต่างๆที่เกี่ยวข้องกับการใช้ความถี่วิทยุกันร่วมและการรบกวนความถี่วิทยุ*	Michael Kraemer: ประเทศ เยอรมัน
WG 5A-5 : *พิจารณาประเด็นต่างๆที่เกี่ยวข้องกับเทคโนโลยีใหม่*	Hitoshi Yoshino: ประเทศ ญี่ปุ่น

๔. การดำเนินการประชุม

การดำเนินการประชุม แบ่งเป็น ๓ ส่วน ดังนี้

๔.๑ การประชุมเต็มคณะ (Plenary Session) เพื่อพิจารณารายงานความคืบหน้าในการศึกษาของแต่ละกลุ่มทำงาน พิจารณาให้ความเห็นชอบอย่างเป็นทางการ (consent) ต่อร่างข้อเสนอแนะใหม่และที่มีการแก้ไข รวมทั้งพิจารณาให้ความเห็นชอบเอกสารติดต่อประสานงาน (Liaison Statement) ที่ออกโดยคณะทำงาน 5A ไปยังหน่วยงานอื่นที่เกี่ยวข้อง

๔.๒ การประชุมกลุ่มทำงาน (Working Groups) จำนวน ๕ กลุ่ม (WG 5A-1, WG 5A-2, WG 5A-3,WG 5A-4 และ WG 5A-5) เพื่อพิจารณาความคืบหน้าของการศึกษาในหัวข้อต่าง ๆ ที่อยู่ในความรับผิดชอบ

๔.๓ การประชุมกลุ่มทำงานย่อย (Sub-Working Groups) เพื่อศึกษาหัวข้อต่างๆ ที่อยู่ในความรับผิดชอบ (CRS, ITS, WASN และ SDR)

๕. ผลการประชุมกลุ่มทำงาน (Working Group)

คณะทำงาน 5A ได้ดำเนินการประชุมกลุ่มทำงาน ๕ กลุ่ม แบบควบคู่และขนานกัน ซึ่งในแต่ละกลุ่มทำงานมีหน้าที่ความรับผิดชอบที่แตกต่างกันไปในแต่ละกลุ่ม ดังมีรายละเอียด ดังนี้

๕.๑ <u>กลุ่มทำงาน 5A-1 (WG 5A-1)</u> : ระเบียบวาระที่เกี่ยวข้อง คือ ระเบียบวาระที่ ๑.๔ (WRC-15)

กลุ่มทำงาน 5A-1 มีหน้าที่รับผิดชอบในการพิจารณาประเด็นต่างๆที่เกี่ยวข้องกับกิจการวิทยุสมัครเล่น และกิจการวิทยุสมัครเล่นผ่านดาวเทียม โดยประเด็นหลักที่อยู่ในความรับผิดชอบของกลุ่มทำงานนี้ คือ การกำหนดความถี่วิทยุให้กับกิจการวิทยุสมัครเล่น เป็นกิจการรอง ในช่วงความถี่วิทยุ ๕๓๐๐ kHz ซึ่งถูกระบุไว้เป็นระเบียบวาระที่ ๑.๔ ของการประชุม WRC-15

ซึ่งในการประชุมครั้งนี้ มีข้อเสนอจากประเทศสมาชิกที่สนใจและกลุ่มทำงานอื่นๆภายใต้ ITU รวมทั้งสิ้น ๑๐ ข้อเสนอ โดยแบ่งการพิจารณาออกเป็น ๓ ประเด็นหลักๆ ดังนี้

๕.๑.๑ <u>ระเบียบวาระที่ ๑.๔ (WRC-15) เรื่อง การกำหนดความถี่วิทยุให้กับกิจการวิทยุสมัครเล่นเป็นกิจการรอง ในย่านความถี่วิทยุ ๕๒๕๐-๕๔๕๐ kHz</u>

ที่ประชุมได้ร่วมกันพิจารณาระเบียบวาระนี้ จากข้อเสนอของประเทศสมาชิกต่างๆที่นำเสนอต่อที่ประชุม โดยได้ร่วมกันจัดทำ ร่างรายงาน ITU-R M[5 MHz COMPAT] ซึ่งเกี่ยวข้องกับ บทวิเคราห์และความเป็นไปได้ในการใช้ความถี่ร่วมกันในย่านความถี่ ๕๒๕๐-๕๔๕๐ kHz ระหว่างกิจการวิทยุสมัครเล่น กิจการประจำที่ กิจการเคลื่อนที่ทางบก

กิจการเคลื่อนที่ทางน้ำ กิจการวิทยุหาตำแหน่ง และ กิจการเคลื่อนที่ทางการบิน โดยมีรายละเอียดปรากฏตาม<u>เอสารแนบ ๑</u> ทั้งนี้ ร่างรายงานฉบับดังกล่าว ยังคงต้องได้รับการแก้ไข ปรับปรุง เพิ่มเติมจากข้อเสนอของประเทศสมาชิกในการประชุมคณะทำงาน 5A ครั้งต่อๆ ไป เพื่อให้มีความเหมาะสมและสอดคล้องกับความเป็นจริงของการใช้ความถี่วิทยุร่วมกันสำหรับกิจการต่างๆในย่านความถี่เดียวกันนี้

๕.๑.๒ <u>การพิจารณาทบทวน เอกสาร ITU-R ต่างๆ ที่เกี่ยวข้องกับกิจการวิทยุสมัครเล่น และกิจการวิทยุสมัครเล่นผ่านดาวเทียม</u>

ในการประชุมครั้งนี้ ที่ประชุมได้ร่วมกันพิจารณาข้อเสนอของประเทศรัสเซีย ในการพิจารณาปรับปรุง คู่มือการใช้งานสำหรับกิจการวิทยุสมัครเล่นและกิจการวิทยุสมัครเล่นผ่านดาวเทียม ในบาง chapter โดยมีรายละเอียดปรากฏตาม<u>เอสารแนบ ๒</u> โดยคาดว่าคู่มือฉบับดังกล่าวนี้ จะแล้วเสร็จในการประชุมคณะทำงาน 5A ครั้งที่ 12 (พฤศจิกายน ๒๕๕๖)

๕.๑.๓ <u>เป้าหมายของกลุ่มทำงาน 5A-1 ในการประชุมคณะทำงาน 5A ครั้งต่อไป (ครั้งที่ 12)</u>

- กระบวนการการดำเนินงานที่เกี่ยวข้องกับระเบียบวาระที่ ๑.๔ (WRC-15)
  - สรุปผลการศึกษา การใช้ความถี่ร่วมกัน จากข้อเสนอของคณะทำงานต่างๆ
  - จัดเตรียมร่างรายงาน การใช้ความถี่ร่วมกัน ให้มีความเหมาะสม
  - ปรับปรุงร่าง CPM ใน section ที่ ๕ และ ๖ โดยพิจารณาจากข้อเสนอของคณะทำงานต่างๆ ของ ITU
  - ส่งร่างรายงาน การใช้ความถี่ร่วมกัน ให้คณะทำงานต่างๆของ ITU พิจารณา เพื่อแสดงความเห็นครั้งสุดท้าย

- จัดส่ง ร่าง CPM ให้คณะทำงานต่างๆของ ITU เพื่อพิจารณา ต่อไป

- พิจารณาปรับปรุง ทบทวน ข้อเสนอแนะของ ITU-R รายงาน รวมทั้งคู่มือที่เกี่ยวข้องกับกิจการวิทยุสมัครเล่นและกิจการวิทยุสมัครเล่นผ่านดาวเทียม (ถ้าจำเป็น)
- พิจารณาปรับปรุง ทบทวน ข้อเสนอแนะของ ITU-D รายงาน รวมทั้งคู่มือที่เกี่ยวข้องกับกิจการวิทยุสมัครเล่นและกิจการวิทยุสมัครเล่นผ่านดาวเทียม (ถ้าจำเป็น) พร้อมทั้งจัดทำร่างเอกสารประสานงาน (Liaison Statement) ไปยังคณะทำงานของ ITU-D ที่เกี่ยวข้อง

๕.๒ กลุ่มทำงาน 5A-2 (WG 5A-2) :

กลุ่มทำงาน 5A-2 มีหน้าที่รับผิดชอบในการพิจารณาประเด็นที่เกี่ยวข้องกับ มาตรฐานและระบบ โดยในการประชุมครั้งนี้ มีข้อเสนอจากประเทศสมาชิก ๒๖ ข้อเสนอ ซึ่งที่ประชุมได้ร่วมกันพิจารณาในประเด็นต่างๆที่เกี่ยวข้อง และสามารถสรุปผลการพิจารณาออกเป็นประเด็นต่างๆ ดังนี้

๕.๒.๑ Wireless home networks

ที่ประชุมได้ร่วมกันพิจารณา และปรับปรุงร่างข้อเสนอแนะ ITU-R M.2003 และรายงาน ITU-R M.2227 และเนื่องจากร่างข้อเสนอแนะและรายงานทั้ง ๒ ฉบับดังกล่าวยังไม่เสร็จสมบูรณ์ ที่ประชุมจึงได้มีมติจัดทำร่างเอกสารประสานงาน (Liaison Statement) ไปยังกลุ่มงานอื่นๆภายใต้ ITU เพื่อร่วมแสดงความเห็นต่อการจัดทำร่างทั้ง ๒ ฉบับดังกล่าวข้างต้น ทั้งนี้ คณะทำงาน 5A จะได้ปรับปรุงให้มีความเหมาะสมและนำเข้าสู่ที่ประชุมคณะทำงาน 5A เพื่อพิจารณาให้ความเห็นชอบ ต่อไป

๕.๒.๒ ATG

ที่ประชุมได้ร่วมกันพิจารณาข้อเสนอของประเทศสมาชิกต่างๆ รวมถึงองค์กร APT ซึ่งที่ประชุมได้ร่วมกันปรับปรุงร่างรายงาน ATG และที่ประชุมคณะทำงาน 5A ได้ให้ความเห็นชอบร่างรายงานดังกล่าว โดยมีรายละเอียดปรากฏตามเอกสารแนบ ๓

๕.๒.๓ Update of Recommendation ITU-R M.1450 : Characteristics of broadband radio local area networks

ที่ประชุมได้ร่วมกันพิจารณาข้อเสนอของประเทศสมาชิกต่างๆ ในการปรับปรุง เพิ่มเติม Recommendation ITU-R M.1450 ให้มีความสมบูรณ์ครบถ้วน โดยมีรายละเอียดปรากฏตามเอกสารแนบ ๔ อย่างไรก็ตามที่ประชุมมีความเห็นว่า ปัจจุบัน มาตรฐาน IEEE 802.11ac ฉบับล่าสุดยังไม่แล้วเสร็จ จึงเห็นสมควรพิจารณามาตรฐานฉบับล่าสุดดังกล่าว ควบคู่กับการปรับปรุง Recommendation ITU-R M.1450 ซึ่งการปรับปรุงดังกล่าวนี้คาดว่าจะแล้วเสร็จในการประชุมกลุ่มทำงาน 5A ครั้งที่ ๑๒ (พฤศจิกายน ๒๕๕๖) ที่ประชุมจึงเห็นสมควรขอความร่วมมือไปยังกลุ่มงานต่างๆของ ITU เพื่อร่วมเสนอความเห็นในการปรับปรุง Recommendation ITU-R M.1450 ให้มีความสมบูรณ์

๕.๒.๔ Update of Recommendation ITU-R M.1763 : Radio interface standards for broadband wireless access systems in the fixed service operating below 66 GHz

ที่ประชุมได้ร่วมกันพิจารณาข้อเสนอของ ประเทศญี่ปุ่น ในการเสนอขอปรับปรุง เพิ่มเติม Recommendation ITU-R M.1763 ทั้งนี้ ที่ประชุมได้ร่วมกันปรับปรุง โดยอ้างอิงตามข้อเสนอของประเทศญี่ปุ่น รายละเอียดปรากฏตามเอกสารแนบ ๕ ทั้งนี้ที่ประชุมเห็นควรขอความร่วมมือไปยังกลุ่มงานต่างๆของ ITU เพื่อให้ความเห็นต่อการปรับปรุงดังกล่าว พร้อมทั้งเสนอความเห็นในการปรับปรุง Recommendation ITU-R M.1763 ให้มีความสมบูรณ์ ต่อไป

๕.๒.๕ Hearing aids

ที่ประชุมได้ร่วมกันพิจารณาร่างข้อเสนอของประเทศสมาชิก และกลุ่มทำงาน 5B เพื่อนำมาพิจารณาปรับปรุง ITU-R M.1076 อย่างไรก็ตาม ที่ประชุมเห็นว่าควรมีการศึกษาในประเด็น ย่านความถี่ที่เหมาะสม โดยอ้างอิงจากผลการศึกษา หรือ ข้อเสนอแนะคำถามที่ปรากฏใน Annex A จากกลุ่มทำงานอื่นๆที่เกี่ยวข้อง รายละเอียดปรากฏตามเอกสารแนบ ๖ ดังนั้นจึงเห็นควรขอความร่วมมือไปยังกลุ่มงานต่างๆของ ITU เพื่อให้ความเห็นเพื่อนำมาปรับปรุง ITU-R M.1076 ให้มีความสมบูรณ์ ต่อไป

๕.๒.๖ เป้าหมายของกลุ่มทำงาน 5A-2 ในการประชุมคณะทำงาน 5A ครั้งต่อไป (ครั้งที่ 12) จะมีการปรับปรุง แก้ไข ITU-R Recommendation Report Question ต่างๆ ตามข้อเสนอของประเทศสมาชิก หรือ กลุ่มงานที่เกี่ยวข้อง ประกอบด้วย

- Recommendation ITU-R M.[LMS.ATG]
- Recommendation ITU-R M.1076
- Recommendation ITU-R M.1450
- Recommendation ITU-R F.1763
- Recommendation ITU-R M.2003
- Report ITU-R M.2227
- Question on Radiocommunication for short-range hearing aids operating in public access systems

๕.๓ กลุ่มทำงาน 5A-3 (WG 5A-3) : ระเบียบวาระที่เกี่ยวข้อง คือ ระเบียบวาระที่ ๑.๓ และ ๑.๑๐(WRC-15)

กลุ่มทำงาน 5A-3 มีหน้าที่รับผิดชอบในการพิจารณาประเด็นที่เกี่ยวข้องกับการป้องกันและบรรเทาสาธารณภัย (Public Protection and Disaster relief: PPDR) ซึ่งสอดคล้องตามระเบียบวาระการประชุมที่ ๑.๓ และ ๑.๑๐ ของการประชุม WRC-15 โดยในการประชุมครั้งนี้ มีข้อเสนอจากประเทศสมาชิก ๑๔ ข้อเสนอ เพื่อเสนอความเห็นหลากหลายประเด็นที่เกี่ยวข้องกับ PPDR ซึ่งที่ประชุมได้ร่วมกันพิจารณาและให้ความเห็นชอบในประเด็นต่างๆ ดังนี้

๕.๓.๑ ที่ประชุมร่วมกันพิจารณาข้อเสนอของประเทศสมาชิก เพื่อจัดทำร่าง CPM สำหรับระเบียบวาระที่ ๑.๓ โดย ซึ่งรายละเอียดร่าง CPM ดังกล่าว จะประกอบด้วยประเด็นสำคัญหลายเรื่อง เนื่องจากร่างฉบับดังกล่าวนี้จะป็นข้อมูลพื้นฐานที่สำคัญต่อการพิจารณาให้ความเห็นของประเทศสมาชิกต่างๆในการประชุม WRC-15 ไม่ว่าจะเป็นในเรื่องของ ผลการศึกษาทางเทคนิคที่เกี่ยวข้อง ข้อเสนอแนะอ้างอิงจากหน่วยงานต่างๆที่เป็นสากล รวมถึง ITU ตลอดจนการนำเสนอทางเลือก ผลดี ผลเสียต่อการพิจารณาแก้ไข Resolution 646 (Rev.WRC-12) ซึ่งยังอยู่ในระหว่างรอการปรับปรุง เพิ่มเติม จาก

ข้อเสนอของประเทศสมาชิก และกลุ่มงานอื่นๆที่สนใจ ดังนั้นที่ประชุมจึงเห็นควรมีร่างเอกสารติดต่อประสานงาน (Liaison Statement) ไปยังหน่วยงานหรือองค์กรที่สนใจ เพื่อพิจารณาให้ความเห็นและจะมีการพิจารณาอีกครั้ง ในการประชุมคณะทำงาน 5A ครั้งต่อไป

๕.๓.๒ ปรับปรุงข้อเสนอแนะ ITU-R M.2015: Frequency arrangements for public protection and disaster relief radiocommunication systems in UHF bands in accordance withResolution 646 (Rev.WRC-12) ตามข้อเสนอของประเทศสมาชิก ที่ประชุมคณะทำงาน 5A จึงเห็นควรมีร่างเอกสารติดต่อประสานงาน (Liaison Statement) ไปยังหน่วยงานหรือองค์กรที่สนใจ เพื่อพิจารณาให้ความเห็นเกี่ยวกับข้อเสนอแนะ ITU-R M.2015 ฉบับแก้ไข รวมไปถึงข้อเสนอแนะอื่นๆที่เกี่ยวข้อง ในการประชุมคณะทำงาน 5A ครั้งต่อไป

๕.๓.๓ ที่ประชุมได้พิจารณาปรับปรุง ร่างรายงาน ITU-R M.2033: Radiocommunication objectives and requirements for public protection and disaster relief (2003) ทั้งนี้ ที่ประชุมเห็นควรมีร่างเอกสารติดต่อประสานงาน (Liaison Statement) ไปยังหน่วยงานหรือองค์กรที่สนใจ เพื่อพิจารณาให้ความเห็นเกี่ยวกับข้อเสนอแนะ ITU-R M.2033 ฉบับแก้ไข รวมไปถึงข้อเสนอแนะอื่นๆที่เกี่ยวข้อง โดยขอให้จัดส่งข้อเสนอแนะดังกล่าวก่อนวันที่ ๑๑ พฤศจิกายน ๒๕๕๖ เพื่อนำเข้าสู่ที่ประชุมคณะทำงาน 5A ครั้งต่อไป

๕.๓.๔ ที่ประชุมได้พิจารณาจัดทำร่างรายงาน ITU-R M.[B-PPDR]:Broadband public protection and disaster relief communications โดยรายงานฉบับดังกล่าวนี้ ได้ระบุถึงเทคนิคและการใช้งานที่เกี่ยวข้องกับ Broadband PPDR แนวโน้มทางด้านเทคโนโลยีต่างๆในอนาคตทของ Broadband PPDR รวมไปถึง ความต้องการของกลุ่มประเทศกำลังพัฒนาที่เกี่ยวข้องกับ Broadband PPDR ซึ่งสอดคล้องตาม Resolution 648 (WRC-12)

๕.๔ <u>กลุ่มทำงาน 5A-4 (WG 5A-4)</u> :

กลุ่มทำงาน 5A-4 มีหน้าที่รับผิดชอบในการพิจารณาประเด็นที่เกี่ยวข้องกับการใช้ความถี่วิทยุร่วมกันและการรบกวนความถี่วิทยุ โดยในการประชุมครั้งนี้ มีข้อเสนอจากประเทศสมาชิก ๓๒ ข้อเสนอ ซึ่งที่ประชุมได้ร่วมกันพิจารณาและให้ความเห็นชอบในประเด็นที่สำคัญๆ ดังนี้

๕.๔.๑ ที่ประชุมได้ร่วมกันพิจารณาข้อเสนอแนะของกลุ่มทำงาน 7B ในการปรับปรุง Recommendation ITU-R SA.1626 อย่างไรก็ตามที่ประชุมยังไม่มีการแก้ไขประเด็นนี้ตามข้อเสนอของกลุ่มทำงาน 7B ในการประชุมครั้งนี้

๕.๔.๒ ที่ประชุมได้ร่วมกันพิจารณาข้อเสนอแนะของบริษัท อีริคสัน ในการปรับปรุง Recommendation ITU-R SA.1336 สำหรับย่านความถี่วิทยุสูงกว่า ๑ GHz อย่างไรก็ตามที่ประชุมเห็นว่า ประเด็นดังกล่าวนี้ สอดคล้องกับหน้าที่ของกลุ่มทำงาน 5C มากกว่าจึงเห็นควร ส่งต่อประเด็นดังกล่าวนี้ไปยังกลุ่มทำงาน 5C เพื่อพิจารณาต่อไป

๕.๔.๓ ที่ประชุมกลุ่มทำงาน 5A ในครั้งนี้ ไม่ได้รับข้อเสนอจากประเทศสมาชิก หรือองค์กรอื่นๆที่เกี่ยวข้อง ในการพิจารณาปรับรุง Report ITU-R M.2116 ที่ประชุมเห็นว่า ควรมีการพิจารณาในการประชุมครั้งต่อไปเพื่อสรุปรายงานฉบับดังกล่าว

๕.๔.๔ ที่ประชุมได้ร่วมกันพิจารณาข้อเสนอของประเทศสมาชิก ในประเด็น การจัดทำคู่มือการประสานงานตามบริเวณชายแดน (Cross-border coordination handbook) แต่อย่างไรก็ตาม ประเด็นดังกล่าวนี้ ต้องมีการประชุมร่วมกันกับกลุ่มทำงาน 5C อีกครั้ง ในการประชุมคณะทำงาน 5A ครั้งต่อไป เพื่อพิจารราและหาข้อสรุปในประเด็นนี้

๕.๔.๕ แผนการดำเนินงานและเป้าหมายของการประชุม WG 5A-4 ในการประชุมครั้งต่อไป (ครั้งที่ ๑๒) ประกอบด้วย

- พิจารณาปรับปรุง Report ITU-R M.2116 ซึ่งเกี่ยวข้องกับ ผลการศึกษาการใช้ความถี่วิทยุร่วมกันระหว่าง broadband wireless systems และกิจการเคลื่อนที่ทางบก สอดคล้องตามข้อเสนอของประเทศสมาชิก
- พิจารณาปรับปรุง ร่าง Report/Recommendation ITU-R M.[MS 14.5 – 15.35 CHAR] ซึ่งเกี่ยวข้องกับคุณสมบัติและมาตรการการป้องกันสำหรับกิจการเคลื่อนที่ในย่านความถี่วิทยุ ๑๔.๕ – ๑๕.๓๕ GHz รายละเอียดปรากฏตามเอกสารแนบ ๗
- พิจารณาข้อเสนอ โมเดลสายอากาศของสถานีฐานในกิจการเคลื่อนที่ทางบก ตามข้อเสนอจากกลุ่มทำงาน 5C

๕.๕ กลุ่มทำงาน 5A-5 (WG 5A-5) :

กลุ่มทำงาน 5A-5 มีหน้าที่รับผิดชอบในการพิจารณาประเด็นต่างๆที่เกี่ยวข้องกับเทคโนโลยีใหม่ ซึ่งที่ประชุมกลุ่มทำงาน 5A-5 พิจารณาแล้ว เห็นควรมีการแบ่งกลุ่มการพิจารณา เพื่อให้ครอบคลุมหน้าที่ความรับผิดชอบของกลุ่มทำงาน 5A-5 ซึ่งประกอบด้วย Cognitive Radio Systems (CRS) , Intelligent Transport System (ITS), Wireless Access Sensor Network (WASN) และ Software Defined Radio (SDR) รวมถึงระเบียบวาระที่ ๑.๑๘ ซึ่งเกี่ยวข้องกับกลุ่มทำงาน 5A-5 ด้วย โดยในการประชุมครั้งนี้ มีข้อเสนอจากประเทศสมาชิกรวม ๒๘ ข้อเสนอ ซึ่งที่ประชุมได้ร่วมกันพิจารณาและให้ความเห็นชอบในประเด็นต่างๆ ดังนี้

๕.๕.๑ Cognitive Radio Systems (CRS)

ที่ประชุมร่วมพิจารณาร่างข้อเสนอของประเทศสมาชิก จำนวน ๑๑ ข้อเสนอ ในการปรับปรุงร่าง Report (PDNR) M.[LMS.CRS2] ทั้งนี้ ร่างฉบับดังกล่าวจะต้องแล้วเสร็จในการประชุมคณะทำงาน 5A ครั้งค่อไป ทั้งนี้ ที่ประชุมยังได้ร่วมกันกำหนดแผนการดำเนินงานของกลุ่มทำงาน 5A-5 (CRS) ไปจนถึง การประชุมคณะทำงาน 5A ในเดือนพฤศจิกายน ๒๕๕๗ ด้วย รายละเอียดปรากฏตามเอกสารแนบ ๘

๕.๕.๒ Intelligent Transport System (ITS)

ที่ประชุมร่วมพิจารณาร่างข้อเสนอของประเทศสมาชิก จำนวน ๑๒ ข้อเสนอ ในการปรับปรุงร่าง Report/Recommendation ต่างๆที่เกี่ยวข้อง ตลอดจนประเด็นที่เกี่ยวกับระเบียบวาระที่ ๑.๑๘ (WRC-15) โดยมีรายละเอียดดังนี้

- ปรับปรุงร่าง Recommendation ITU-R M.[V2X] และ แผนการดำเนินงานในการกำหนดมาตรฐานวิทยุคมนาคมสำหรับ เครื่องยนต์-เครื่องยนต์ และ เครื่องยนต์-โครงสร้างพื้นฐานอื่นๆ สำหรับระบบ ITS ทั้งนี้ ที่ประชุมจะได้นำส่งร่างที่ได้รับการปรับปรุงฉบับดังกล่าวนี้ ไปยังกลุ่มงานอื่นๆที่สนใจ เพื่อให้ความเห็น และนำไปพิจารณาอีกครั้งในการประชุมคณะทำงาน 5A ครั้งต่อไป

- ในส่วนของร่าง รายงาน ITU-R M.2228 : Advanced ITS radiocommunication นั้น เนื่องจากการประชุมครั้งนี้ไม่มีข้อเสนอจากประเทศสมาชิกใดๆเพิ่มเติม จึงเห็นควรมีการพิจารณาร่างฉบับดังกล่าว ในการประชุมคณะทำงาน 5A ครั้งต่อไป
- ปรับปรุงร่าง Recommendation ITU-R M.[AUTO] ซึ่งเกี่ยวข้องกับระบบเรดาร์อัตโนมัติ ในย่านความถี่วิทยุ ๗๖-๘๑ GHz ซึ่งที่ประชุมเห็นชอบให้นำเสนอร่างฉบับดังกล่าวนี้ เสนอต่อที่ประชุมกลุ่มศึกษา 5 ในการประชุมครั้งต่อไป (พฤศจิกายน ๒๐๑๓)

๕.๕.๓ แผนการดำเนินงานและเป้าหมายของการประชุม WG 5A-5 ในการประชุมครั้งต่อไป (ครั้งที่ ๑๒) ประกอบด้วย

- ปรับปรุง Report (PDNR) M.[LMS.CRS2] ให้สอดคล้องกับ ITU-R 241-1/5 และ Resolution ITU-R 58 ซึ่งคาดว่าจะแล้วเสร็จในการประชุมกลุ่มทำงาน 5A ครั้งที่ ๑๒ นี้ อย่างไรก็ตามหากมีข้อเสนอเพิ่มเติมจากประเทศสมาชิกในการประชุมครั้งที่ ๑๒ ดังกล่าว ที่ประชุมอาจมีการพิจารณาปรับปรุงให้เป็น Report (PDNR) M.[LMS.CRS3] ซึ่งก็จะต้องมีการพิจารณาทบทวนกระบวนการทำงานของกลุ่มทำงาน 5A-5 ใหม่อีกครั้ง
- ปรับปรุงร่าง Recommendation ITU-R M.[V2X] และรายงาน ITU-R M.2228 : Advanced ITS radiocommunication
- ปรับปรุงร่าง Recommendation ITU-R M.[AUTO] ที่อ้างอิงอยู่ในระเบียบวาระที่ ๑.๑๘ (WRC-15)

๖. การประชุมคณะทำงานครั้งต่อไป

กำหนดการประชุมของคณะทำงาน 5A ครั้งต่อไป (ครั้งที่ ๑๒) ระหว่างวันที่ ๑๘ – ๒๙ พฤศจิกายน ๒๐๑๓ และกำหนดการประชุมกลุ่มศึกษาที่ ๕ ระหว่างวันที่ ๒ – ๓ ธันวาคม ๒๐๑๓ ณ นครเจนีวา ประเทศสวิตเซอร์แลนด์

เอกสารแนบ ๑

Preliminary draft new Report ITU-R M.[5 MHz COMPAT]

Document 5A/TEMP/139-E
29 May 2013
English only

Working Party 5A
(Sub-Working Group 5A-1)

WORKING DOCUMENT TOWARDS A PRELIMINARY
DRAFT NEW REPORT ITU-R M.[5 MHZ COMPAT]

Compatibility analysis of possible amateur systems with fixed, land mobile, maritime mobile and radiolocation services in the frequency band 5 250-5 450 kHz and the aeronautical mobile service in an adjacent band

1 Introduction

The frequency band 5 250-5 450 kHz is allocated to the fixed and mobile services excluding aeronautical mobile), and in the band 5 250-5 275 kHz to the radiolocation service for oceanographic radar purposes on a non-interference basis to the allocated services in accordance with Resolution **612 (Rev.WRC-12).**

Resolution **807 (WRC-12)** includes, as Agenda item 1.4 for WRC-15 "1.4 to consider possible new allocation to the amateur service on a secondary basis within the band 5 250-5 450 kHz in accordance with Resolution **649 (WRC-12)**".

This Report discusses compatibility aspects for frequency use in this band.

2 Related ITU-R Recommendations and Reports

Editor's note: Extracted from doc 254

Recommendation ITU-R F.339-8 – Bandwidths, signal-to-noise ratios and fading allowances in HF fixed and land mobile radiocommunication systems

Recommendation ITU-R P.368-9 – Ground-wave propagation curves for frequencies between 10 kHz and 30 MHz

Recommendation ITU-R P.372-10 – Radio noise

Recommendation ITU-R P.525-2 – Calculation of free-space attenuation

Recommendation ITU-R P.533-11 – Method for the prediction of the performance of HF circuits

Formatted: French (Switzerland)

Field Code Changed

Recommendation ITU-R P.832-3 – World Atlas of Ground Conductivities

Recommendation ITU-R F.1610 – Planning, design and implementation of HF fixed service radio systems

Recommendation ITU-R M.1732-1 − Characteristics of systems operating in the amateur and amateur-satellite services for use in sharing studies

Recommendation ITU-R F.1761 – Characteristics of HF fixed radiocommunication systems

Recommendation ITU-R F.240-7 – Signal to interference protection ratios for various classes of emissions in the fixed service below about 30 MHz

Recommendation ITU-R F.162-3 – Use of directional transmitting antennas in the fixed service operating in bands below about 30 MHz

Recommendation ITU-R BS.705-1 – HF transmitting and receiving antennas characteristics and diagrams

Recommendation ITU-R M.1874 – Technical and operational characteristics of oceanographic radars operating in sub-bands within the frequency range 3-50 MHz

Report ITU-R M.2234 – The feasibility of sharing sub-bands between oceanographic radars operating in the radiolocation service and fixed and mobile services within the frequency band 3-50 MHz

ITU-R Handbook – Ionosphere and its Effects on Radiowave Propagation Handbook, Edition 1998

Editor's note: Any other documents that should be added?

3 Abbreviations

Editor's note: Extracted from Doc. 5A/254

AS	Amateur service
FS	Fixed service
SNR	S/N, Signal-to-Noise Ratio
SNIR	S/(N+I), Signal-to-Noise plus Interference Ratio
SSB	Single-Sideband Suppressed Carrier Analogue Voice Transmission
SSN	Sunspot Number
UTC	Coordinated Universal Time

4 Background

Editor's note: Extracted from Doc. 5A/254

The frequency range 5 250-5 450 kHz is allocated to fixed and mobile (except aeronautical mobile) services in all three Regions on a primary basis. Radiolocation services are also allocated in the range 5 250 to 5 275 kHz as a secondary service in Regions 1 and 3 and Primary in Region 2.

Editor's note: Indication of incumbent usage could go here if desired

5 Characteristics of fixed service stations used in the compatibility study

Editor's note: The following is an extract from liaison statement **5A/77-**E

Appropriate fixed service characteristics for sharing studies between fixed service and amateur service stations can be found in Recommendations ITU-R F.1761, ITU-R F.1762 and ITU-R F.1821.

Editor's note: Other information to be added if required

6 Characteristics of amateur service stations that might be used in the 5 250-5 450 kHz frequency band

Editor's note: Extracted from Doc.5A/237

WP 5A has developed a draft Report ITU-R M.[5 MHz CHAR] which contains the list of possible amateur service station parameters in this frequency band. In accordance with this draft Report the majority of commercial amateur equipment has output power of 100-150 W and uses near-omnidirectional antennae.

Therefore in the compatibility study it was assumed that amateur station uses omnidirectional antenna and transmitter with output power of 100 W (20 dBW).

Editor's note: Other information to be added if required

7 Scenarios for the possible impact upon the fixed service by stations of the amateur service

Editor's note: For each of the methods the geographic details of the modeled fixed service and potential amateur service stations should go here. As far as possible the links should be representative of real situations.

7.1 Scenarios for study method 1 (Russian)

7.2 Scenarios for study method 2 (Canadian)

7.3 Scenarios for study method 3 (China)

8 Methodology of interference impact assessment from amateur service stations on the fixed/land mobile service, aeronautical and oceanographic radar services

8.1 Methodology of interference impact assessment proposed by WP 5C

Editors note: Russian & Canadian input

8.1.1 Interference impact assessment from amateur service stations on the fixed/land mobile service

Editor's note: The following is from liaison statement **5A/77-E**

Recommendation ITU-R P.533 and the associated software model should be used for performing required sharing and compatibility studies.

Fixed HF systems typically use directional antennas but are not limited to such design. Therefore studies should take into account a mixture of directional systems using yagi antennas at the maximum gain listed, and omni-directional whip antennas using a gain of 0 dB.

Editor's note: presumably whip antennas are only used for short range links?

The impact from the amateur station transmission reference link should be calculated by determining the reference link S/N ratio (in dB) for the worst month for the amateur station using a relative sunspot number for portions of the sunspot cycle corresponding to both low sunspot activity and high sunspot activity.

A reference link signal level should also be determined for the fixed service link as an actual S/N level (in dB). The amateur reference link S/N ratio should be used to reduce the fixed service reference link S/N ratio to determine S/I and compared to the required S/N levels found in Recommendations ITU-R F.1761, ITU-R F.1762 and ITU-R F.1821 for all three transmission types to determine if it can still meet the required S/N level for all three types of service. This will determine the long-term effects of any amateur allocation.

~~*Editor's note: what are the 'three transmission types'? Digital voice, analogue voice & data?*~~

The fixed/mobile service transmissions modes to be studied are:

300 HF1B telegraphy from F.339 using both stable & fading S/N criteria

3k00J3E Single Sideband analogue voice F.339 using both stable & fading S/N criteria

~~3k00J2D~~ [3k00J2E] Digital voice F.1821 & F.339 using both stable & fading S/N criteria

Editorial note: check designation for digital voice

The amateur service transmissions modes to be used is any mode with a bandwidth up to 2.8~~3~~ kHz

This would provide results for a number of scenarios as shown in the example table below:

Fixed reference links for evaluating potential interference from amateur allocations at 5 MHz

Fixed reference link	Antenna	Sunspot number
<Transmit> to <Receive>	Yagi	<Minimum value>
<Transmit> to <Receive>	Yagi	<Maximum value>
<Transmit> to <Receive>	Omni-Directional	<Minimum value>
<Transmit> to <Receive>	Omni-Directional	<Maximum value>

Systems from all three characteristic Recommendations should be evaluated.

Editor's note: The following paragraph is useful for clarity & is from Doc.5A/257

In accordance with the protection criteria specified in Recommendation ITU-R F.339 the calculation of the indicated values is carried out for the reference bandwidth of 1 Hz.

8.1.2 Interference impact assessment on the aeronautical service

8.1.3 Interference impact assessment on oceanographic radar systems

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8.2 Methodology of interference impact assessment from amateur service stations on the fixed/land mobile service based on I/N criteria.

Editor's note: Chinese contribution

9 Parameters used for compatibility study

Editor's note 1: metadata is fundamental to a full and proper analysis of the results so this section should contain the parameters/settings used for the REC 533 software. If there is no agreement on the particular details, there will be multiple subsections under this topic.

Editor's note 2: Need to consider the link reliability figure. While 50% may be suitable for an amateur link, is it suitable for a fixed link?

10 Result of studies

Editor's note: Tables etc. showing the results of the various conditions i.e. SSN, antenna type, transmissions modes etc. will go here.

11 Analysis of the results

Editor's note: Analysis of the results e.g. link availability with & without interference from the amateur service, impacts of antenna types & Smoothed Sunspot Numbers etc. Hopefully with some statistical or probability analysis of likely impact and some indication of uncertainties associated with the propagation models and any other relevant calculations.

12 Conclusion

It's complicated…

Editor's note: no doubt there will be multiple sections here…

~~13.~~ Attachments

Editor's note: Each input contribution will be attached or embedded here as annexes to this study:

5A/242 (Canada) 242e.docx	5A/250 (USA) 250e.docx	5A/254 (Canada) 254e.docx
5A/280 (China) 280e.docx	5A/289 (UK, Netherlands, Norway) 289e.docx	5A/237 (Russian Federation) 237e.docx
5A/253 (Canada) 253e.docx		

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เอกสารแนบ ๒

PRELIMINARY DRAFT Revision to ITU-R Handbook for amateur and amateur-satellite services

Source: Document 5A/TEMP/90

Annex 13 to
Document 5A/198-E
20 November 2012
English only

Annex 13 to Working Party 5A Chairman's Report

PRELIMINARY DRAFT REVISION TO ITU-R HANDBOOK FOR AMATEUR AND AMATEUR-SATELLITE SERVICES

Foreword

This Handbook provides general information about the amateur and amateur-satellite services. It also includes a compendium of existing ITU texts of relevance to the amateur and amateur-satellite services.

The amateur service is the oldest radio service and pre-dates regulation of radiocommunication. In 1912, amateurs could use any frequency above 1.5 MHz, as these frequencies were regarded "of no value for marine, governmental and commercial communications" or "undesirable and scarcely useful". By 1924, amateurs made way for other services in bands above 1.5 MHz. Today, the amateur service operates in relatively small allocations throughout the spectrum.

The 1963 World Administrative Radio Conference created Footnote 284A, which states: "In the band 144-146 MHz, artificial satellites may be used by the amateur service". The amateur-satellite service was created and given frequency allocations at the 1971 Space WARC. Since then, ~~more than 60~~ scores of amateur satellites have been designed, constructed and operated by amateurs. In addition, amateur radio has been used aboard manned space stations including MIR and the International Space Station. Most ~~of the~~ astronauts and cosmonauts are licensed amateur radio operators.

Self-training is an important purpose of the amateur services, as articulated in the definition of the amateur service in ~~Article~~ No. **1.56** of the Radio Regulations (RR).

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Radio amateurs have made significant technical contributions to the fields of radio propagation, high frequency single sideband radiotelephone, HF data communications, packet radio protocols and communication satellite design.

RR No. 25.9A encourages administrations to allow amateur stations to support disaster relief. Amateur radio continues to provide basic radiocommunications especially in the early ~~days~~ moments of a disaster ~~following~~ causing the loss or overloading of normal telecommunications networks.

This Handbook is intended to present, in one publication, information about the amateur services for administrations and amateur radio organizations.

Paul RINALDO[TBD]
Chairman,
Radiocommunication Working Party 8A5A
(Working Group 1 – Amateur services)

CHAPTER 1

The amateur services

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CHAPTER 2

Amateur service

2.1 Applications of bands allocated to the amateur service

The following table describes typical applications of frequency bands available to the amateur service. Refer to Article 5 of the Radio Regulations (RR) for the specific allocation status of each band. Refer to national regulations for specific allocations, as they may vary by country.

Metric reference	**Frequency band (kHz) (R = Region)**	**Applications**
2200 m	135.7-137.8	Propagation in this band is via surface wave, guided between the earth and the D layer of the ionosphere. Power output is limited to 1 W e.i.r.p., which is sufficient for transcontinental and transoceanic transmissions at night.
630 m	472-479	Propagation in this band permits short-range communications during daytime hours and longer range communications via ionospheric refraction at night, when D layer absorption weakens. Power output is limited to either 1 W or 5 W e.i.r.p., depending on station location.
160 m	1 810-1 850 R1 1 800-2 000 R2, R3	Its propagation characteristics allow short-range communications during daytime hours, and medium and long-range communications during night-time hours. This band is particularly useful during sunspot minima, when the maximum usable frequency (MUF) is below 3 500 kHz.
80 m	3 500-3 800 R1 3 500-4 000 R2 3 500-3 900 R3	This band is used for contacts over distances of up to 500 km during the day, and for distances of 2 000 km and more at night. It is heavily used during communications emergencies.
40 m	7 000-7 200 R1, R3 7 000-7 300 R2	The 7 MHz band is heavily used 24 hours each day. During daylight hours, the band carries the bulk of amateur sky wave communication over distances of less than 1 300 km.
30 m	10 100-10 150 all regions, secondary	This band is in use 24 hours each day, as a bridge between the 7 MHz and 14 MHz bands.
20 m	14 000-14 350	This is the most popular band for international communications.
17 m	18 068-18 168	The band is used as an alternative to 14 MHz which is often congested with traffic.
15 m	21 000-21 450	These bands are used particularly during the daytime and when sunspot activity is high.
12 m	24 890-24 990	
10 m	28 000-29 700	
	Frequency band (MHz)	
6 m	50-52 or 50-54 certain R1 countries 50-54 R2, R3	This band is used for local communication at all times, including telecommand of objects such as models. Sky wave, tropospheric scatter and meteor burst propagation are used for distances up to 2 000 km.
2 m	144-146 R1 144-148 R2, R3	This band is heavily used throughout the world for short-range communications including the use of repeaters.
1.25 m	220-225 R2	Where allocated, this band serves as an alternative to the 144 MHz band for short-range communications.

Metric reference	**Frequency band (MHz) (*end*) (R = Region)**	**Applications**
70 cm	430-440 all regions secondary	This band is used for short-range communications including amateur analogue and digital television. Amateur use of this band is generally secondary to radiodetermination.
	430-450 and 440-450 certain countries secondary RR No. 5.270	
33 cm	902-928 R2 secondary	The 902 MHz band is allocated to the amateur service only in Region 2, where it is also used for industrial, scientific and medical applications, and low-power devices.
23 cm	1 240-1 300 secondary	These bands are used for short-range communications and for experimentation.
13 cm	2 300-2 450 secondary	
9 cm	3 300-3 500 R2, R3 secondary	
5 cm	5 650-5 850 R1, R3	
	5 650-5 925 R2	
	Frequency band (GHz)	
3 cm	10-10.5 secondary	
1.2 cm	24-24.05 primary	
	24.05-24.25 secondary	
6 mm	47-47.2	
4 mm	76-77.5 secondary	
	77.5-78 primary	
	78-81 secondary	
2.5 mm	122.25-123 secondary	
2 mm	134-136 primary	
	136-141 secondary	
1 mm	241-248 secondary	
	248-250 primary	

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[Editor’s Note: The new elements from the table below have been vetted, and should be appropriately formatted and incorporated into the table above by the May 2013 meeting of Working Party 5A.]

Metric reference	**Frequency band (kHz) (R = Region), RR Radio Regulations**	**Application**
2 200 m	135.7-137.8 secondary Geographical constraints are given in RR Nos. **5.67A** and **5.67B**	Propagation in this band permits short-range communications during daytime hours and longer range communications via ionospheric refraction at night, when D layer absorption weakens. Power output is limited to 1 W e.i.r.p., which is sufficient for transcontinental and transoceanic transmissions at night.
630 m	472-479 secondary Geographical and technical constraints are given in RR Nos. **5.82**, **5.80A** and **5.80B**	Propagation in this band permits short-range communications during daytime hours and longer range communications via ionospheric refraction at night, when D layer absorption weakens. Power output is limited to either 1 W or 5 W e.i.r.p., depending on station location (see RR Nos. **5.80A** and **5.80B**).
160 m	1 810-1 850 R1 (co-primary use with other services see RR Nos. **5.98**, **5.99**, **5.100**, **5 101**, **5.103**)	Its propagation characteristics allow short-range communications during daytime hours, and medium and long-range communications during night-time hours. This band is particularly useful during sunspot minima, when the maximum usable frequency (MUF) is below 3 500 kHz.
	1 800-1 850 R2	
	1 800-2 000 R2, R3 (co-primary use with other services see RR No. **5.102**)	
80 m	3 500-3 800 R1 (co-primary use with other services) - see RR No. **5.92**)	This band is used for contacts over distances of up to 500 km during the day, and for distances of 2 000 km and more at night. It is heavily used during communications emergencies.
	3 500-3 750 R2 (see also RR No. **5.119**) (primary)	
	3 750-4 000 R2 (co-primary use with other services) - see also RR Nos. **5.122**, **5.125**)	
	3 500-3 900 R3 (co-primary use with other services)	
40 m	7 000-7 200 R1, R3 (primary) (see also RR Nos. **5.140**, **5.141**, **5.141A**, **5.142**) 7 000-7 300 R2 (primary) (see also RR No. **5.142**)	The 7 MHz band is heavily used 24 hours each day. During daylight hours, the band carries the bulk of amateur sky wave communication over distances of less than 1 300 km.

Metric reference	Frequency band (kHz) (R = Region), RR Radio Regulations	Application
30 m	10 100-10 150 (secondary)	This band is in use 24 hours each day, as a bridge between the 7 MHz and 14 MHz bands.
20 m	14 000-14 250 (primary)	This is the most popular band for international communications.
	14 250 14 350 (conditions of co-primary use with other services in a number of countries are given in RR No. **5.152**)	
17 m	18 068-18 168 (conditions of co-primary use with other services in a number of countries are given in RR No. **5.154**)	The band is used as an alternative to 14 MHz which is often congested with traffic.
15 m	21 000-21 450 (primary)	These bands are used particularly during the daytime and when sunspot activity is high.
12 m	24 890-24 990 (primary)	
10 m	28 000-29 700 (primary)	
	Frequency band (MHz)	
6 m	50-54 R1 (Only allocated in 11 countries of the Africa Region where allocation is primary. See RR No. **5.169**)	This band is used for local communication at all times including via repeaters. [Use of this band may also include telecommand of objects such as models.] The band may also be used on occasion for communication for distances up to 2 000 km by sky wave, tropospheric scatter, earth-moon-earth (EME), sporadic reflection from the E layer of the ionosphere (Es) and scattering by the ionized trails of meteors (MS) .
	50-54 R2, R3 (geographical constraints are given in RR Nos. **5.162A**, **5.166**, **5.167**, **5.167A**, **5.168**, **5.170**)	
2 m	144-146 R1 (primary)	This band is heavily used throughout the world for short-range communications, including the use of repeaters. This band is actively used for Earth-Moon-Earth (EME) communications using analog and digital modulation techniques, for different types of radio waves propagation – tropospheric scattering and superrefraction (TROPO), scattering by irregularities in the lower ionosphere (FAI), scattering by the ionized trails of meteors (MS) as well as ionosphere scattering in the circumpolar regions during the polar storms (AURORA) making it possible to contact, using analog and digital modulation techniques, over distances of up to 2 000-3 000 km. This band is actively used for local communications in times of disasters. It is also used for contacts with the use of repeaters on board amateur satellites.
	144-148 R2, R3 (conditions of co-primary use with other services in a number of countries are given in RR No. **5.217**)	

Metric reference	Frequency band (kHz) (R = Region), RR Radio Regulations	Application
1.25 m	220-225 R2	Where allocated, this band serves as an alternative to the 144 MHz band for short-range communications.
70 cm	430-440 R1 co-primary use with other services (see RR Nos. **5.138**, **5.271**, **5.272**, **5.273**, **5.274**, **5.275**, **5.276**, **5.277**, **5.279A**, **5.280**, **5.281**, **5.282**, **5.283**) 420-430 and 440-450 in several countries R2, R3 on a secondary basis RR No. **5.270** 430-440 R2,R3 (secondary)	This band is used for short-range communications including repeaters and amateur analogue and digital television. It is also used for Earth-Moon-Earth (EME) communications using analogue and digital modulation techniques. Tropospheric scattering and superrefraction (TROPO) make it possible to contact over distances of up to 1 000 km. It is also used for contacts with the use of repeaters on board amateur satellites.
33 cm	902-928 R2 secondary.RR No. 5.150	This band is allocated to the amateur service only in Region 2.
23 cm	1 240-1 300 secondary	This band is used for short-range communications using analog and digital modulation techniques, as well as for digital television and repeater networks. Tropospheric scattering and superrefraction (TROPO) make it possible to contact over distances of up to 1 000 km. This band is the most popular for Earth-Moon-Earth (EME) communications using analog and digital modulation methods. Also this band is used for contacts with the use of repeaters on board amateur satellites.
13 cm	2 300-2 450 secondary	This band is used for short-range communications and for experimentation, and also for contacts with the use of repeaters on board amateur satellites (space-to-Earth).
9 cm	3 300-3 500 R2, R3 secondary	
5 cm	5 650-5 850 R1, R3 5 650-5 925 R2 secondary in all three regions	This band is used for short-range communications and for Earth-Moon-Earth (EME) communications using analog and digital modulation methods.
3 cm	10-10.5 secondary	This band is used for short-range communications and for Earth-Moon-Earth (EME) communications using analog and digital modulation methods. In case of scattering due to atmospheric precipitations (RS), the communication range can be up to 500 km.

Metric reference	**Frequency band (kHz) (R = Region), RR Radio Regulations**	**Application**
1.2 cm	24-24.05 primary	These bands (at 24 GHz, 47 GHz and 76 GHz) are used for short-range communications and for experimentation, and also for Earth-Moon-Earth (EME) communications.
	24.05-24.25 secondary RR 5.150	
6 mm	47-47.2 primary	
4 mm	76-77.5 secondary 77.5-78 primary 78-81 secondary	
2.5 mm	122.25-123 secondary	
2 mm	134-136 primary	
	136-141 secondary	
1 mm	241-248 secondary	
	248-250 primary	

CHAPTER 3

Amateur-satellite service

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3.3 Operational amateur satellites

Satellite	Launch	Observations
AMSAT-OSCAR 7	1974	Linear transponder, beacons (sunlight hours)
UoSat-OSCAR 11	1984	Telemetry beacon
AMRAD-OSCAR 27	1993	FM voice repeater, packet telemetry
Fuji-OSCAR 29	1996	9 600-Bd store-and forward, linear transponder, beacon, “digitalker”
Gurwin-OSCAR 32	1998	9 600-Bd packet bulletin board
SEDSat-OSCAR 33	1998	9 600-Bd packet repeater
Navy-OSCAR 44	2001	1 200-Bd store-and-forward digital repeater
Saudi-OSCAR 50	2002	FM repeater and several experiments
RS-22	2003	Telemetry beacon
VUSat-OSCAR 52	2005	Linear transponder and Morse CW beacon
CubeSat-OSCAR 55	2003	Telemetry beacons
CubeSat-OSCAR 57	2003	Beacon and telemetry
CubeSat-OSCAR 58	2005	Beacon and telemetry

GeneSat-1	2006	1 200-Bd telemetry beacon
Delfi-OSCAR 64	2008	1 200-Bd telemetry beacon
Cubesat OSCAR 65	2008	1 200-Bd telemetry beacon, 9 600-Bd digipeater
Cubesat OSCAR 66	2008	Morse CW beacon, FM packet repeater, digitalker
COMPASS-1	2008	Morse CW beacon
RS-30	2008	Morse CW beacon
PRISM	2009	Morse CW beacon, 1 200-Bd and 9 600-Bd telemetry beacons
KKS-1	2009	Morse CW beacon, digital down link
STARS	2009	Morse CW beacon, 1 200-Bd packet down link
SwissCube	2009	Morse CW beacon, 1 200-Bd telemetry beacon
ITUpSAT1	2009	Morse CW beacon, 19 200-Bd telemetry beacon
UWE-2	2009	9 600-Bd telemetry beacon
BEESAT	2009	Morse CW beacon, 4 800-Bd and 9 600-Bd telemetry beacons
Hope OSCAR 68	2009	Morse CW beacon
Fastrac OSCAR 69	2010	1 200-Bd telemetry beacon
Fastrac OSCAR 70	2010	1 200-Bd telemetry beacon
O/OREOS	2010	1 200-Bd telemetry beacon
SRMSAT	2011	Morse CW beacon
JUNGU	2011	Morse CW beacon
SRMSAT	2011	Morse CW beacon
Explorer 1 Prime Unit 2	2011	1 200-Bd telemetry beacon
MCubed	2011	9 600-Bd telemetry beacon
RAX-2	2011	9 600-Bd telemetry beacon
AO-71	2011	Morse CW beacon
PW-Sat	2012	Morse CW beacon
MO-72	2012	625-Bd and 1 250-Bd telemetry beacons
ARISS	Ongoing	Amateur Radio on the International Space Station (ARISS) includes voice communications, packet radio and several experiments.

NOTE – Additional information is available at http://www.amsat.org.

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PRELIMINARY DRAFT NEW REPORT ITU-R M.[LMS.ATG]
Systems for public mobile communications with aircraft

Radiocommunication Study Groups

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Working Party 5A

PRELIMINARY DRAFT NEW REPORT ITU-R M.[LMS.ATG]

Systems for public mobile communications with aircraft

1 Introduction

This Report deals with the general principles, technical characteristics and operational features of terrestrial systems for public mobile communications with aircraft.

2 General operational considerations

2.1 The system should be fully compatible and capable of interfacing with the international public switched telephone network, public data network, the Internet, or any combinations thereof.

2.2 The system should have adequate bandwidth to meet the foreseeable demand for the services.

2.3 The Quality of Service should be that which meets the objectives of the system. For example, if the objective is to provide high quality voice service, then the Quality of Service should be comparable to that of the public switched network (voice and data). If the objective is to provide best-effort Internet type traffic, then typically there are no Quality of Service mechanisms being used, at least for the best-effort traffic.

2.4 The system should provide, in so far as possible, uninterrupted coverage throughout the designated service areas with the capability of coordinated operation across national borders.

2.5 The airborne equipment must be electromagnetically compatible with other aircraft systems in accordance with appropriate regulatory requirements and should have minimal impact on aircraft engineering, maintenance and operations.

2.6 The system must have no adverse influence on the safe operation of the aircraft.

2.7 The system should not cause harmful interference to other terrestrial communication systems.

3 System technical characteristics and operational features

3.1 Technical characteristics and operational features of the system for public communications with aircraft in some countries in Region 1 are given in Annex 1.

3.2 Technical characteristics and operational features of the system for public communications with aircraft in some countries in Region 2 are given in Annex 2.

3.3 Technical characteristics and operational features of the system for public communications with aircraft in some countries in Region 3 are given in Annex 3.

3.4 Channel propagation effects on a terrestrial air-to-ground system are given in Recommendation ITU-R P.528-3 “Propagation curves for aeronautical mobile and radionavigation services using the VHF, UHF and SHF bands,” which provides useful information for design of systems for public mobile communications with aircraft.

Annexes: 3

ANNEX 1

Systems for public communications with aircraft in some countries in Region 1

1 Introduction

A broadband direct air-to-ground communications (DA2GC) system constitutes an application to provide for various types of telecommunications services, such as internet access and mobile multimedia services, during flights. The connection with the flight passengers' user terminals on-board aircraft is to be realised by already available fixed or Wi-Fi-based on-board connectivity network and/or via GSMOBA (GSM on board aircraft) and in the future possibly also via UMTS and/or LTE.

The main application field would be Air Passenger Communications (APC). In addition a broadband DA2GC system could also support Airline Administrative Communications services (AAC) and thus improve aircraft operation, resulting in particular in reduced OPEX for the airlines. Safety-relevant communications such as Air Traffic Control (ATC) and related services are not intended to be covered.

In some countries in Region 1, there are currently three systems aiming to provide broadband DA2GC. These are described in the sections below.

2 System 1 as described in ETSI TR 103 054

2.1 System architecture

This broadband DA2GC system is based on 3GPP LTE Rel. 8+ specifications. In particular synchronization algorithms as well as the maximum Tx power of the On-board Unit (OBU) are to be modified compared to terrestrial mobile radio usage in order to cope with the high Doppler frequency shift caused by aircraft speed and large cell sizes. In addition the Ground Station (GS) antenna adjustment has to be matched to cover typical aircraft altitudes between 3 and 12 km by adaptation of vertical diagrams including antenna up-tilt. When commercial, this solution will be able to provide in-flight mobile voice and broadband data communications services.

The major building blocks (see Fig. 1 below) of the end-to-end system architecture are:

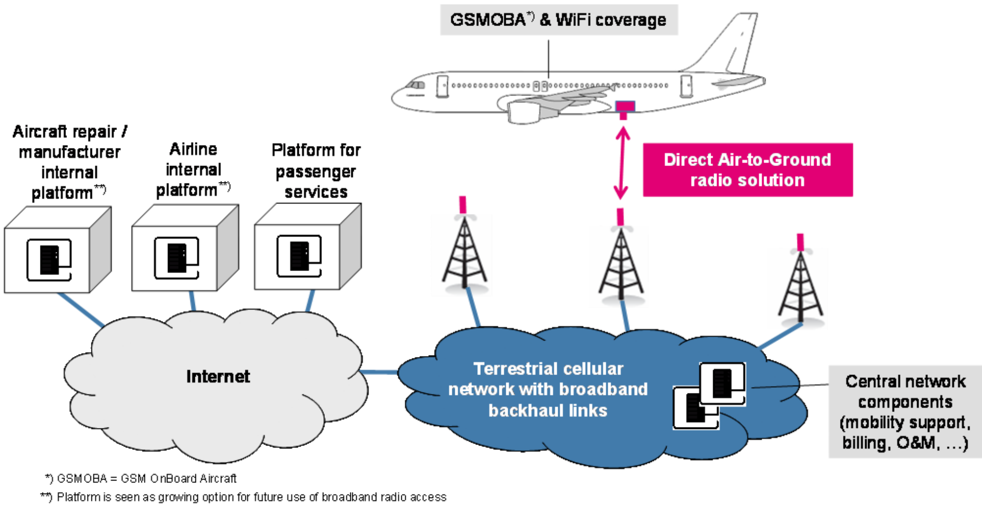
– service access network infrastructure on-board the aircraft, e.g. WiFi coverage and GSMOBA (both already standardised);
– DA2GC network infrastructure on-board aircraft, e.g. modem (OBU), interface to on-board network(s), external antenna, cabling;
– terrestrial radio access network for DA2GC with broadband backhaul links, which would preferably be based on existing infrastructure, but with modifications (e.g. with regard to antenna types and base station implementation) to establish high-performance radio links to aircraft in DA2GC environment;
– mobile core network for session, mobility, subscriber and security management providing IP connectivity to external packet data networks (e.g. intranet, internet, IMS);

– central network components required for O&M, billing, etc. in the DA2GC network;

– various IP-based service delivery platforms e.g. for passenger services or for airline or aircraft repair / manufacturer internal applications.

FIGURE 1

System architecture for the broadband DA2GC system as described in ETSI TR 103 054



2.2 Spectrum needs

Spectrum above 6 GHz is not viewed as appropriate for such an application due to wave propagation aspects (e.g. increased path loss, Doppler shift).

Paired spectrum of 2 x 10 MHz for FDD operation is considered necessary to cope with short- to medium-term demand. Unpaired spectrum of 20 MHz for TDD operation would also be an option, but system performance would slightly suffer due to guard time intervals required for large cell sizes.

2.3 Test flights

For this system a trial flight with prototype equipment was successfully performed in Germany within the 2.6 GHz FDD bands (useable only for trial, but not available for deployment of DA2GC due to planned LTE-deployment for terrestrial cellular mobile) with a signal bandwidth of 2 x 10 MHz.

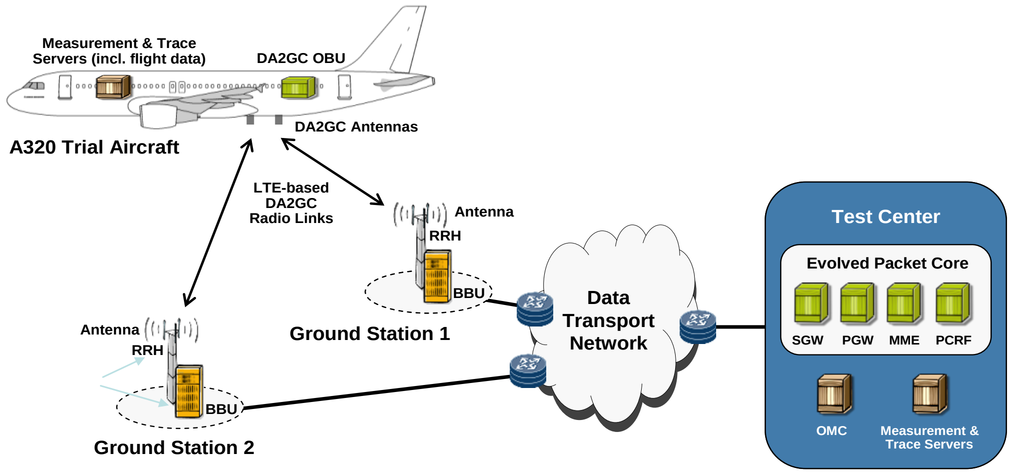
Trial set-up details (see Fig. 2):

– Two sites with an inter-site distance of about 100 km were equipped with LTE-based DA2GC GSs consisting of baseband unit (BBU) and remote radio head (RRH) and with antennas with three sectors (up-tilt), connected with an LTE evolved packet core (EPC) and measurement & data trace servers via a broadband data transport network.

– An Airbus A320 aircraft was equipped with a DA2GC OBU with maximum Tx power of 37 dBm and with two DA2GC antennas below the aircraft fuselage (2 Rx / 1 Tx).

FIGURE 2

Trial flight set-up for the broadband DA2GC system as described in ETSI TR 103 054



During the 3 hours lasting trial flight the aircraft flew with speeds between 500 and more than 800 km/h at different altitudes between 4 000 m and 10 000 m. The flight maneuvers included phases with inter- and intra-site (sector) handovers as well as phases with large distances to the sites.

Trial results:

– The radio link between the GS and Aircraft Station (AS) was established at distances of more than 100 km from the sites to the aircraft flying at speeds of more than 800 km/h and altitudes up to 10 000 m.

– Peak data rates of up to 30 Mbit/s in the forward link (ground-to-air) and 17 Mbit/s in the reverse link (air-to-ground) were achieved.

– In addition to high background data traffic a video conference was established between the teams in the aircraft and the test center which allowed to follow the flight phases in real time and to demonstrate the low latency of the overall DA2GC system (round trip time < 50 ms) compared to satellite-based systems.

It should be noted that the GS equipment used (except of antenna adjustment) was basically state of the art LTE-equipment for 2.6 GHz terrestrial cellular mobile deployment. Only the OBU was modified to allow the overall system to work in the aeronautical environment with large cell ranges and high aircraft speeds. The trial showed the very high performance and flexibility of the LTE based technology even in this early release state.

3 System 2 as described in ETSI TR 101 599

3.1 System architecture

This broadband DA2GC system makes use of adaptive beamforming antennas in order to achieve the desired system performance whilst maintaining lower transmit power levels than would otherwise be necessary. This feature eases co-frequency sharing with other systems by minimising interference into other services and, at the same time, reducing the impact of incoming interference on the achievable link performance. The decision to use beamforming technology in this DA2GC system implementation was also influenced by the current policy drive in Europe and elsewhere. This recognises the increasing demand on finite spectrum resources and encourages spectrum sharing through the use of smart technologies etc.

The overall system connectivity also enables the facility to provide non-safety relevant airline information services whilst maintaining complete isolation between such data and the various internet and infotainment services available to passengers in the aircraft cabin.

From a frequency sharing perspective, an important feature of this system is the use of four sectors at the ground station, with each sector having at least eight phased array beamforming antennas (i.e. eight elements per quadrant) and an array of digitally controlled antenna elements connected to the aircraft radio, which are mounted on the underside of the airframe in order to constitute an adaptive array.

The use of beamforming permits the production of shaped and dynamically steerable beams in both the forward link (ground-to-air) and reverse link (air-to-ground) directions, thereby enabling the desired system performance objectives to be maintained as the aircraft traverses its route whilst, at the same time, minimising interference into other co-frequency systems. This is achieved through the benefits of tailored radiation patterns which can be optimised to reduce interference and allow operation at lower transmit powers (on the ground and in the air) than would otherwise be necessary if more conventional fixed antennas were deployed.

In respect of the underlying modulation and coding schemes used, etc., the system uses OFDM/TDMA and has much in common with other existing and proposed mobile broadband backhaul technologies.

3.2 Spectrum needs

This broadband DA2GC system is optimised for use in the frequency bands around 2.4 GHz and 5.8 GHz, which are used for various licence-exempt radio applications. The system can operate with variable bandwidths in any sub-band within the relevant frequency range. For optimum performance, in TDD mode, the system would require a contiguous block of spectrum of 20 MHz. Alternatively, 2 × 10 MHz contiguous blocks would be needed if operated in FDD mode (although the forward and return links need not necessarily be within the same frequency band). These spectrum requirements are driven by the need to supply sufficient capacity to serve passengers and crew on-board the aircraft with the desired range of broadband services.

3.3 Test flights

This system has already undergone initial flight testing in the 2.4 GHz and 5.8 GHz bands.

4 System 3 as described in ETSI draft TR 103 108

4.1 System architecture

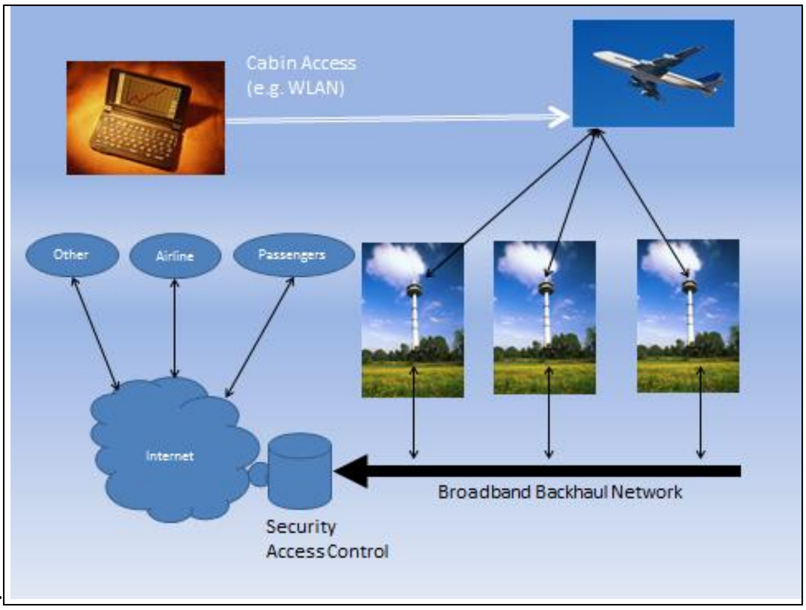
This broadband DA2GC system is a UMTS TDD system based on commercial off the shelf equipment that complies with the 3GPP Release 7 standards. A separate frequency converter is used to support operation in the 5 855-5 875 MHz band although operation in other bands has been demonstrated. Signal-in-space characteristics conform to these standards apart from the operating frequency band, Doppler shift compensation, and extended timing advance to accommodate increased range.

Any co-channel interference is minimised using ground station antenna control whereby sectors not required by aircraft at a given time are not illuminated. (i.e., the transmitter is inhibited).

The overall end-to-end system architecture of the broadband DA2GC system is illustrated in Figure 3.

FIGURE 3

System architecture for the broadband DA2GC system as described in ETSI TR 103 108



The major building blocks of the end-to-end system architecture, similar to those described in section 2.1, include flight deck and cabin WLAN access, dedicated air/ground IP backhaul and a network control function providing, among other things, security.

4.2 Spectrum needs

The system can use switch-selectable bandwidths of 5 or 10 MHz. Although single channel operation is possible, the use of additional channels reduces potential inter-cell interference and also any interference to other systems.

The required spectrum is 20 MHz candidate band thereby enabling 2 x 10 MHz or 4 x 5 MHz channels. The system does not require contiguous spectrum.

4.3 Test flights

A series of test flights using 3G technology have been completed using two turbojet aircraft types. These demonstrated a robust air-to-ground link in different spectrum bands, namely VHF (aeronautical communications), 2 GHz and 5 GHz. Live video from the flight deck and cabin was transmitted to the ground. Simultaneously an international voice call was made by one passenger while another browsed the internet and watched a streaming video from a ground server. Ranges in excess of 250 km were achieved which is operationally important to maintain coverage over, for example, the Mediterranean Sea.

For certain 5 GHz flights, a modified aircraft marker antenna was used. This included two 5 GHz antenna elements in addition to the marker element itself. This new antenna had the same form and fit as the original, thereby simplifying installation.

ANNEX 2

System for public communications with aircraft in some countries in Region 2

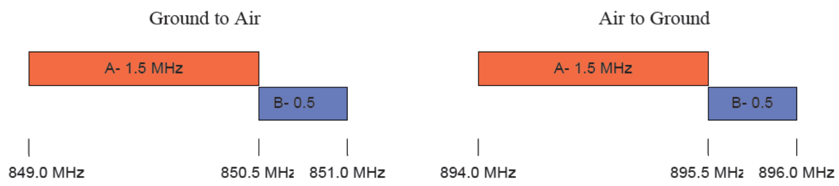
1 System for public communications with aircraft in Canada and United States

In Canada[1] and the United States[2], the band pair 849-851 MHz and 894-896 MHz is allocated to the aeronautical mobile service for public correspondence with aircraft. These bands are designated for paired nationwide exclusive assignment to the licensee or licensees of systems providing radio telecommunications service, including voice telephony, broadband Internet and data transmission service, to persons on-board aircraft. However, fixed services and ancillary land mobile services are not permitted.

In Canada and the United States, the band plan, described below in Figure 1, is based on two block pairs: 849-850.5/894-895.5 MHz and 850.5-851/895.5-896 MHz. The band 849-851 MHz is limited to transmissions from ground stations and the use of the band 894-896 MHz is limited to transmissions from airborne stations.

FIGURE 1

The band plan for aeronautical mobile service in Canada and the United States



The technical rules for certification and systems deployment in the band in the United States and Canada are technology neutral. The maximum ERP limits for ground stations and airborne stations are as follows:

Ground station	500 W ERP
Airborne station	12 W ERP

[1] Refer to http://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf09134.html.

[2] Refer to: http://www.gpo.gov/fdsys/pkg/CFR-2010-title47-vol2/pdf/CFR-2010-title47-vol2-part22-subpartG-subjectgroup-id140.pdf

In the United States, the air-to-ground radiotelephone service falls under the U.S. Federal Communications (FCC) Part 22 rules, Subpart G. Commercial aviation air-ground systems may use any type of emission or technology that complies with these technical rules.

2 Safety-of-flight considerations

In addition to the administrations rules governing air-to-ground services, national aviation administration and aircraft operator rules and policies restrict the use of personal electronic devices (PEDs) on aircraft. The use of PEDs, which include wireless telephones, pagers, personal digital assistants, portable music players, video games and laptop computers, remains subject to national aviation administration and aircraft operator authority over in-flight safety. Providers of in-flight wireless broadband and other communications services for transmission using the air-to-ground frequencies must coordinate with airlines and comply with any national administration rules in order to offer such services. Aircraft operators undertake extensive testing and adhere to stringent safety certification protocols when installing and operating communications equipment to ensure that all avionics systems are protected from interference in accordance with national administration rules.

3 An example commercial aviation air-to-ground system operating in the United States consistent with IMT-2000 CDMA multi-carrier as described in Recommendation ITU-R M.1457

3.1 Introduction

This air-to-ground system is currently deployed and operational in continental United States and part of Alaska[3]. It operates in the 849-850.5 MHz and 894-895.5 MHz bands and offers in-flight broadband services to all Wi-Fi enabled laptops, notebooks and smartphones. It uses a modified version of the IMT-2000 CDMA[4] Multi-Carrier network to provide a high-speed connection directly from the aircraft to the ground. Some of the characteristics features of this network are: high capacity of 300 kbps to 500 kbps with peak rates of 3.1 Mbps, very large cell size (up to 400 km radius), modifications made to the IMT-2000 CDMA Multi-Carrier1xEV-DO air interface to accommodate extended cell coverage and airplane speed, deployment using off the shelf components such as Radio Access Networks (RANs) and Radio Network Controllers (RNCs).

3.2 System architecture

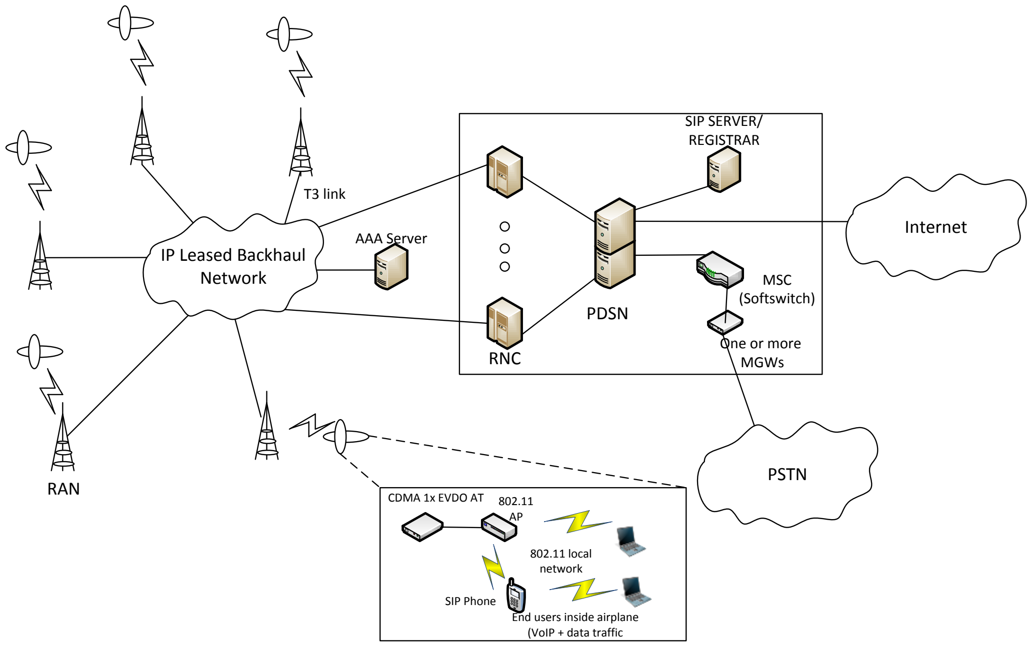
The overall end-to-end system architecture of this air-to-ground system is illustrated in Figure 2.

[3] http://www.gogoair.com/gogo/cms/work.do

[4] CDMA2000 High Rate Packet Data Interface Specifications, 3GPP2 C.S0024-A Version 1.0, March

FIGURE 2

IMT-2000 CDMA multi-carrier air-to-ground system network architecture



Each Radio Access Network (RAN) supports 1 carrier and 6 sectors. Each sector can generate about 2.2 Mbps peak throughput. The end users inside the airplane are on a local 802.11 access network connected to an access point (AP). The AP is connected to a 1x EV-DO card, which is the access terminal (AT) for the 1xEV-DO network and a point-to-point protocol (PPP) session is setup between the AT and the PDSN. In addition to data, VoIP can be supported as well. A cabin 2G/3G Picocell can be deployed to allow passengers place and receive voice calls on their own personal cellular phones. The authentication, authorization and accounting (AAA) server, one or more RNCs, packet data serving node (PDSN), media gateways (MGW), Softswitch which controls the MGWs, SIP Server/Registrar can all be co-located in one location.

3.3 Modifications to the IMT-2000 CDMA multi-carrier air-interface

The following sections describe the various enhancements made to the IMT-2000 CDMA multi-carrier 1xEV-DO air interface in order to enable its application as a viable air interface technology for air-to-ground communication.

3.3.1 Expanded range of Doppler shifts

Airplanes travel at speeds far greater than is usual for the operation of cellular mobile units, including high speed trains. For the worst case orientation of a plane traveling at 340 m/s and at a carrier frequency of 850 MHz, the Doppler frequency shift seen by the airborne access terminal is approximately 964 Hz. When the terminal transmits, the Doppler shift perceived by the base station is approximately doubled to 1 928 Hz. The different searching operations at both the base station and the access terminal needed to be modified to accommodate the extended range of the observed Doppler shifts.

At the base station, the access channel searching algorithm is extended to additional frequency bins that cover the expected Doppler range of the airborne system. Furthermore, in case of handoff searching, when a sector gets added to the access terminal's (AT) active set, the newly added sector needs to search and start demodulating the AT's signal. However, the newly added sector may not be managed by the same base station that was already demodulating the access terminal, and hence the new base station needs to perform the same search procedure that is used for the access channel. When the access terminal tracks one sector and monitors other sectors for handoff, there could be a frequency offset differential due to different Doppler shifts between the serving sector and the candidate sectors. This means that there is an underestimation of the true SINR of the candidate pilot, because the SINR estimator suffers from phase coherence loss due to frequency error. SINR estimation for non-serving sectors needs to be compensated using estimates of Doppler frequency shifts.

3.3.2 Expanded cell radius

The airborne system supports cell radii of up to 400 km. The cell radii for a typical terrestrially-based cellular system are in the order of a few kilometers. In order to cope with large cells, modifications to the baseline reverse link demodulation algorithms are needed. A larger traffic search window is required to search for multipath components, and the multipath search window is extended to 256 chips. The reasoning for this is that the existence of strong multipath components are much more unlikely in the airborne system than in typical terrestrial cellular systems due to radio propagation conditions. Nevertheless, if a signal multipath component were to exist, then the lag difference between the main line-of-sight path and the multipath will most likely be much greater than the few chips (normally less than 10) that is typical in terrestrial communications. For this reason the search window sizes should be extended to 256 chips, corresponding to ~64 kilometers. Furthermore, due to larger cell radii as compared to the conventional terrestrial cellular systems, a much bigger access channel search window is required. If the cell radius is assumed to be R km, then the maximum possible time of arrival difference between two airplanes inside the cell (measured in chips) is given by the following equation.

$$\Delta = 2R * 10^3 \frac{1.2288 * 10^6}{c}$$

where c is the speed of light in m/s. For R=400 km we obtain $\Delta \sim 3\,333$ chips. This quantity is how large the total access channel search window needs to be.

Changes to some search parameters are also needed on the AT side to support large cell radii. In order for the AT to find neighboring sectors and correctly perform active and candidate set management, the neighbor search windows have to be increased. This is because with large cell radii, the differential delay between the serving sector and transmissions from candidate sectors can be quite large. Given the geometry of the network, it should be sufficient for the neighbor search windows to be expanded by a factor of 8, and this can be accomplished by reinterpreting the search window size field in the neighbor list message (section 9.7.6.2.5 in [1]).

Additional changes need to be made for increasing the data rate control (DRC) length. In the IMT-2000 CDMA multi-carrier 1xEV-DO system, the access terminal continuously send their desired forward link data rate on the DRC to the base station. The DRC word can extend 1, 2, 4 or 8 reverse link slots. Right after the access terminal has finished sending a given DRC, it expects that the next forward link slot directed to it will be encoded according to its last DRC request.

The reverse link timing of the DRC channel is advanced by one-half slot with respect to the forward link timing for the base station to allow the base station enough time to process the last DRC sent by each AT. This 1 024-chip budget is more than enough for regular terrestrial communications since the cell radii are of the order of a few km. However, for the airborne system, this is insufficient since the one-way propagation delay to the edge of a base station covering 250 km is already around 1 024 chips. The solution lies in choosing a long DRC length and, at the base station side, decoding the DRC word before the whole length of it has been received.

3.3.3 Handoff

The IMT-2000 CDMA Multi-Carrier 1xEV-DO airborne system uses multiple transmit and receive antennas on the access terminal side. The system uses four antennas, two sets of cross-polarization pairs. The access terminal has two antenna ports and a switch matrix to control multiplexing of the four antenna inputs into the two antenna ports on the access terminal. To provide spatial diversity in demodulation of the serving sector, the system combines the two antenna inputs belonging to the best or strongest polarization. Occasionally, the access terminal needs to search other antenna ports for possible transmissions from other sectors. To do so without breaking the connection to the serving sector, the access terminal effectively switches to single antenna demodulation. At the same time, the antenna port connected to the antenna with weaker input is switched to other antenna inputs to search for pilot transmissions from sectors on the AT’s neighbor list. When this brief search is done, the AT resumes dual antenna demodulation.

The purpose of the the IMT-2000 CDMA multi-carrier 1xEV-DO airborne system handoff procedure is to ensure that the access terminal is communicating with the access network (AN) through the best or strongest serving sector while using its best polarization pair of antennas for forward link demodulation. At the same time, the access terminal should transmit on the reverse link using its best antenna in orientation and polarization. The complexities of the airborne handoff procedure arise from the fact that as the serving sector changes, so does the concept of best antennas on the forward and reverse links.

4 System for general aviation air-to-ground radiotelephone within the United States of America

4.1 General aviation air-to-ground radiotelephone service

This service operates in the 454-459 MHz band and can provide a variety of telecommunications services to private aircraft such as small single engine planes and corporate jets. CFR47 § 22.805 contains the channel allocations for the general aviation air-to-ground service. These channels have a bandwidth of 20 kHz and are designated by their center frequencies in megahertz.

TABLE 1

Signalling channel pair for general aviation air-ground systems

Ground	Airborne mobile
454.675	459.675

Communication channel pairs

Ground	Airborne mobile
454.700	459.700
454.725	459.725
454.750	459.750
454.775	459.775
454.800	459.800
454.825	459.825
454.850	459.850
454.875	459.875
454.900	459.900
454.925	459.925
454.950	459.950
454.975	459.975

Notes on Table 1:

a) Channel 454.675 MHz is assigned to each and every ground station, to be used only for automatically alerting airborne mobile stations of incoming calls.

b) All airborne mobile channels are assigned for use by each and every airborne mobile station.

The transmitting power of ground and airborne mobile transmitters operating in the general aviation air-ground radiotelephone service on the channels listed in CFR47 § 22.805 must not exceed:

a) *Ground station transmitters.* The effective radiated power of ground stations must not exceed 100 Watts and must not be less than 50 Watts, except as provided in CFR47 § 2.811.

b) *Airborne mobile transmitters.* The transmitter power output of airborne mobile transmitters must not exceed 25 Watts and must not be less than 4 Watts.

ANNEX 3

System for public communications with aircraft in some countries in Region 3[5]

1 Introduction

To meet the growing demand of the current and future airborne broadband communication, China has made significant effort on planning, developing, and deploying the air-to-ground (ATG) communication systems with aircraft. The system is based on the SCDMA broadband wireless access standard in Recommendation ITU-R M.1801. The SCDMA ATG wireless broadband access system contains base stations and terminals. The base stations deployed to cover the entire flight course and communicate with the airborne terminals to achieve broadband communication between the ground and airplanes. The prototype systems have been successfully tested in trial flights at the frequency range of 1.785-1.805 GHz. The system's ATG broadband communication capability has been successfully tested in China.

2 Operational features

The system operational features are as follows:

– Automatically connecting to the terrestrial broadband wireless network to provide air-to-ground communications.
– Supporting the voice, trunked voice and broadband data communication services such as providing backhaul of the on-board WiFi, cellular pico-cells, and on-board wireline voice calls and Internet access.
– Supporting the seamless communication roaming and handoff on the complete flight course.

3 System architecture

The basic system architecture is shown in Figure 1.

The system functions are as follows:

– The system includes base stations (BTS) on the ground connected to PTSN, Internet and airborne terminals with interfaces to other on-board devices such as wireline hubs, WiFi routers, pico-cells, among others.
– The radio access layer provides the radio access functions between the BTS and airborne terminals. The radio access layer performs basic radio access functions such random access, paging, voice communications, data communications and trunked voice functions.

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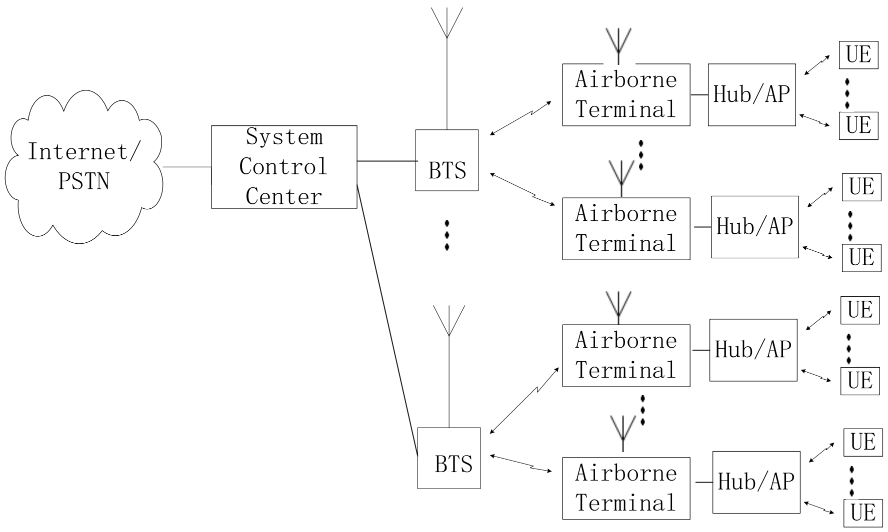
5 APT has developed a guideline on the maximum permitted power for cellular base stations onboard aircraft. See APT/AWF/OP-02(Rev. 2): APT Guideline on "Technical conditions for the use of mobile phones on-board aircraft".

– The core control layer provides the control functions, such as handoff, roaming, terminal and user authentication, voice call switching, and data routing. It is between the BTS and other core network equipment such as data switches and routers, soft switches, media gateways, AAA (Authentication, Authorization, and Accounting) servers, billing servers, and HLR (Home Location Register).

– This entire ATG communication network including all layers supports separation of different data flows and also provides adequate protection on the data.

FIGURE 1

System architecture



4 Channelization scenario

The SCDMA radio interface supports a channel bandwidth of a multiple of 1 MHz up to 5 MHz. Subchannelization and code spread, specially defined inside each 1 MHz bandwidth, provides frequency diversity and interference observation capability for radio resource assignment with bandwidth granularity of 8 kbit/s. The channelization also allows coordinated dynamic channel allocations among cells to efficiently avoid mutual interference. The system employs TDD to separate uplink and downlink transmission.

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Preliminary draft revision of RECOMMENDATION ITU-R M.1450-4
Characteristics of broadband radio local area networks

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Working Party 5A
(Drafting Group 5A2-2)

PRELIMINARY DRAFT REVISION OF RECOMMENDATION ITU-R M.1450-4

Characteristics of broadband radio local area networks

(Questions ITU-R 212/5 and ITU-R 238/5)

Summary of the revision

~~[TBD]~~In this revision:

- information related to standards already referenced in the current Recommendation has been updated;
- four new standards IEEE 802.11ac, IEEE 802.11ad, EN 301 893 and EN 302 567 and relevant information (technical parameters and spectrum masks) have been introduced;
- and updated information with regard to European implementation of the band 57-66 GHz has been introduced.

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Scope

This Recommendation provides the characteristics of broadband radio local area networks (RLANs) including technical parameters, and information on RLAN standards and operational characteristics. Basic characteristics of broadband RLANs and general guidance for their system design are also addressed.

The ITU Radiocommunication Assembly,

considering

a) that broadband radio local area networks (RLANs) are widely used for fixed, semi-fixed (transportable) and portable computer equipment for a variety of broadband applications;

b) that broadband RLANs are used for fixed, nomadic and mobile wireless access applications;

c) that broadband RLAN standards currently being developed are compatible with current wired LAN standards;

d) that it is desirable to establish guidelines for broadband RLANs in various frequency bands;

e) that broadband RLANs should be implemented with careful consideration to compatibility with other radio applications,

noting

a) that Report ITU-R F.2086 provides technical and operational characteristics and applications of broadband wireless access systems (WAS) in the fixed service;

b) that other information on broadband WAS, including RLANs, is contained in Recommendations ITU-R F.1763, ITU-R M.1652, ITU-R M.1739 and ITU-R M.1801,

recommends

1 that the broadband RLAN standards in Table 2 should be used (see also Notes 1, 2 and 3);

2 that Annex 2 should be used for general information on RLANs, including their basic characteristics;

3 that the following Notes should be regarded as part of this Recommendation.

NOTE 1 – Acronyms and terminology used in this Recommendation are given in Table 1.

NOTE 2 – Annex 1 provides detailed information on how to obtain complete standards described in Table 2.

NOTE 3 – This Recommendation does not exclude the implementation of other RLAN systems.

TABLE 1

Acronyms and terms used in this Recommendation

Access method	Scheme used to provide multiple access to a channel
AP	Access point
ARIB	Association of Radio Industries and Businesses
ATM	Asynchronous transfer mode
Bit rate	The rate of transfer of a bit of information from one network device to another
BPSK	Binary phase-shift keying
BRAN	Broadband Radio Access Networks (A technical committee of ETSI)
Channelization	Bandwidth of each channel and number of channels that can be contained in the RF bandwidth allocation
Channel Indexing	The frequency difference between adjacent channel center frequencies
CSMA/CA	Carrier sensing multiple access with collision avoidance
DAA	Detect And Avoid
DFS	Dynamic frequency selection
DSSS	Direct sequence spread spectrum
e.i.r.p.	Equivalent isotropically radiated power
ETSI	European Telecommunications Standards Institute
Frequency band	Nominal operating spectrum of operation

FHSS	Frequency Hopping Spread Spectrum
HIPERLAN2	High performance radio LAN 2
HiSWANa	High speed wireless access network – type a
HSWA	High speed wireless access
IEEE	Institute of Electrical and Electronics Engineers
IETF	Internet Engineering Task Force
LAN	Local area network
LBT	Listen before talk
MU	Medium Utilisation
MMAC	Multimedia mobile access communication
Modulation	The method used to put information onto an RF carrier
MIMO	Multiple input multiple output
OFDM	Orthogonal frequency division multiplexing
PSD	Power spectral density
PSTN	Public switched telephone network
QAM	Quadrature amplitude modulation
QoS	Quality of Service
QPSK	Quaternary phase-shift keying
RF	Radio frequency
RLAN	Radio local area network
SSMA	Spread spectrum multiple access
Tx power	Transmitter power – RF power in Watts produced by the transmitter
TCP	Transmission control protocol
TDD	Time division duplex
TDMA	Time-division multiple access
TPC	Transmit power control
WATM	Wireless asynchronous transfer mode

TABLE 2

Characteristics including technical parameters associated with broadband RLAN standards

Characteristics	IEEE Std 802.11-2012~~07~~ (Clause 1~~5~~7, commonly known as 802.11b)	IEEE Std 802.11-2012~~07~~ (Clause 18~~7~~, commonly known as 802.11a(1))	IEEE Std 802.11-2012~~07~~ (Clause 19~~8~~, commonly known as 802.11g(1))	IEEE Std 802.11-2012~~07~~ (Clause 18~~9~~~~7~~, Annex ~~I~~ D and Annex ~~J~~E, commonly known as 802.11j)	IEEE Std 802.11~~n-2009~~-2012 (Clause 20, commonly known as 802.11n)	IEEE P802.11ac	IEEE Std 802.11ad-2012	ETSI EN 300 328	ETSI ~~BRAN HIPERLAN2~~ EN 301 893 ~~(1), (2)~~	ARIB HiSWANa, (1)	ETSI EN 302 567
Access method	**CSMA/CA, SSMA**	**CSMA/CA**					**Scheduled, CSMA/CA**		**TDMA/TDD**		
Modulation	CCK (8 complex chip spreading)	64-QAM-OFDM 16-QAM-OFDM QPSK-OFDM BPSK-OFDM 52 subcarriers (see Fig. 1)	DSSS/CCK OFDM PBCC DSSS-OFDM	64-QAM-OFDM 16-QAM-OFDM QPSK-OFDM BPSK-OFDM 52 subcarriers (see Fig. 1)	64-QAM-OFDM 16-QAM-OFDM QPSK-OFDM BPSK-OFDM 56 subcarriers in 20 MHz 114 subcarriers in 40 MHz MIMO, 1 – 4 spatial streams	256-QAM-OFDM 64-QAM-OFDM 16-QAM-OFDM QPSK-OFDM BPSK-OFDM 56 subcarriers in 20 MHz 114 subcarriers in 40 MHz 242 subcarriers in 80 MHz 484 subcarriers in 160 MHz and 80+80 MHz MIMO, 1-8 spatial streams	Single Carrier: DPSK, π/2-BPSK, π/2-QPSK, π/2-16QAM OFDM : 64-QAM, 16-QAM, QPSK, SQPSK 352 subcarriers	No restriction on the type of modulation ~~OFDM~~	64-QAM-OFDM 16-QAM-OFDM QPSK-OFDM BPSK-OFDM 52 subcarriers (see Fig. 1)		

Data rate	1, 2, 5.5 and 11 Mbit/s	6, 9, 12, 18, 24, 36, 48 and 54 Mbit/s	1, 2, 5.5, 6, 9, 11, 12, 18, 22, 24, 33, 36, 48 and 54 Mbit/s	3, 4.5, 6, 9, 12, 18, 24 and 27 Mbit/s for 10 MHz channel spacing 6, 9, 12, 18, 24, 36, 48 and 54 Mbit/s for 20 MHz channel spacing	From 6.5 to 288.9 Mbit/s for 20 MHz channel spacing From 6 to 600 Mbit/s for 40 MHz channel spacing	From 6.5 to 693.3 Mbit/s for 20 MHz channel spacing From 13.5 to 1 600 Mbit/s for 40 MHz channel spacing From 29.3 to 3 466.7 Mbit/s for 80 MHz channel spacing From 58.5 to 6 933.3 Mbit/s for 160 MHz and 80+80 MHz channel spacing			6, 9, 12, 18, 27, 36 and 54 Mbit/s		
Frequency band	2 400-2 483.5 MHz	5 150-5 250 MHz(5) 5 250-5 350 MHz(4) 5 470-5 725 MHz(4) 5 725-5 825 MHz	2 400-2 483.5 MHz	~~4 900~~4 940-~~5 000~~4 990 MHz(3) 5 030-5 091 MHz(3) 5 150-5 250 MHz(5) 5 250-5 350 MHz(4) 5 470-5 725 MHz(4) 5 725-5 825 MHz	2 400-2 483,5 MHz 5 150-5 250 MHz(5) 5 250-5 350 MHz(4) 5 470-5 725 MHz(4) 5 725-5 825 MHz	5 150-5 250 MHz(5) 5 250-5 350 MHz(4) 5 470-5 725 MHz(4) 5 725-5 825 MHz	57-66 GHz	2 400-2 483.5 MHz	5 150-5 350(5) and 5 470-5 725 MHz(4)	4 900 to 5 000 MHz(3) 5 150 to 5 250 MHz (5)	57-66 GHz
~~Channelization~~ Channel indexing	5 MHz				5 MHz in 2.4 GHz 20 MHz in 5 GHz	20 MHz	2 160 MHz		20 MHz	20 MHz channel spacing 4 channels in 100 MHz	
Spectrum mask	802.11b mask (Fig. 4)	OFDM mask (Fig. 1)			OFDM mask (Fig. 2A, 2B for 20 MHz and Fig. 3A, 3B for 40 MHz)	OFDM mask (Fig. 2B for 20 MHz, Fig. 3B for 40 MHz, Fig. 3C for 80 MHz, Fig. 3D for 160 MHz, and Fig. 3E for 80+80 MHz)	802.11ad mask (Fig. 5)		~~OFDM mask~~ ~~(~~Fig. 1x~~)~~	OFDM mask (Fig. 1)	

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TABLE 2 (*end*)

Characteristics	IEEE Std 802.11-2012 (Clause 17, commonly known as 802.11b) ~~IEEE Std 802.11-2007 (Clause 15, commonly known as 802.11b)~~	IEEE Std 802.11-2012 (Clause 18, commonly known as 802.11a[(1)]) ~~IEEE Std 802.11-2007 (Clause 17, commonly known as 802.11a[(1)])~~	IEEE Std 802.11-2012 (Clause 19, commonly known as 802.11g[(1)]) ~~IEEE Std 802.11-2007 (Clause 18, commonly known as 802.11g[(1)])~~	IEEE Std 802.11-2012 (Clause 19, Annex D and Annex E, commonly known as 802.11j) ~~IEEE Std 802.11-2007 (Clause 17, Annex I and Annex J, commonly known as 802.11j)~~	IEEE Std 802.11-2012 (Clause 20, commonly known as 802.11n) ~~IEEE Std 802.11n-2009 (Clause 20)~~	IEEE P802.11ac	IEEE Std 802.11ad-2012	EN 300 328	~~BRAN HIPERLAN2 (~~EN 301 893 ~~1), (2)~~	ARIB HiSWANa, [(1)]	ETSI EN 302 567
Transmitter											
Interference mitigation	**LBT**	**LBT/DFS/TPC**	**LBT**		**LBT/DFS/TPC**		**LBT**	**DAA/LBT, DAA/non-LBT, MU**	**LBT/DFS/TPC**	**LBT**	
Receiver											
Sensitivity	**Listed in Standard**										

(1) Parameters for the physical layer are common between IEEE 802.11a ~~and ETSI BRAN HIPERLAN2~~ and ARIB HiSWANa.

~~(2) WATM (Wireless ATM) and advanced IP with QoS are intended for use over ETSI BRAN HIPERLAN2 physical transport.~~

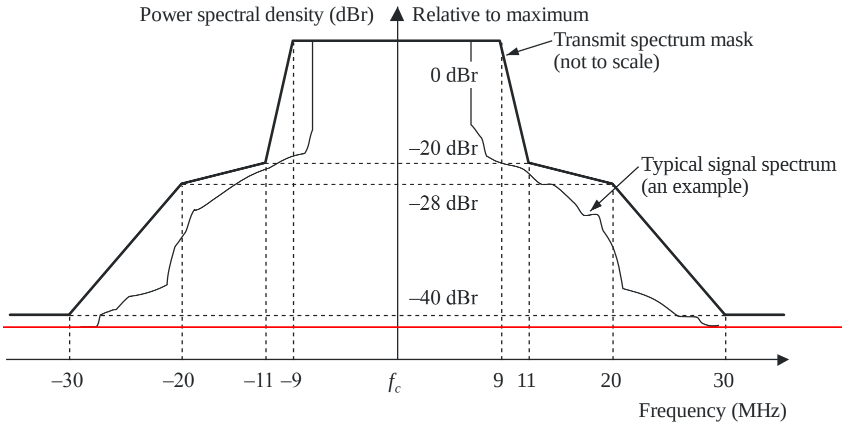
(3) See 802.11j-2004 and JAPAN MIC ordinance for Regulating Radio Equipment, Articles 49-20 and 49-21.

(4) DFS rules apply in the 5 250-5 350 and 5 470-5 725 MHz bands in many administrations and administrations must be consulted.

(5) **Pursuant to Resolution 229 (WRC-03), operation in the 5 150-5 250 MHz band is limited to indoor use.**

FIGURE 1

OFDM transmit spectrum mask for 802.11a, 11g, 11j, ~~HIPERLAN2~~ and HiSWANa systems



Note 1 – The outer heavy line is the spectrum mask for 802.11a, 11g, 11j, HiSWANa and the inner thin line is the envelope spectrum of OFDM signals with 52 subcarriers.

Note 2 – The measurements shall be made using a 100 kHz resolution bandwidth and a 30 kHz video bandwidth.

Note 3 – In the case of the 10 MHz channel spacing in 802.11j, the frequency scale shall be half.

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FIGURE 1X

Transmit spectrum mask for EN 301 893

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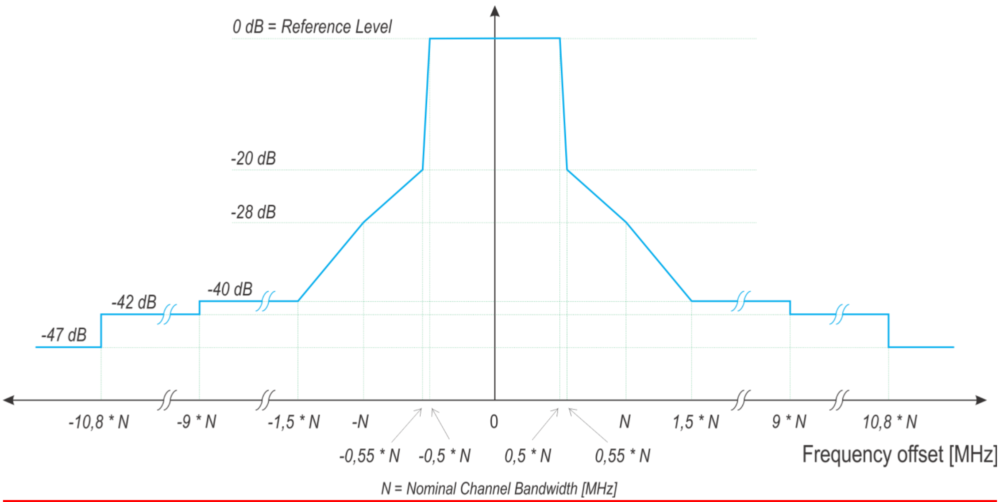
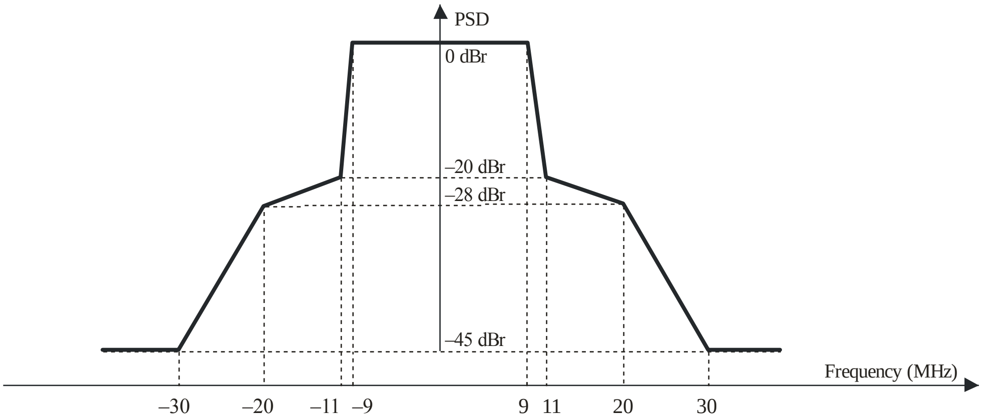


NOTE - dBc is the spectral density relative to the maximum spectral power density of the transmitted signal.

FIGURE 2a

Transmit spectral mask for 20 MHz 802.11n transmission in 2.4 GHz band



Note 1 – Maximum of –45 dBr and –53 dBm/MHz at 30 MHz frequency offset and above.

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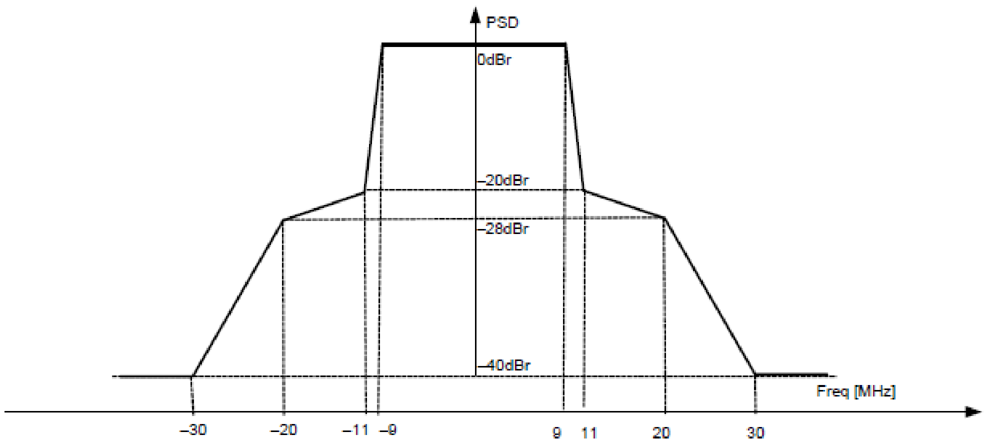
FIGURE 2b

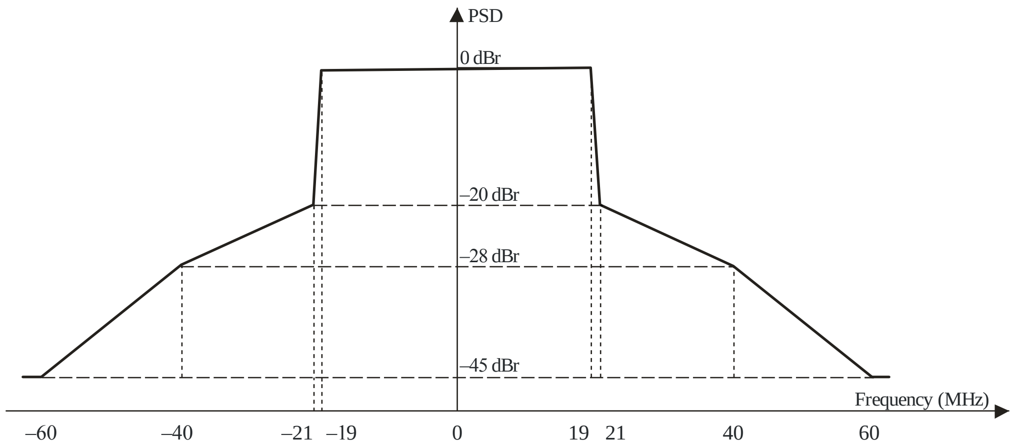
Transmit spectral mask for a 20 MHz 802.11n transmission in 5 GHz band and ~~interim~~ transmit spectral mask for 802.11ac



NOTE 1 – For 802.11n, the maximum of –40 dBr and –53 dBm/MHz at 30 MHz frequency offset and above. For 802.11ac, the transmit spectrum shall not exceed the maximum of the ~~interim~~ transmit spectral mask and –53 dBm/MHz at any frequency offset.

FIGURE 3a

Transmit spectral mask for a 40 MHz 802.11n channel in 2.4 GHz band



Note 1 – Maximum of –45 dBr and –56 dBm/MHz at 60 MHz frequency offset and above.

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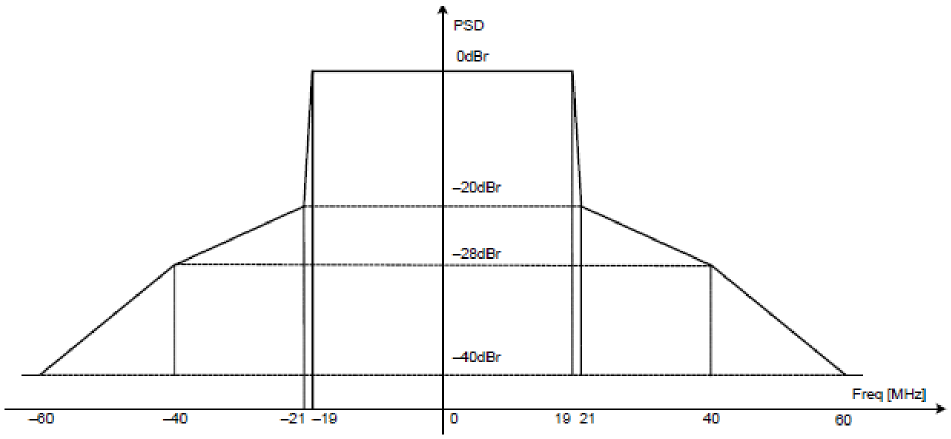
FIGURE 3b

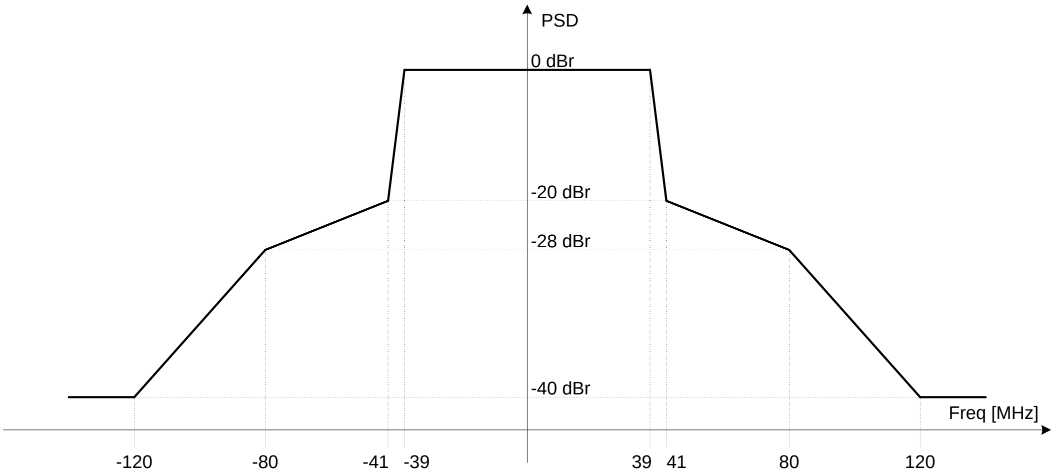
Transmit spectral mask for a 40 MHz 802.11n channel in 5 GHz band and ~~interim~~ transmit spectral mask for 802.11ac



NOTE 1 – For 802.11n, maximum of –40 dBr and –56 dBm/MHz at 60 MHz frequency offset and above. For 802.11ac, the transmit spectrum shall not exceed the maximum of the ~~interim~~ transmit spectral mask and –56 dBm/MHz at any frequency offset.

FIGURE 3c

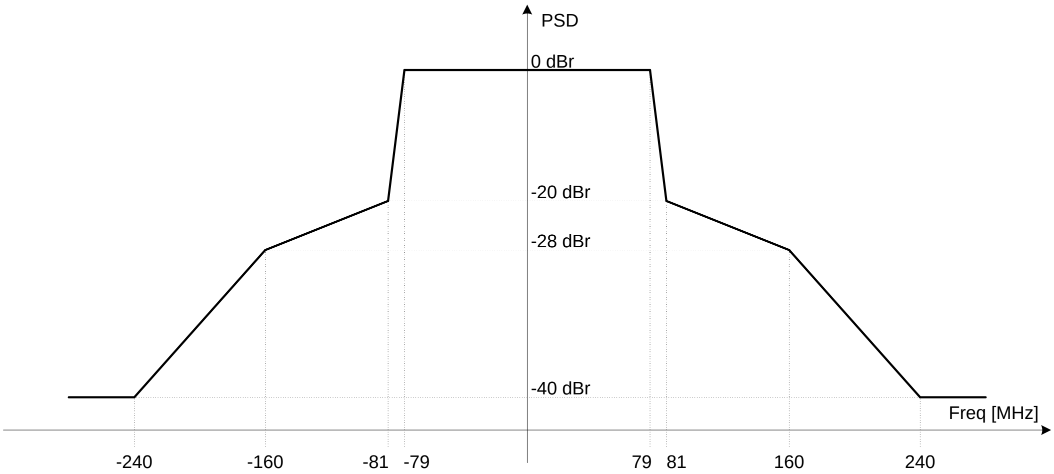
~~Interim t~~Transmit spectral mask for a 80 MHz 802.11ac channel



NOTE 1 – The transmit spectrum shall not exceed the maximum of the ~~interim~~ transmit spectral mask and –59 dBm/MHz at any frequency offset.

FIGURE 3d

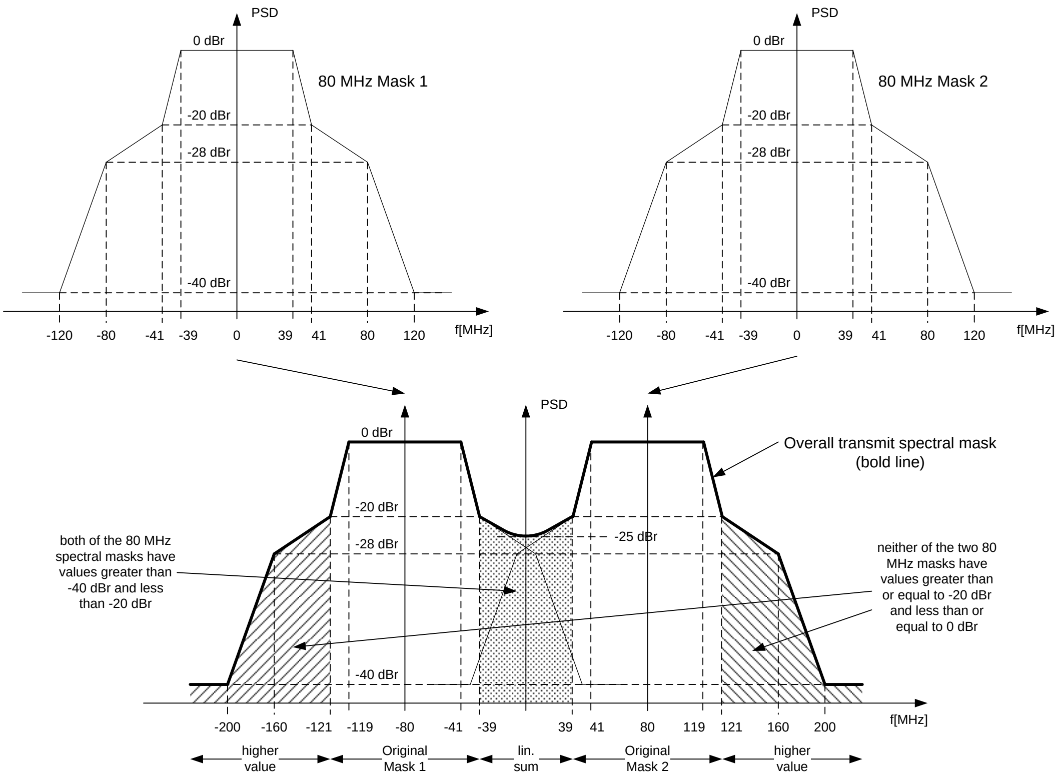
~~Interim t~~Transmit spectral mask for a 160 MHz 802.11ac channel



NOTE 1 – The transmit spectrum shall not exceed the maximum of the ~~interim~~ transmit spectral mask and –59 dBm/MHz at any frequency offset.

FIGURE 3e

~~Interim t~~Transmit spectral mask for a 80+80 MHz 802.11ac channel



NOTE 1 – The transmit spectrum shall not exceed the maximum of the ~~interim~~ transmit spectral mask and –59 dBm/MHz at any frequency offset.

FIGURE 4

Transmit spectrum mask for 802.11b

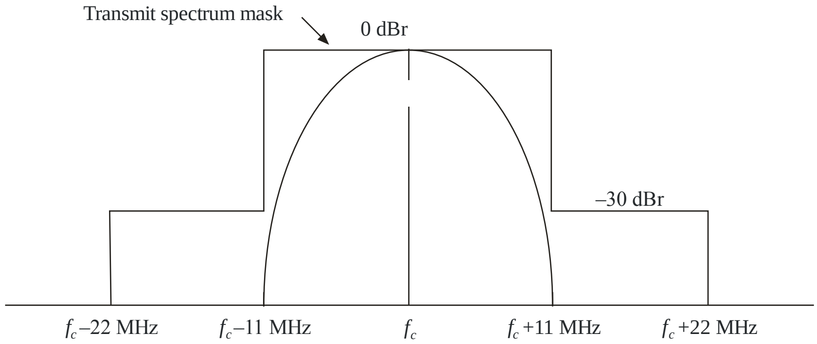


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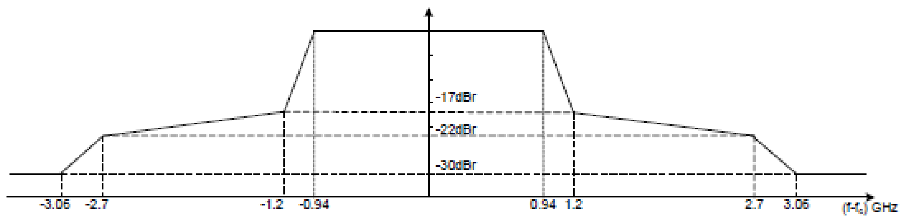
FIGURE 5

Transmit spectrum mask for 802.11ad



ANNEX 1

Obtaining additional information on RLAN standards

The ETSI EN 300 328, EN 301 893 and EN 302 567 standards can be downloaded from http://pda.etsi.org/pda/queryform.asp. In addition to these standards, the Hiperlan type 2 standards can still be downloaded from the above link

HIPERLAN2 standards are TS 101 475 for the physical layer and TS 101 761-1 to TS 101 761-5 for the DLC layer, and these can be downloaded from the ETSI Publications Download Area at: http://www.etsi.org/services_products/freestandard/home.htm.

The IEEE 802.11 standards can be downloaded from: http://standards.ieee.org/getieee802/index.html.

IEEE 802.11 has developed a set of standards for RLANs, IEEE Std 802.11 – 201207, which has been harmonized with IEC/ISO[1]. The medium access control (MAC) and physical characteristics for wireless local area networks (LANs) are specified in ISO/IEC 8802-11:2005, which is part of a series of standards for local and metropolitan area networks. The medium access control unit in ISO/IEC 8802-11:2005 is designed to support physical layer units as they may be adopted dependent on the availability of spectrum. ISO/IEC 8802-11:2005 contains five physical layer units: four radio units, operating in the 2 400-2 500 MHz band and in the bands comprising 5 150-5 250 MHz, 5 250-5 350 MHz, 5 470-5 725 MHz, and 5 725-5 825 MHz, and one baseband infrared (IR) unit. One radio unit employs the frequency-hopping spread spectrum (FHSS) technique, two employ the direct sequence spread spectrum (DSSS) technique, and another employs the orthogonal frequency division multiplexing (OFDM) technique, and another employs multiple input multiple output (MIMO) technique.

[1] ISO/IEC 8802-11:2005, Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications.

ANNEX 2

**Basic characteristics of broadband RLANs
and general guidance for deployment**

1 Introduction

Broadband RLAN standards have been designed to allow compatibility with wired LANs such as IEEE 802.3, 10BASE-T, 100BASE-T and 51.2 Mbit/s ATM at comparable data rates.
Some broadband RLANs have been developed to be compatible with current wired LANs and are intended to function as a wireless extension of wired LANs using TCP/IP and ATM protocols. Recent spectrum allocations by some administrations promote development of broadband RLANs. This allows applications such as audio/video streaming to be supported with high QoS.

Portability is a feature provided by broadband RLANs but not wired LANs. New laptop and palmtop computers are portable and have the ability, when connected to a wired LAN, to provide interactive services. However, when they are connected to wired LANs they are no longer portable. Broadband RLANs allow portable computing devices to remain portable and operate at maximum potential.

Private on-premise, computer networks are not covered by traditional definitions of fixed and mobile wireless access and should be considered. The nomadic users are no longer bound to a desk. Instead, they are able to carry their computing devices with them and maintain contact with the wired LAN in a facility. In addition, mobile devices such as cellular telephones are beginning to incorporate the ability to connect to wireless LANs when available to supplement traditional cellular networks.

Speeds of notebook computers and hand-held computing devices continue to increase. Many of these devices are able to provide interactive communications between users on a wired network but sacrifice portability when connected. Multimedia applications and services require broadband communications facilities not only for wired terminals but also for portable and personal communications devices. Wired local area network standards, i.e. IEEE 802.3ab 1000BASE-T, are able to transport high rate, multimedia applications. To maintain portability, future wireless LANs will need to transport higher data rates. Broadband RLANs are generally interpreted as those that can provide data throughput greater than 10 Mbit/s.

2 Mobility

Broadband RLANs may be either pseudo fixed as in the case of a desktop computer that may be transported from place to place or portable as in the case of a laptop or palmtop devices working on batteries or cellular telephones with integrated wireless LAN connectivity. Relative velocity between these devices and an RLAN wireless access point remains low. In warehousing applications, RLANs may be used to maintain contact with lift trucks at speeds of up to 6 m/s. RLAN devices are generally not designed to be used at automotive or higher speeds.

3 Operational environment and considerations of interface

Broadband RLANs are predominantly deployed inside buildings, in offices, factories, warehouses, etc. For RLAN devices deployed inside buildings, emissions are attenuated by the structure.

RLANs utilize low power levels because of the short distances inside buildings. Power spectral density requirements are based on the basic service area of a single RLAN defined by a circle with a radius from 10 to 50 m. When larger networks are required, RLANS may be logically concatenated via bridge or router function to form larger networks without increasing their composite power spectral density.

One of the most useful RLAN features is the connection of mobile computer users to a wireless LAN network. In other words, a mobile user can be connected to his own LAN subnetwork anywhere within the RLAN service area. The service area may expand to other locations under different LAN subnetworks, enhancing the mobile user's convenience.

There are several remote access network techniques to enable the RLAN service area to extend to other RLANs under different subnetworks. International Engineering Task Force (IETF) has developed a number of the protocol standards on this subject.

To achieve the coverage areas specified above, it is assumed that RLANs require a peak power spectral density of e.g. approximately 10 mW/MHz in the 5 GHz operating frequency range (see Table 3). For data transmission, some standards use higher power spectral density for initialization and control the transmit power according to evaluation of the RF link quality. This technique is referred to as transmit power control (TPC). The required power spectral density is proportional to the square of the operating frequency. The large scale, average power spectral density will be substantially lower than the peak value. RLAN devices share the frequency spectrum on a time basis. Activity ratio will vary depending on the usage, in terms of application and period of the day.

Broadband RLAN devices are normally deployed in high-density configurations and may use an etiquette such as listen before talk and dynamic channel selection (referred to here as dynamic frequency selection, DFS), TPC to facilitate spectrum sharing between devices.

4 System architecture including fixed applications

Broadband RLANs are often point-to-multipoint architecture. Point-to-multipoint applications commonly use omnidirectional, down-looking antennas. The multipoint architecture employs several system configurations:

– point-to-multipoint centralized system (multiple devices connecting to a central device or access point via a radio interface);

– point-to-multipoint non-centralized system (multiple devices communicating in a small area on an ad hoc basis);

– RLAN technology is sometimes used to implement fixed applications, which provide point-to-multipoint (P-MP) or point-to-point (P-P) links, e.g. between buildings in a campus environment. P-MP systems usually adopt cellular deployment using frequency reuse schemes similar to mobile applications. Technical examples of such schemes are given in Report ITU-R F.2086 (see § 6.6). Point-to-point systems commonly use directional antennas that allow greater distance between devices with a narrow lobe angle. This allows band sharing via channel and spatial reuse with a minimum of interference with other applications;

– RLAN technology is sometimes used for multipoint-to-multipoint (fixed and/or mobile mesh network topology, in which multiple nodes relay a message to its destination). Omnidirectional and/or directional antennas are used for links between the nodes of the mesh network. These links may use one or multiple RF channels. The mesh topology enhances the overall reliability of the network by enabling multiple redundant communications paths throughout the network. If one link fails for any reason (including the introduction of strong RF interference), the network automatically routes messages through alternate paths.

5 Interference mitigation techniques under frequency sharing environments

RLANs are generally intended to operate in unlicensed or license-exempt spectrum and must allow adjacent uncoordinated networks to coexist whilst providing high service quality to users. In the 5 GHz bands, sharing with primary services must also be possible. Whilst multiple access techniques might allow a single frequency channel to be used by several nodes, support of many users with high service quality requires that enough channels are available to ensure access to the radio resource is not limited through queuing, etc. One technique that achieves a flexible sharing of the radio resource is DFS.

In DFS all radio resources are available at all RLAN nodes. A node (usually a controller node or access point (AP)) can temporarily allocate a channel and the selection of a suitable channel is performed based on interference detected or certain quality criteria, e.g. received signal strength, *C*/*I*. To obtain relevant quality criteria both the mobile terminals and the access point make measurements at regular intervals and report this to the entity making the selection.

In the 5 250-5 350 MHz and 5 470-5 725 MHz bands, DFS must be implemented to ensure compatible operation with systems in the co-primary services, i.e. the radiolocation service.

DFS can also be implemented to ensure that all available frequency channels are utilized with equal probability. This maximizes the availability of a channel to node when it is ready to transmit, and it also ensures that the RF energy is spread uniformly over all channels when integrated over a large number of users. The latter effect facilitates sharing with other services that may be sensitive to the aggregated interference in any particular channel, such as satellite-borne receivers.

TPC is intended to reduce unnecessary device power consumption, but also aids in spectrum reuse by reducing the interference range of RLAN nodes.

6 General technical characteristics

Table 3 summarizes technical characteristics applicable to operation of RLANs in certain frequency bands and in certain geographic areas. Operation in the 5 150-5 250 MHz, 5 250-5 350 MHz and 5 470-5 725 MHz frequency bands are ~~,~~ in accordance with Resolution **229 (Rev.WRC-~~03~~12)**.

TABLE 3

General technical requirements applicable in certain administrations and/or regions ~~in the 2.4 and 5 GHz bands~~

General band designation	Administration or region	Specific frequency band (MHz)	Transmitter output power (mW) (except as noted)	Antenna gain (dBi)
2.4 GHz band	USA	2 400-2 483.5	1 000	0-6 dBi[(1)] (Omni)
	Canada	2 400-2 483.5	4 W e.i.r.p.[(2)]	N/A
	Europe	2 400-2 483.5	100 mW (e.i.r.p.)[(3)]	N/A
	Japan	2 471-2 497 2 400-2 483.5	10 mW/MHz[(4)] 10 mW/MHz[(4)]	0-6 dBi (Omni) 0-6 dBi (Omni)
5 GHz band[(5), (6)]	USA	5 150-5 250[(7)] 5 250-5 350 5 470-5 725 5 725-5 850	50 2.5 mW/MHz 250 12.5 mW/MHz 250 12.5 mW/MHz 1 000 50.1 mW/MHz	0-6 dBi[(1)] (Omni) 0-6 dBi[(1)] (Omni) 0-6 dBi[(1)] (Omni) 0-6 dBi[(8)] (Omni)
	Canada	5 150-5 250[(7)] 5 250-5 350 5 470-5 725 5 725-5 850	200 mW e.i.r.p. 10 dBm/MHz e.i.r.p. 250 12.5 mW/MHz (11 dBm/MHz) 1 000 mW e.i.r.p.[(9)] 250 12.5 mW/MHz (11 dBm/MHz) 1 000 mW e.i.r.p.[(9)] 1 000 50.1 mW/MHz[(9)]	
	Europe	5 150-5 250[(7)] 5 250-5 350[(10)] 5 470-5 725	200 mW (e.i.r.p.) 10 mW/MHz (e.i.r.p.)~~0.25 mW/25 kHz~~ 200 mW (e.i.r.p.) 10 mW/MHz (e.i.r.p.) 1 000 mW (e.i.r.p.) 50 mW/MHz (e.i.r.p.)	N/A
~~57-66 GHz~~	~~Europe~~	~~57-66 GHz~~	~~40 dBm (e.i.r.p.)[(12)]~~ ~~13 dBm/MHz (e.i.r.p)~~	~~N/A~~

TABLE 3 (*end*)

General band designation	Administration or region	Specific frequency band (MHz)	Transmitter output power (mW) (except as noted)	Antenna gain (dBi)
5 GHz band[5], [6] (*cont.*)	Japan[4]	4 900-5 000[11] 5 150-5 250[7] 5 250-5 350[10] 5 470-5 725	250 mW 50 mW/MHz 10 mW/MHz (e.i.r.p.) 10 mW/MHz (e.i.r.p.) 50 mW/MHz (e.i.r.p.)	13 N/A N/A N/A
57-66 GHz	Europe	57-66 GHz	40 dBm (e.i.r.p.)[12] 13 dBm/MHz (e.i.r.p)	N/A

(1) In the United States of America, for antenna gains greater than 6 dBi, some reduction in output power required. See sections 15.407 and 15.247 of the FCC's rules for details.

(2) Canada permits point-to-point systems in this band with e.i.r.p. > 4 W provided that the higher e.i.r.p. is achieved by employing higher gain antenna, but not higher transmitter output power.

(3) This requirement refers to ETSI EN 300 328.

(4) See Japan MIC ordinance for Regulating Radio Equipment, Articles 49-20 and 49-21 for details.

(5) Resolution 229 (WRC-03) establishes the conditions under which WAS, including RLANs, may use the 5 150-5 250 MHz, 5 250-5 350 MHz and 5 470-5 725 MHz.

(6) DFS rules apply in the 5 250-5 350 MHz and 5 470-5 725 MHz bands in regions and administrations and must be consulted.

(7) Pursuant to Resolution 229 (WRC-03), operation in the 5 150-5 250 MHz band is limited to indoor use.

(8) In the United States of America, for antenna gains greater than 6 dBi, some reduction in output power required, except for systems solely used for point-to-point. See sections 15.407 and 15.247 of the FCC's rules for details.

(9) See RSS-210, Annex 9 for the detailed rules on devices with maximum e.i.r.p. greater than 200 mW: http://strategis.ic.gc.ca/epic/site/smt-gst.nsf/en/sf01320e.html.

(10) In Europe and Japan, operation in the 5 250-5 350 MHz band is also limited to indoor use.

(11) For fixed wireless access, registered.

(12) This refers to the highest power level of the transmitter power control range during the transmission burst if transmitter power control is implemented. Fixed outdoor installations are not allowed.

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PRELIMINARY DRAFT REVISIONOF RECOMMENDATION ITU-R F.1763
Radio interface standards for broadband wireless access systems in the fixed service operating below 66 GHz

Radiocommunication Study Groups

International Telecommunication Union

Source: Documents 5A/259, 5A/260 and 5A/272

Document 5A/TEMP/101-E
23 May 2013
English only

Working Party 5A

WORKING DOCUMENT TOWARDS A PRELIMINARY DRAFT REVISION OF RECOMMENDATION ITU-R F.1763

Radio interface standards for broadband wireless access systems in the fixed service operating below 66 GHz

(Question ITU-R 236/9215-4/5)

(2006)

Summary of revision: TBD

Editor's Note: This working document towards a preliminary draft revision should be sent to BWA contacts of external organizations to invite their comments.]

1 Introduction

This Recommendation recommends specific standards for broadband wireless access (BWA)[1] systems in the fixed service for international use. These standards are composed of common specifications developed by standardization bodies with broad international participation. Using these standards, manufacturers, operators, and device suppliers should be able to design interoperable, cost-effective equipment and systems or devices. It is also noted that some standards for systems operating in the mobile service can be utilized to provide fixed BWA.

The standards support a wide range of fixed and nomadic broadband applications, in urban, suburban and rural areas, for both generic Internet-type data and real-time data, including applications such as voice and videoconferencing.

2 Scope

This Recommendation identifies specific radio interface standards for broadband wireless access (BWA)[1] systems in the fixed service operating below 66 GHz, addressing profiles for the recommended interoperability standards. It provides references to the standards for interoperability between BWA systems.

[1] "Wireless access" and "BWA" are defined in Recommendation ITU-R F.1399.

The interoperability standards referenced in this Recommendation include the following specifications:

– system profiles;

– physical layer parameters, i.e. channelization, modulation scheme, data rates;

– medium access control (MAC) layer messages and header fields;

– conformance testing methods.

This Recommendation is not intended to deal with the identification of suitable frequency bands for BWA systems, nor any regulatory issues.

~~3~~ References

Recommendation ITU-R F.1399: Vocabulary of terms for wireless access.

Recommendation ITU-R F.1401: Considerations for the identification of possible frequency bands for fixed wireless access and related sharing studies.

Recommendation ITU-R F.1499: Radio transmission systems for fixed broadband wireless access based on cable modem standard.

ITU-R Handbook on Fixed Wireless Access: (Volume 1 of the Land Mobile (including Wireless Access)).

Recommendation ITU-R M.1450: Characteristics of broadband radio local area networks.

Recommendation ITU-R M.1457: Detailed specifications of the terrestrial radio interfaces of International Mobile Telecommunications-2000 (IMT-2000).

Recommendation ITU-R M.1801: Radio interface standards for broadband wireless access systems, including mobile and nomadic applications, in the mobile service operating below 6 GHz.

[~~ITU-T~~ Recommendation ITU-T J.122: Second-generation transmission systems for interactive cable television services – IP cable modems].

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~~4~~ Acronyms and Abbreviations

ATM	Asynchronous transfer mode
ATS	Abstract test suite
BRAN	Broadband radio access network (ETSI)
BWA	Broadband wireless access
CL	Convergence layer
DLC	Data link control
ETSI	European Telecommunications Standards Institute
FDD	Frequency division duplex
FEC	Forward error correction
HA	HiperACCESS (ETSI)
HiperACCESS	High PERformance Radio ACCESS network
HiperMAN	High PERformance Radio Metropolitan Area Network
HM	HiperMAN (ETSI)
IEEE	Institute of Electrical and Electronics Engineers

IP	Internet Protocol
LAN	Local area network
LoS	Line of sight
MAC	Medium access control (OSI layer)
MAN	Metropolitan Area Network
MIB	Management information base
MIMO	Multiple input multiple output
NLoS	Non-line of sight
OFDM	Orthogonal frequency-division multiplexing
OFDMA	Orthogonal frequency-division multiple access
OSI	Open systems interconnection
PHS	Personal handyphone system
PHY	PHYsical (OSI layer)
PICS	Protocol implementation conformance statement
QoS	Quality of service
RCT	Radio conformance test
SC	Single carrier
SDO	Standards Development Organization
SME	Small Medium Enterprise
SNMP	Simple network management protocol
SOHO	Small Office Home Office
TDD	Time division duplex
TS	Technical specification (ETSI)
TSS&TP	Test suite structure and test purposes
WirelessMAN	Wireless Metropolitan Area Network (IEEE)
XGP	eXtended Global Platform

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The ITU Radiocommunication Assembly,

considering

a) that it is useful to identify standards for broadband wireless access (BWA) systems in the fixed service for international use;

b) that the standards for BWA systems in the fixed services are developed by standardization development bodies with broad international participation;

~~d~~c) that standards for systems operating in the mobile service can be utilized to provide fixed BWA;

~~e~~d) that standards for BWA support a wide range of fixed and nomadic broadband applications, such as voice and videoconferencing, in urban, suburban, and rural areas,

noting

a) Recommendation ITU-R F.1499, which specifies radio transmission systems for fixed broadband wireless access (BWA) based on cable modem standards;

b) the Handbook on Fixed Wireless Access (Volume 1 of the Land Mobile (including Wireless Access)), which also includes a number of proprietary solutions for fixed BWA;

c) Recommendation ITU-R F.1401, which provides considerations for the identification of possible frequency bands for fixed wireless access and related sharing studies;

d) Recommendation ITU-R M.1450, which recommends broadband radio local area networks standards;

e) Recommendation ITU-R M.1457, which recommends IMT-2000 terrestrial radio interface standards, some of which may also be used to provide fixed BWA,;

f) Recommendation ITU-R M.1801: Radio interface standards for broadband wireless access systems, including mobile and nomadic applications, in the mobile service operating below 6 GHz, some of which is also used to provide fixed BWA;

g) Recommendation ITU-R M.2012: Detailed specifications of the terrestrial radio interfaces of International Mobile Telecommunications-Advanced (IMT-Advanced);

[h) ITU-T Recommendation ITU-T J.122, which defines the second generation of radio-frequency interface for high-speed data-over-cable systems,]

recommends

1 that administrations take into account the standards in *notings d), e), f),* and *g)* which can be also utilized to provide fixed service operations;

12 that the specific radio interface standards in Annexes 1 to 3 may be used for BWA systems in the fixed service operating below 66 GHz (see Note 1).

NOTE 1 – Other radio interfaces used for BWA systems that differ from those referenced in Annex 1, including future versions of these standards referenced in Annex 1, could be addressed in the future in ITU-R following the procedures of Resolution ITU-R 1-46.

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Annex 1

IEEE and ETSI Radio interface standards for BWA systems in the fixed service

[Editor's note: This annex should be confirmed and revised by IEEE and ETSI, as appropriate.]

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1 Overview of the radio interface

Depending on the frequency band and implementation details, an access system built in accordance with this standardized interoperable radio interface can support a wide range of applications, from enterprise applications to residential applications in urban, suburban and rural areas. This radio interface can also be applied to other applications, such as for backhaul network applications. The specification could easily support both generic Internet-type data and real-time data, including applications such as voice and videoconferencing.

This type of system is referred to as a wireless metropolitan area network (WirelessMAN in IEEE 802.16, HiperACCESS and HiperMAN in ETSI BRAN[2]). The word "metropolitan" refers not to the application but to the scale. The architecture for this type of system is primarily point-to-multipoint (P-MP), with a base station serving subscribers in a cell that can range up to tens of kilometres. Fixed terminals are ideal for providing broadband wireless access to buildings, such as businesses, homes, Internet cafes, telephone shops (telecentres), etc. Also, typically in frequencies below 11 GHz, portable terminals such as laptop computers and bookshelf terminals support nomadic wireless access.

The radio interface includes support for a variety of data rates. At higher frequencies (e.g. above 10 GHz), supported data rates range over 100 Mbit/s per 25 MHz or 28 MHz channel, with many channels available under some administrations. At the lower frequencies (e.g. below 11 GHz), data rates range up to 70 Mbit/s per 20 MHz channel. The radio interface supports both TDD and FDD operation, along with operational use of various advanced antenna processing techniques, such as beamforming, precoding, space-time coding, MIMO, etc.

The radio interface includes a physical layer (PHY) as well as a medium-access control layer (MAC). The MAC is based on demand-assigned multiple access in which transmissions are scheduled according to priority and availability. This design is driven by the need to support carrier-class access to public networks, both Internet protocol (IP) and asynchronous transfer mode (ATM), with full quality of service (QoS) support.

The MAC supports several PHY specifications, depending on the frequency bands of interest and the operational requirements. In particular, the alternatives include, typically:

a) *Below 11 GHz*

– WirelessMAN-OFDM and HiperMAN: this specification, defined in IEEE Standard 802.16 and in ETSI TS 102 177, is based on OFDM.

– WirelessMAN-OFDMA: this specification, defined in IEEE Standard 802.16, is based on OFDMA.

– WirelessMAN-SCa: this specification, defined in IEEE Standard 802.16, uses single-carrier transmission, based on TDD and FDD.

b) *Above 10 GHz*

– WirelessMAN-SC: this specification, defined in IEEE Standard 802.16, uses single-carrier transmission, based on TDD/FDD, time-division multiplexing (TDM)/time-division multiple access (TDMA).

– HiperACCESS: this specification, defined by ETSI BRAN for frequencies above 11 GHz, uses single-carrier TDM and TDMA transmission.

All the above PHYs use the same MAC, with the exception of HiperACCESS. The HiperACCESS standard defines an interoperable P-MP system for fixed BWA above 10 GHz, while using single-carrier TDM downlink and TDMA uplink transmissions for high spectral efficiency and flexibility.

Appendix 1 illustrates pictorially the equivalencies and differences between the IEEE and ETSI standards.

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[2] ETSI (European Telecommunications Standards Institute) and IEEE (Institute of Electrical and Electronics Engineers) are standards development organizations (SDOs) responsible for the radio interface standards considered in this Annex.

These IEEE and ETSI standards are radio interface interoperability standards. An interoperability standard is a document that establishes engineering and technical requirements that are necessary to be employed in the design of systems, units, or forces and to use the services so exchanged to enable them to operate effectively together. Further relevant definitions describing other types of standards have been published by ISO/IEC[3].

The SDOs, which have developed the above standards, define system profiles for the recommended interoperability parameters. IEEE 802.16 profiles are included in the main standards document. HiperMAN profiles are defined in ETSI TS 102 210, while HiperACCESS profiles are contained in ETSI TS 101 999 and TS 102 000. The profiles are necessary to facilitate interoperability. Further guidance, including references to conformance test specifications, are provided in Appendix 2.

2 Detailed specification of the radio interface

The specifications contained in this section include the following standards for BWA in the fixed service:

2.1 IEEE Standard 802.16-2004

802.16-2004 IEEE Standard for local and metropolitan area networks Part 16: Air Interface for Fixed Broadband Wireless Access Systems.

Abstract: This standard specifies the air interface of fixed BWA systems supporting multimedia services. The MAC layer supports a primarily point-to-multipoint architecture, with an optional mesh topology. The MAC is structured to support multiple PHY specifications, each suited to a particular operational environment. For operational frequencies from 10-66 GHz, the PHY is based on single-carrier modulation. For frequencies below 11 GHz, where propagation without a direct line of sight must be accommodated, three alternatives are provided, using OFDM, OFDMA, and single-carrier modulation. This standard revises and consolidates IEEE Standards 802.16-2001, 802.16a-2003, and 802.16c-2002.

Standard: The IEEE Standard is available in electronic form at the following address:
http://standards.ieee.org/getieee802/download/802.16-2004.pdf

Subject to IEEE's Corrigendum 1[4]
http://standards.ieee.org/getieee802/download/802.16e-2005.pdf

2.2 ETSI Standards

The specifications contained in this section include the following standards for BWA in the fixed service:

a) Standards addressing fixed BWA below 11 GHz:

– ETSI TS 102 177 v1.2.1: Broadband Radio Access Networks (BRAN); HiperMAN; Physical (PHY) Layer.

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[3] "Standardization and related activities – General vocabulary", ISO/IEC Guide 2, Eighth Edition. Geneva, Switzerland, International Organization for Standardization, 2004.

[4] The cited publication includes not only Corrigendum 1 but also additional content that is applicable to the mobile service only and is not part of this Recommendation.

– ETSI TS 102 178 v1.2.1: Broadband Radio Access Networks (BRAN); HiperMAN; Data Link Control (DLC) Layer.

– ETSI TS 102 210 v1.2.1: Broadband Radio Access Networks (BRAN); HiperMAN; System Profiles.

– ETSI TS 102 389 v1.1.1: Broadband Radio Access Networks (BRAN); HiperMAN; Simple Network Management Protocol (SNMP) Management Information Base (MIB).

Abstract: The HiperMAN standards addresses interoperability for fixed BWA systems in 2-11 GHz frequencies, while using OFDM downlink and OFDMA uplink, to provide high cell sizes in non-line of sight (NLoS) operation. The standard provides for FDD and TDD support, high spectral efficiency and data rates, adaptive modulation, high cell radius, support for advanced antenna systems, high security encryption algorithms. Its profiles are targeting the 1.75 MHz, 3.5 MHz and 7 MHz channel spacing, suitable for the 3.5 GHz band.

b) Standards addressing fixed BWA above 10 GHz:

– ETSI TS 101 999 v1.1.1: Broadband Radio Access Networks (BRAN); HiperACCESS; Physical (PHY) Layer.

– ETSI TS 102 000 v1.4.1: Broadband Radio Access Networks (BRAN); HiperACCESS, Data Link Control (DLC) Layer.

– ETSI TS 102 115 v1.1.1: Broadband Radio Access Networks (BRAN); HiperACCESS; Cell-based Convergence Layer. Part 1: Common Part and Part 2: UNI Service Specific Convergence Sublayer (SSCS).

– ETSI TS 102 117 v1.1.1: Broadband Radio Access Networks (BRAN); HiperACCESS; Packet-based Convergence Layer. Part 1: Common Part and Part 2: Ethernet SSCS.

Abstract: HiperACCESS specifies the air interface of fixed broadband wireless access systems with P-MP (point-to-multipoint) topology. The standard is optimized for packet- and cell-based core networks. The main applications are backhaul networks under line-of-sight (LoS) conditions, SME (small medium enterprise) and SOHO (small office home office). The HiperACCESS specification consists of several parts: physical layer based on single-carrier transmission, optimized for LoS links above 10 GHz, DLC (data link control layer) with a well-controlled set of optional features and hooks for future evolution, several convergence layers, a comprehensive set of test specifications to ensure interoperability between equipment from different manufacturers. The adaptive concept of HiperACCESS provides high throughput of more than 100 Mbit/s under normal propagation conditions, allows high frequency reuse factors, and guarantees minor and controllable interference to other systems and adjustable power flux-densities according to national regulatory conditions.

Standards: All the ETSI standards are available in electronic form at: http://pda.etsi.org/pda/queryform.asp, by specifying in the search box the standard number.

Appendix 1
to Annex 1

Comparison and equivalency of the IEEE and ETSI standards

1 Introduction

This Appendix illustrates the equivalency between the IEEE and ETSI standards covered in this Recommendation. Since the specifications are different for the interoperability standards for systems intended to operate below 11 GHz or above 10 GHz, they are shown separately in Figs. 1 and 2.

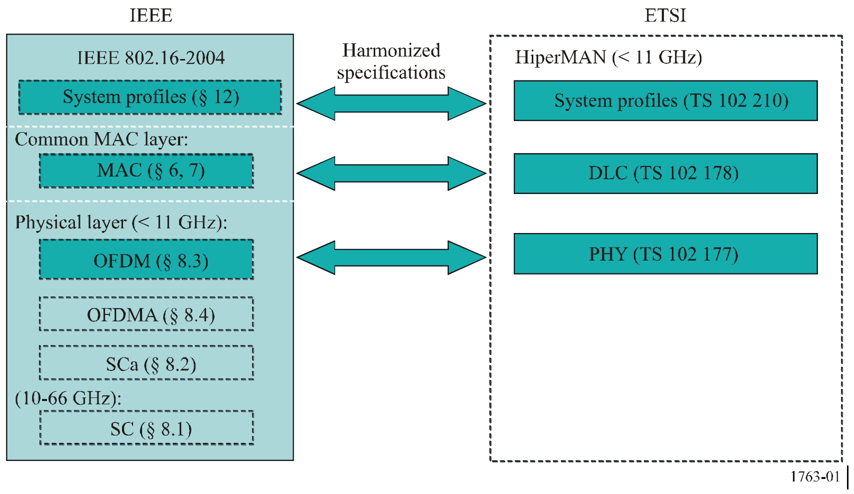
It should be noted that there is a 1 GHz overlap between the applicability of the two sets of standards. This offers a choice of specifications in the 10-11 GHz range, and system designers will select the standards to use for this band, depending on whether they wish to achieve commonality with systems below 10 GHz or systems above 11 GHz.

2 Standards for bands below 11 GHz

Figure 1 shows the harmonized interoperability specifications of the IEEE WirelessMAN and the ETSI HiperMAN standards, for bands below 11 GHz, which include specifications for the OFDM physical layer, MAC, security, and the system profiles.

FIGURE 1

BWA Standards harmonized for interoperability for frequencies below 11 GHz

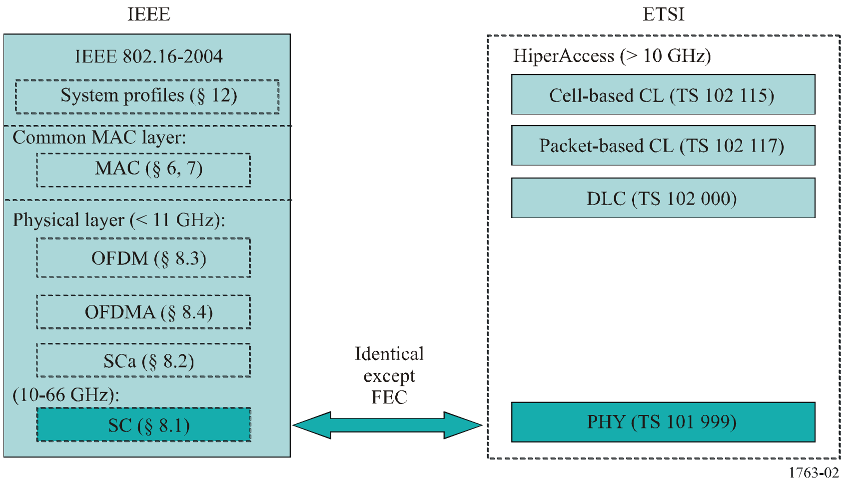


3 Standards for bands above 10 GHz

Figure 2 shows the similarities between the IEEE WirelessMAN and ETSI HiperACCESS standards for frequencies above 10 GHz. The specifications for systems above 10 GHz are different in HiperACCESS and WirelessMAN.

FIGURE 2

BWA Standards common elements for frequencies above 10 GHz



Appendix 2
to Annex 1

Conformance testing specifications

1 Introduction

The system profiles are sets of features to be used in typical implementation cases. Since the standards contain options to fulfill the needs in multiple environments, the first step towards ensuring interoperability is the definition of common system profiles. An exception is HiperAccess where system profiles are not needed since the base station has full control about the use of optional features on a per terminal basis.

Features specified in the standard as optional may be listed in a profile as “required” or “conditionally required”. Profiles do not change “mandatory” status if specified in the standard itself. Optional features shall be implemented as specified in the standard.

The next steps towards ensuring interoperability are conformance testing and interoperability testing.

– Conformance testing is the act of determining to what extent a single implementation conforms to the individual requirements of its base standard.

– Interoperability testing is the act of determining if end-to-end functionality between at least) two communicating systems is as required by those base systems’ standards.

The conformance testing specifications for WirelessMAN, HiperMAN and HiperACCESS are defined according to ISO/IEC 9646 “Information Technology – Open Systems Interconnection – Conformance testing methodology and framework”.

2 Conformance test specifications for IEEE 802.16-2004 WirelessMAN and ETSI HiperMAN for bands below 11 GHz

The following HiperMAN test specifications are applicable equally to both the HiperMAN DLC and WirelessMAN MAC standards, which demonstrate the equivalency of these standards.

ETSI TS 102 385-1 V1.1.1 (2005-02)

Broadband Radio Access Networks (BRAN); HiperMAN; Conformance testing for the Data Link Control Layer (DLC); Part 1: Procotol Implementation Conformance Statement (PICS) proforma.

ETSI TS 102 385-2 V1.1.1 (2005-02)

Broadband Radio Access Networks (BRAN); HiperMAN; Conformance testing for the Data Link Control Layer (DLC); Part 2: Test Suite Structure and Test Purposes (TSS&TP) specification.

3 Conformance test specifications for IEEE 802.16-2004 WirelessMAN and ETSI HiperACCESS for bands above 10 GHz

The testing specifications for systems above 10 GHz are different for WirelessMAN and HiperACCESS.

3.1 Conformance test specifications for IEEE 802.16-2004 WirelessMAN for 10-66 GHz

The conformance test specifications for IEEE 802.16-2004 WirelessMAN are in the following IEEE standards:

IEEE Standard 802.16/Conformance01-2003

IEEE Standard for Conformance to IEEE 802.16 – Part 1: Protocol Implementation Conformance Statements for 10-66 GHz WirelessMAN-SC Air Interface.

IEEE Standard 802.16/Conformance02-2003

IEEE Standard for Conformance to IEEE 802.16 – Part 2: Test Suite Structure and Test Purposes (TSS&TP) for 10-66 GHz WirelessMAN-SC.

IEEE Standard 802.16/Conformance03-2004

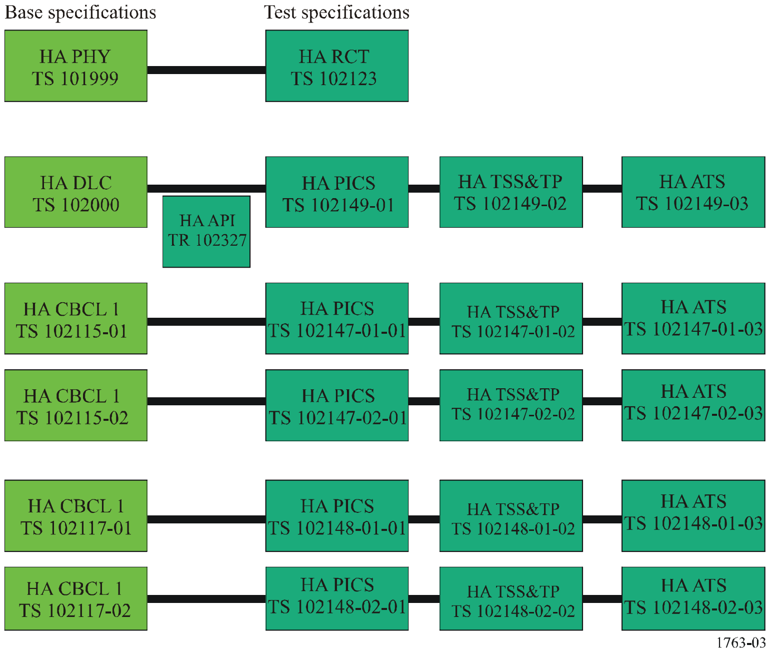
IEEE Standard for Conformance to IEEE 802.16 – Part 3: Radio Conformance Tests (RCT) for 10-66 GHz WirelessMAN-SC Air Interface 10-66 GHz WirelessMAN-SC Air Interface.

3.2 Conformance test specifications for ETSI HiperACCESS for bands above 10 GHz

Figure 3 shows the relation between base and test specifications for HiperACCESS.

FIGURE 3

BRAN HiperACCESS standards and test specifications



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Annex 2

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The "eXtended Global Platform: XGP" radio interface standards for BWA systems in the fixed service

1 Overview of the radio interface

The "eXtended Global Platform: XGP" is one of modern BWA systems which was originally developed as a next-generation system of PHS. PHS had been designed and developed not only as a mobile system but also as a fixed system called "Wireless local loop: WLL". XGP is an enhanced version of PHS, and therefore supports both mobile and fixed use as well.

XGP is a BWA system which utilizes OFDMA, SC-FDMA/TDMA-TDD, and some more advanced features described below:

– Realization of always-connected environment at IP level

The always-connected session at IP level that enables users to start up high-speed transmission immediately is essential, taking into account the convenience of always-connected environment provided in wired broadband circumstance, etc.

– High transmission data rate

It supports data rates over 100 Mbit/s per 20 MHz bandwidth.

– High efficiency in spectral utilization

Highly efficient spectral utilization is necessary in order to avoid interruption of service applications by a shortage of frequency, due to a serious traffic congestion concentrated at a business district or downtown area.

In addition, it has the ability of highly efficient spectral utilization by adopting the latest technologies such as an adaptive array antenna technology, a space division multiple access technology and so on. These technologies also contribute to make cell-designing plans unnecessary. As a result, the cell radius less than 100 m can be realized.

Mobile/Fixed wireless systems, which are used for point-to-multipoint service, generally require a relatively high level of accuracy in terms of their installation position in order to avoid interferences to other cells. In the case of macro-cell networks, there would be a geographical offset of the base station from the intended position/building to its adjacent alternative position/building, for example due to unsuccessful negotiations with the building owners. The offset causes inter-cell interferences but they still lie within the range of tolerable error.

In the case of micro-cell networks, this offset, however, cannot be ignored since the offset is relatively large being compared to cell radius of micro-cell. Readjustments of the surrounding cell layout are needed to avoid coverage holes due to the offset, in some cases.

This issue has already been solved with XGP system, as it has an interference-robust structure and does not require strict accuracy for base station positions, resulting in less trouble in the construction of micro-cell networks.

XGP is a system, among BWA systems, which possesses a differentiating feature by flexibly utilizing micro- and macro-cells in its network in order to efficiently accommodate heavy traffic in densely-populated areas.

In addition to XGP original mode, the specification of XGP version 2 or later has the Global Mode that refers to 3GPP specification (LTE TDD) in order to attain the scale of merits provided by LTE. XGP, therefore, becomes substantially compatible with LTE TDD and can be regarded as a part of LTE community sharing a common eco-system.

The XGP specification also accommodates some specific requirements complying with regional or local regulations.

2 Detailed specification of the radio interface

Duplex method of XGP is TDD. TDD is not needed for paired spectrum channels, and allows to devote resources to uplink and downlink asymmetrically, freeing capacity for up/downlink data-intensive applications.

The operation channel bandwidths supported by XGP are 1.25 MHz, 2.5 MHz, 5 MHz, 10 MHz, 20 MHz, 22.5 MHz, 25 MHz, 30 MHz and its modulation scheme supports BPSK, QPSK, 16-QAM, 64-QAM and 256-QAM. The subcarrier frequency spacing is 15 kHz and 37.5 kHz. The time-frame has 4, 8, 10, 16, 20 slots of 2.5 ms, 5 ms, 10 ms. Each slot can be used separately, or continuously by a single user, and moreover continuously in an asymmetric frame structure.

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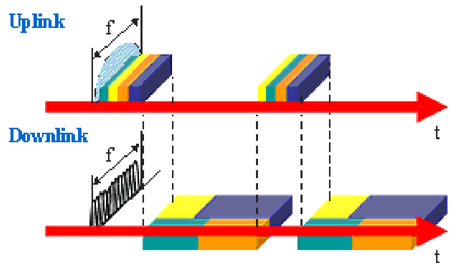
The frame structure image of XGP is shown in Fig. A2-1.

FIGURE A2-1

The frame structure image of XGP



XGP achieves efficient spectral utilization mainly by the function of adaptive array antenna.

Adaptive array antenna is a technique to make adaptive beam forming from a BS/MS to an MS/BS by combining signals of respective antennas. The adaptive array antenna uses multiple antennas and combines their signals (1) to adaptively form a beam to desired directions in order to avoid harmful interference from interferers and (2) to send the most suitable radio waves/signals to a specific terminal by using the formed beam. In XGP system that employs OFDMA SC-FDMA/TDMA-TDD schemes, this antenna technology is well-suited and can be effectively applied to both transmitter and receiver. It has a potential to increase XGP's spectrum efficiency and to make it possible to cover a wider area with lower cost.

System profiles, physical layer parameters, and also MAC layer messages of XGP system are described in following standards.

The "eXtended Global Platform" specifications of XGP Forum are available in an electronic form at its website:

"A-GN4.00-02-TS: eXtended Global Platform Specifications" http://www.xgpforum.com.

The Association of Radio Industries and Businesses (ARIB) has also standardized "eXtended Global Platform" for Japanese domestic use.

The ARIB standard of "eXtended Global Platform" is also available at the ARIB website.

"ARIB STD-T95: OFDMA/TDMA TDD Broadband Access System ARIB STANDARD" http://www.arib.or.jp/english/index.html.

The standard "ARIB STD-T95" includes Japanese regulation specifications as well as the system original specifications.

3 Conformance test specifications for XGP

The Conformance test specifications for "eXtended Global Platform" are available in an electronic form at the website below:

"XXXXXXXX" http://www.xgpforum.com.

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[*XGP Forum's Note: Conformance test specification of XGP is underway in XGP Forum. The link of the website will be provided at Working Party 5A November meeting by the Forum.*]

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Annex 3

Radio interface standards of Multiple Gigabit Wireless Systems for BWA systems in the fixed service

[Editor's note: This section will be provided by Wireless Gigabit Alliance as appropriate.]

1 Overview of the radio interface

2 Detailed specification of the radio interface

3 Conformance test specifications for MGWS

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Preliminary draft Revisionof recommendation ITU-R M.1076
Wireless communication systems for persons with impaired hearing

Radiocommunication Study Groups

Source: Document 5A/TEMP/60

Subject: Recommendation ITU-R M.1076

Document 5A/TEMP/115-E
23 May 2013
English only

Working Party 5A

WORKING DOCUMENT TOWARDS A PRELIMINARY DRAFT REVISION OF RECOMMENDATION ITU-R M.1076

Wireless communication systems for persons with impaired hearing

~~(Question ITU-R 49/8)~~

(1994)

Summary of revision

[*Editor's note*: To be filled in]

Scope

This Recommendation provides an overview of some radio frequency tuning ranges and systems characteristics for wireless accessibility of hearing aids to public, home and personal audio services.

The ITU Radiocommunication Assembly,

considering

New A ITU action item

a) that many forms of hearing impairment cannot be satisfactorily improved by audio amplification only;

b) that a number of means have been used to transfer speech signals to the listener's hearing device. These means include infrared radiation, use of the magnetic induction internal to current loops, including operation at audio frequencies, VHF and UHF radio and the external induction field of a radiating antenna;

c) that some 10% of people suffer from mild to severe hearing loss;

d) that users of aids for hearing impaired (hearing aids including assistive listening devices) are found in every country of the world and also travel between continents;

e) that personal services include access to mobile phone and personal audio services;

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f) that home services include access to television, radio and alarms;

g) that public services include access to points of sales, counters, public address systems at airports, train stations, religious places, theatres, events and cinemas;

h) that for public use it is useful to have a standardized wireless system, operating on common globally harmonized tuning range;

j) that Annex 1 contains some information concerning radio system concepts;

~~d~~k) that Annex 2 contains summary system characteristics of radio induction field ~~and~~, VHF and UHF systems suitable for wireless hearing aid,

recommends

1 that the technical parameters for radiocommunication systems for persons with impaired hearing should be in accordance with Annexes 1 and 2;

2 that administrations consider suitable frequency tuning ranges for the operation of wireless systems for hearing impaired persons requiring operation on a global basis;

3 that the practical application of infrared systems and audio frequency induction loops to ~~communicating~~ communicate with persons with impaired hearing should also be considered for some applications.

ANNEX 1

Radiocommunication systems for persons with impaired hearing

1 System concepts

~~1.1 Radio induction field system~~

~~The mobile-to-mobile induction field hearing assistance system exploits the FM capture effect to permit co-channel operation with selection by proximity. This pattern of selection closely parallels that used in ordinary conversation.~~

~~When an induction field hearing aid receiver is operated in the vicinity of two co-channel transmitters using a medium deviation FM transmission, the rapid change in field strength together with the FM capture effect ensures that there is a rapid changeover in reception from the more distant transmitter to the nearer transmitter with little subsequent breakthrough of consequence. For example, for a frequency deviation of 12 kHz and 75 µs receiver de-emphasis, it can be shown that, at a field strength ratio of 8:1, the maximum breakthrough from the more distant transmitter is 34 dB (unweighted). Within the region of inverse cubic decay of the induction field, the unwanted transmitter need only be at twice the distance of the wanted one to achieve this result. The field decay rate is illustrated in Fig. 1.~~

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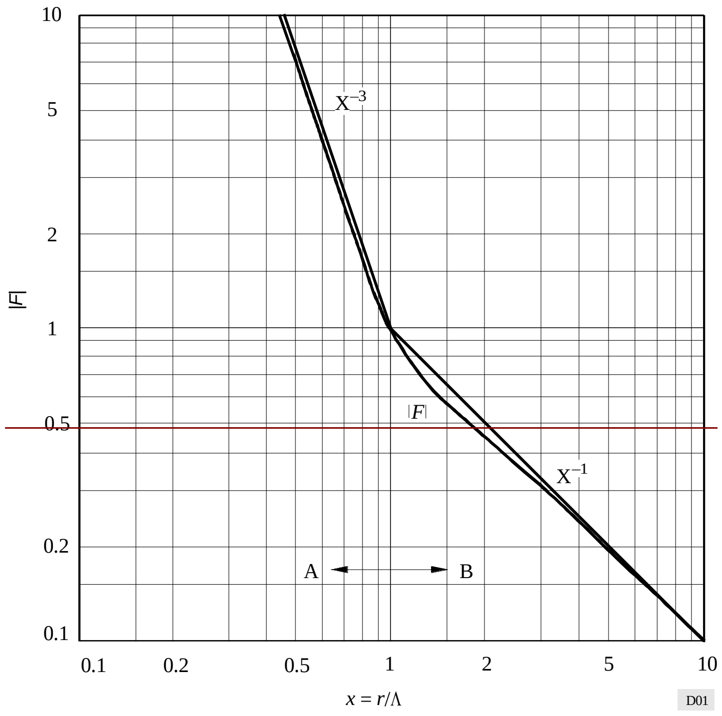
FIGURE 1

The field in free-space near a small dipole



The field intensity |F| in the equatorial plane is proportional to

$$\left| 1/r^3 + j/\Lambda r^2 - 1/\Lambda^2 r \right|$$

Λ : radian wavelength = λ/2π ≈ 48 m divided by frequency (MHz)

A: induction
B: radiation

~~FIGURE 1...[D01] = 17 CM~~

~~A magnetic induction field is preferred as it is less perturbed by conducting objects such as the human body, and is compatible with the use of compact ferrite rod antennas. The measured decay of a magnetic induction field is shown in Fig. 2.~~

~~The design of the induction-field hearing aid proceeds from the following four principles:~~

~~The upper limit for the carrier frequency is about 4 MHz; at higher frequencies the extent of the rapidly decaying induction field is less that 12 m, which is insufficient.~~

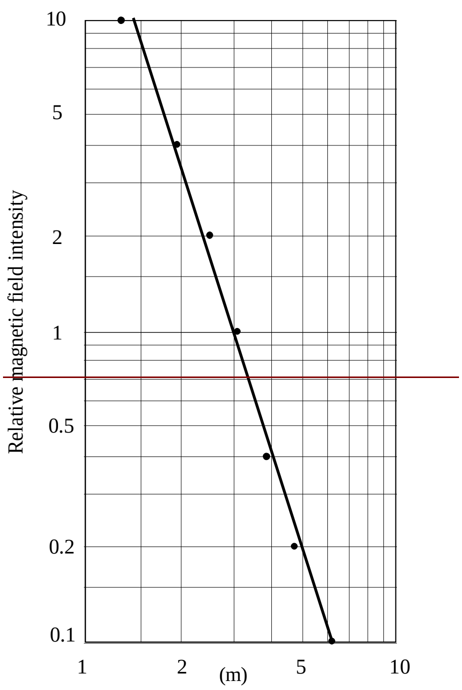
~~The lower limit to the maximum frequency deviation is taken as 12 kHz as with lesser deviations, excessive breakthrough from nearby co-channel transmission occurs.~~

~~The lower limit of the carrier frequency is taken as 3 MHz. The quality factor (Q) of tuned windings on ferrite rod antennas is of the order of 200. At lower carrier frequencies the bandwidth of the tuned antenna circuits cannot accommodate the required frequency deviation.~~

~~The mean carrier frequency of all transmitters should be stabilized to within 20 Hz of their nominal channel frequency to avoid the production of sustained audible beat notes in receivers operated near more than one co-channel transmitter. Since the carrier frequency has been set below 4 MHz, the required degree of stabilization can be obtained by reference against quartz crystal oscillators operating at ambient temperature.~~

FIGURE 2

The measured decay of a magnetic induction field



The points represent the measured values of the field; the straight line is an exact inverse cubic decay. The measurements were made in the laboratory in proximity to large metal objects. A frequency of 3.6 MHz was used.

D02

~~FIGURE 2...[D02] = 15 CM~~

Historically, hearing aids consisted of little more than basic "miniature audio amplifiers" placed in or behind their ear(s) solely boosting the incoming sounds. As semiconductor technology has evolved and become miniaturised, hearing impaired people enjoy extremely sophisticated digital systems incorporating a range of communication capabilities.

State-of-the-art technology uses specialized Digital Signal Processing (DSP) technology that is advanced enough to fulfil the stringent mechanical (ultra miniature) and power consumption (only one small single cell battery) requirements that are specified for modern hearing aid devices. DSPs manipulate the incoming sound spectrum mathematically, converting it into a digital representation; programmable software then manipulates this digital representation to achieve:

– background noise reduction;

– correction of user ~~patient~~ specific deficiencies;

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– enhancement of sound cues and other listening parameters used by the brain to reconstruct normal hearing.

Hearing aids contribute to user safety, comfort and enjoyable listening experience. However, real life offers an incredible richness in different listening environments in some of which even the most sophisticated hearing instruments show only a limited benefit. Examples of acoustic environments or listening situations where the performance of conventional hearing instruments can substantially be improved by applying additional communication devices are the following:

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– reverberant environments such as big churches or lecture halls;

– communication over larger distances, e.g. in a lecture or in a classroom;

– communication on the telephone, especially cell phones.

– situations with large background noise levels (e.g. rooms, halls and areas with multi-talker speech; engine noise inside or outside of trains and busses, etc).

In these environments the application of assistive listening systems (ALS) based on wireless communication technologies offer substantial additional benefits and significantly improve speech intelligibility. The advent of digital broadcasting is now displacing some of the frequencies where these wireless ALS's have traditionally operated.

In North America and Europe, approximately 1 person in 10 has some form of hearing loss, from mild to severe. Today only 20 % of these people are assisted by hearing aid technology. The binaural rate (wearing two hearing aids: one left and one right) is ~75 % to 80 % in North America, ~60 % in Europe and 10 % to 12 % in the rest of the world. Reasons for such low adoption rates in general vary from negative stigma associated with wearing cosmetically non-appealing devices to high cost and certain types of hearing losses that could not be corrected.

Recent progress made in binaural hearing health revealed that having for example the right hearing aid being able to communicate with the left hearing aid and vice versa helps achieve another level of breakthrough in restoring someone's hearing. This also directly contributes to the safety of that person's listening environment, for example directionality of sounds can be better perceived, in cases such as an approaching ambulance or fire truck which cannot be seen but only heard, is physically located. In some instances where one ear is totally impaired, sounds captured from that side of the head can be relayed to the other ear and processed such as that person experiences full 360° hearing again.

A major role of allowing the hearing impaired to communicate and also enjoy similar experiences to those with normal hearing has been played by the Telecoil system which is in world-wide use. Unfortunately these are difficult or impossible to install in large public places such as airports and train stations and are both expensive to install and maintain. Also building owners are often reluctant to allow them to be installed. In addition they only supply a single low quality voice channel. This lack of flexibility and cost have given rise to an explosion of radio based systems for most teaching, especially sports coaching[1] and domestic use where multiple channels are required[2].

Hearing aids can be described as body worn therapeutic medical devices used to provide improved medical treatment of a patient. Therefore, they are subject to the very same constraints as all other body worn medical devices:

- They perform therapeutic tasks aimed a treating, curing, hence bettering patient's lives.
- They are installed / worn in and around the body.

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1 Football and horse riding are some of the many sports now using this equipment for coaching

2 Many schools require in excess of 25 channels.

- They are subject to severe power consumption constraints, due to their discreet mechanical size, that commands very small source of energy (single cell battery).
- A worldwide deployable tuning range will facilitate the use of these devices for international travellers in public areas.
- These devices rely on the radio spectrum to be optimized in terms of energy spent for range and link robustness achieved, hence a low noise floor and minimal interference band, where body tissue absorption and spectrum usage density are taken into account.
- If these devices are exposed to an environment of high emissions the user could experience pain and possible damage[3] to the ear drum and/or other physical incapacity.

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1.1 Induction-Loop system (often referred to as Telecoil)

Inductive systems rely on coupling an audio amplifier, e.g. for the microphone of a speaker in a lecture hall or a teacher in a classroom, directly to an induction loop system which basically directly transmits the rather low frequency audio signal as a radiated time varying magnetic field. Induction loop systems use a large coil antenna integrated in the floor of a large room for radiating the magnetic field. Once properly installed, and given that the listener's hearing aids include "T" coils, an IL system is undoubtedly the most convenient and possibly the most cost effective ALS. To hear the audio, all a person has to do is enter the looped area and switch his/her personal hearing aids to the telecoil position. As long as the person's hearing aids include "T" coils, he or she always has an assistive device "receiver" available

However this technology also has some technical drawbacks which limit the range of application of this technology. The physics of inductive coupling requires the receiving coil (T-Coil) to be perpendicularly oriented to the field of the sending coil or induction loop. This is sometimes difficult to achieve because the orientation of the induction loop is fixed and the orientation of the T-Coil depends on how it is built into the hearing instrument and the person's orientation. Furthermore, the inductive transmission strongly depends on the distance between sender and receiver which sometime results in a weak signal. The receiver also always has to remain within the loop in order to receive a signal. External interferences (from power lines or fluorescent lights, computer monitors copiers, fax machines, cell phones, etc.) creating background noises or distortions in the hearing instrument, are difficult to remove. Next, in school environments, several different systems are required for different classrooms. When applying two different systems in neighbouring classrooms it often is difficult to avoid spill over from one induction loop system to the next although recently technological progress has been made for reducing this problem. Furthermore, induction loop systems are not portable and can only be applied where they have been pre-installed.

1.2 VHF ~~system~~and UHF systems

~~Systems~~Current systems employing VHF and UHF FM (sub 2 GHz) radio transmission are capable of providing communication over distances greater than those using the radio induction-field system, as they employ transmission via a radiation field which decays less rapidly with distance than does an induction field. As a consequence, VHF and UHF radio transmission systems

[3] http://www.access-board.gov/research/interference.htm

http://www.fda.gov/Radiation-EmittingProducts/RadiationEmittingProductsandProcedures/HomeBusinessandEntertainment/CellPhones/ucm116327.htm

Formatted: Tab stops: 0.5 cm, Left + Not at 2 cm require that each transmission in any locale, such as a school classroom and its environs, be assigned a separate frequency channel~~. This requirement is met with available frequency assignment methods, and is not a significant factor in the operation of the system~~.

~~—~~VHF and UHF reception is generally less susceptible to interference from natural and man-made noise than is reception at lower frequencies~~,~~ and systems employing VHF and UHF radio transmission ~~may~~will be useful in ~~certain~~many circumstances to avoid local problems of interference which ~~may~~ affect the operation of the radio induction-field system.

~~—~~Radiocommunication systems intended only for short-range communication are capable of producing high field strengths at their required working distances, without radiating significant levels of power. Exploitation of the resulting possibilities of shared spectrum usage can result~~s~~ in improved spectrum utilization, and may allow large numbers of channels to be made available, for example to satisfy the requirements of large schools for any children with impaired hearing which is increasingly a requirement of national legislation and an objective for children above five weeks old in many countries.

Equipment takes a number of physical forms from add on receivers for behind the ear systems to belt mounted units and necklace units. Currently narrow band FM systems predominate for teaching systems with Bluetooth connectivity for mobile phones and some domestic equipment using radio LAN technology for connection to multimedia terminals.

Scarcity of spectrum has meant that the narrow band fixed frequency channel equipment using a 100% duty cycle is not suitable for sharing with other services or SRD's therefore development of more spectrum efficient techniques such as frequency hopping and control from a remote database are currently under development. One such system is shown below.

Overview of the system

Wireless audio systems considered here transmit speech or audio from a microphone, over a digital radio link, to a receiver> An assistive listening system for use by the hearing impaired in public spaces such as airports, Railway stations, churches and theatres, where the transmitter is connected to the audio programme or public address system and the receiver is worn by deaf users, or integrated into users' hearing aids.

The use of digital technology, e.g. with 4GFSK modulation and low bit-rate audio coding, provides a balance between the need for good audio quality (a requirement to maintain intelligibility and minimise user fatigue), spectrum efficiency and range. These systems can work well between 150 MHz and about 2 GHz.

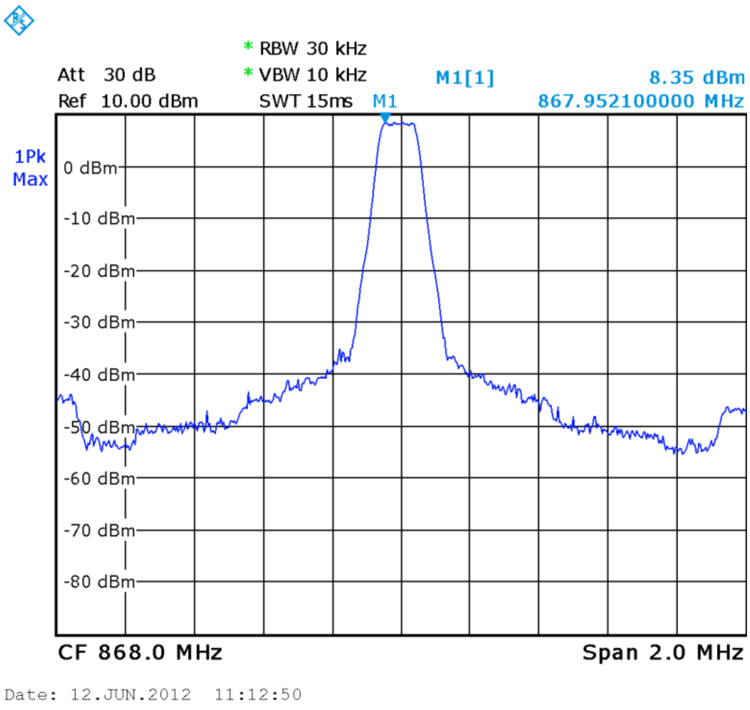
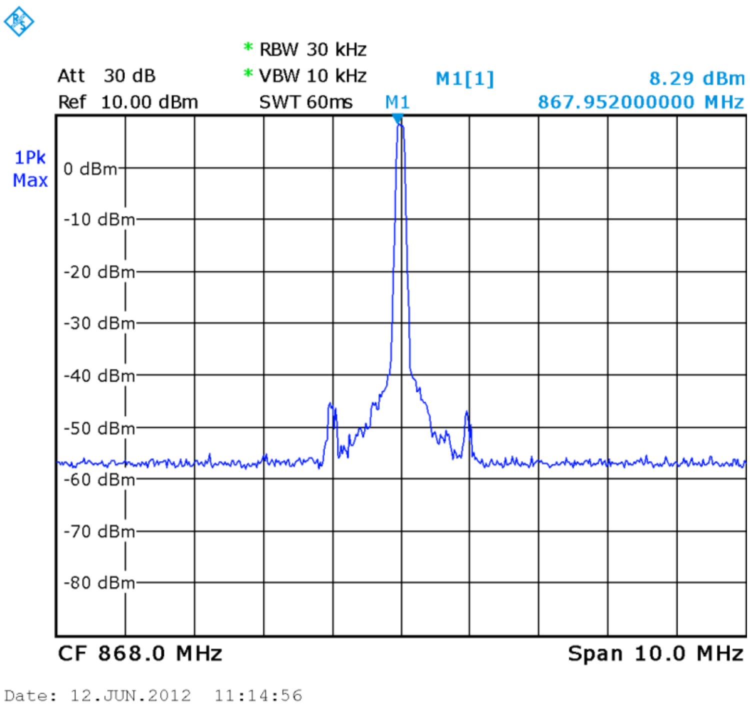
Depending on available spectrum and coexistence requirements, systems to operate in approximately 200 kHz, 400 kHz and 600 kHz occupied bandwidth are outlined. The transmitter and receiver duty cycle is inversely proportional to the bandwidth, which means that the amount of spectrum resource used is roughly independent of the bandwidth, but the receiver power consumption is proportional to the duty cycle.

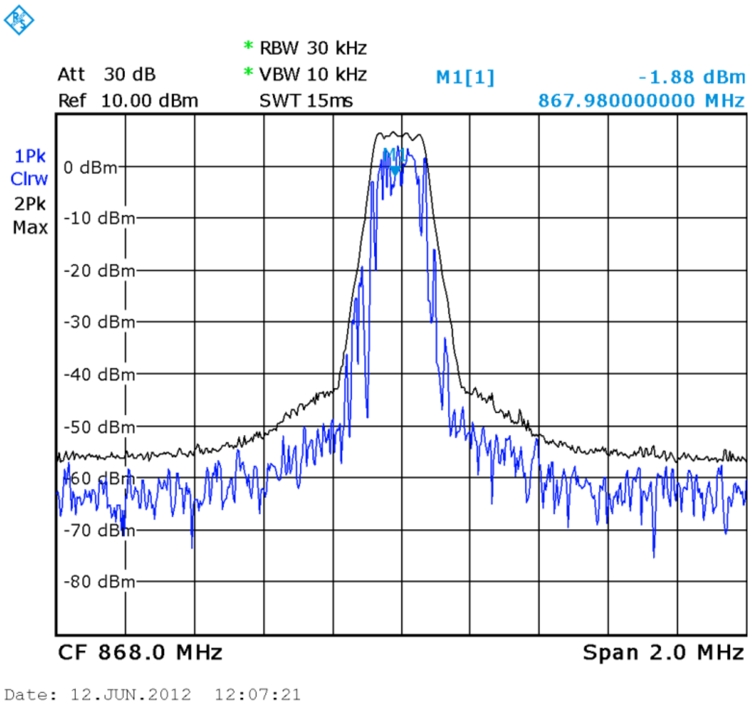
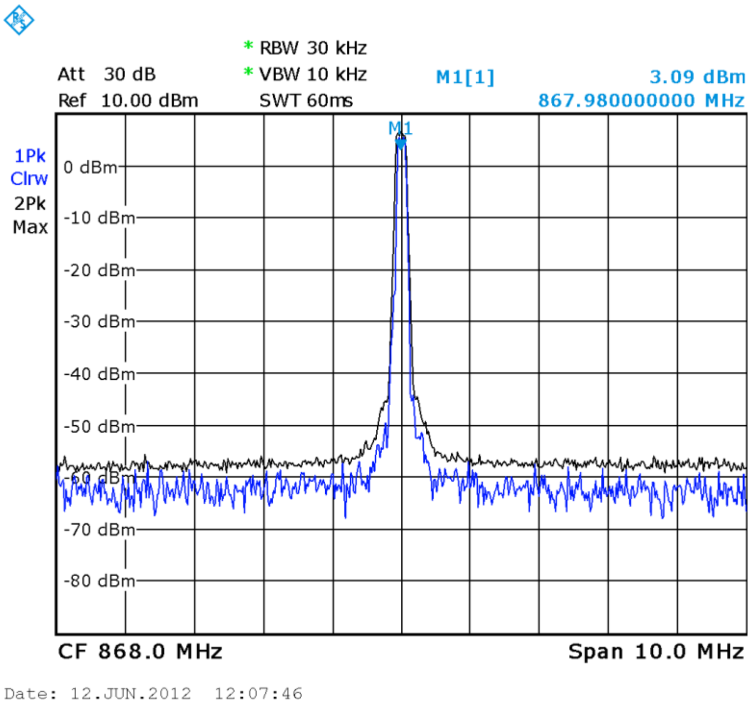
This means that a 600 kHz system would allow receivers to consume approximately 1/3 the power of a 200 kHz system, which is highly beneficial in power-limited applications such as hearing aids. Wider bandwidth also decreases end-to-end delay, which is of benefit to many audio applications where the audio must maintain lip-sync with the talker in order to maximise intelligibility.

Below are given technical parameters for wireless communication systems for access of hearing impaired people to public services. The most appropriate channel bandwidth/parameters set should be chosen in accordance with coexistence requirements for the radio frequency band in which such a system would be realized.

200 kHz system

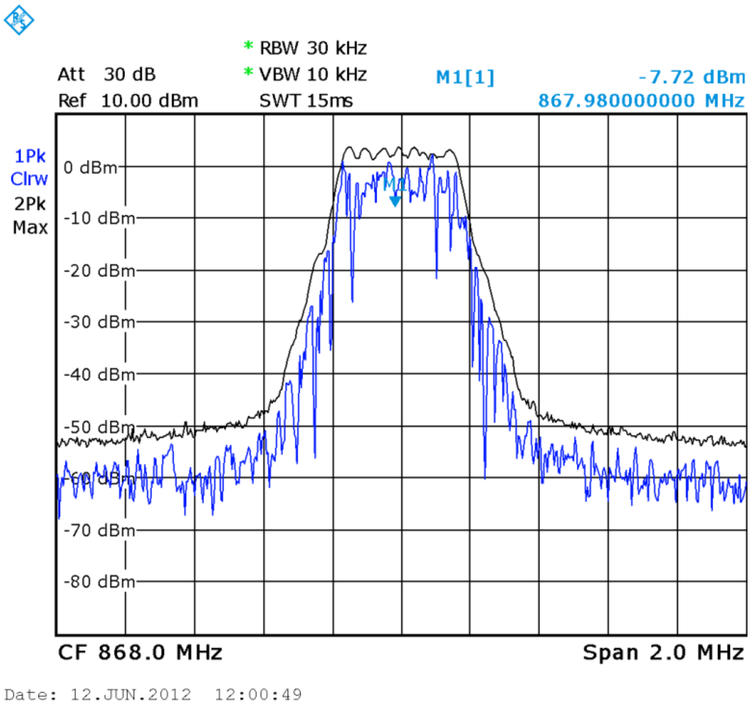
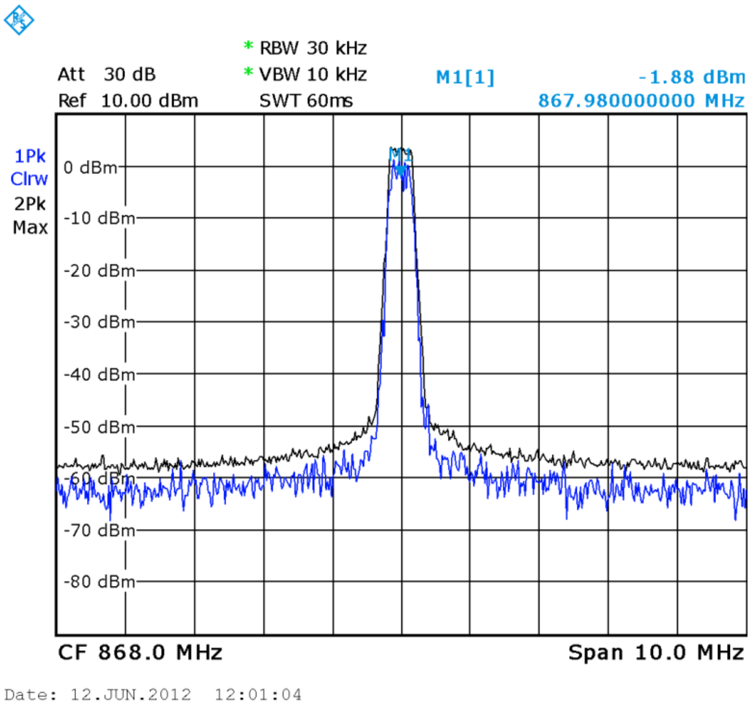
Channel bandwidth	200 kHz
Frequency tolerance	±0.005% (transmitter) ±0.005% (receiver)
Transmitter radiated power (ERP)	10 mW
Transmitter field strength @30m	88 dBμV/m
Transmitter out of band emission @30m	70 dBμV/m, 100 kHz from carrier, narrowband 40 dBμV/m, 1 MHz from carrier, wideband
Transmitter modulation (indicative)	4GFSK @120 kbit/s, ±40 kHz maximum deviation (outer symbols), BT = 0.5
Transmitter duty cycle (indicative)	30-50% for one audio channel
Receiver sensitivity, direct inject	–80 dBm or better
Receiver selectivity	30 dB minimum, adjacent channel 40 dB minimum, alternate channel, image channel and above
Receiver blocking rejection	50 dB minimum, ±2 MHz separation

Example transmitter mask (max hold) (note measurement noise floor at –55 dBm) Nominal 200 kHz bandwidth	 

Example transmitter mask (average and max hold) (note measurement noise floor at –55 dBm) Nominal 200 kHz bandwidth	 

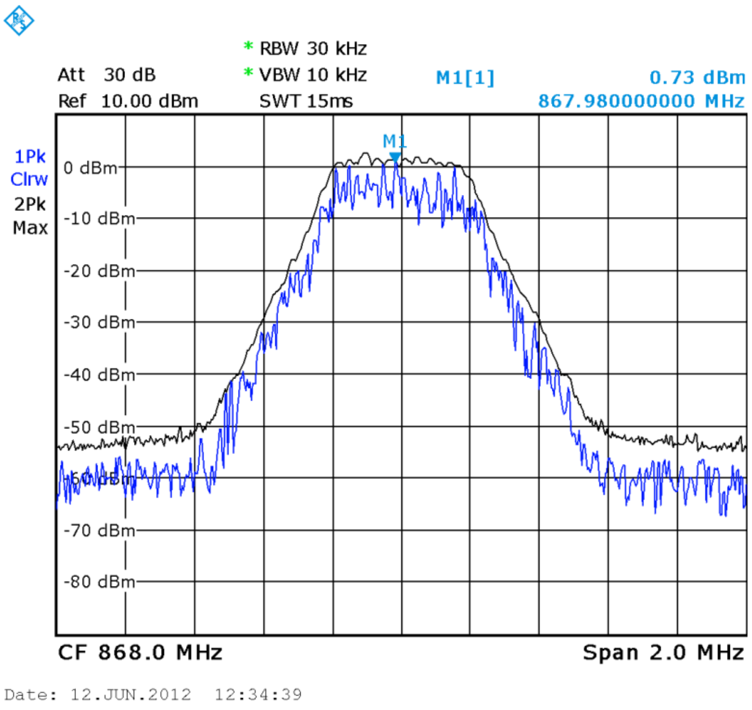
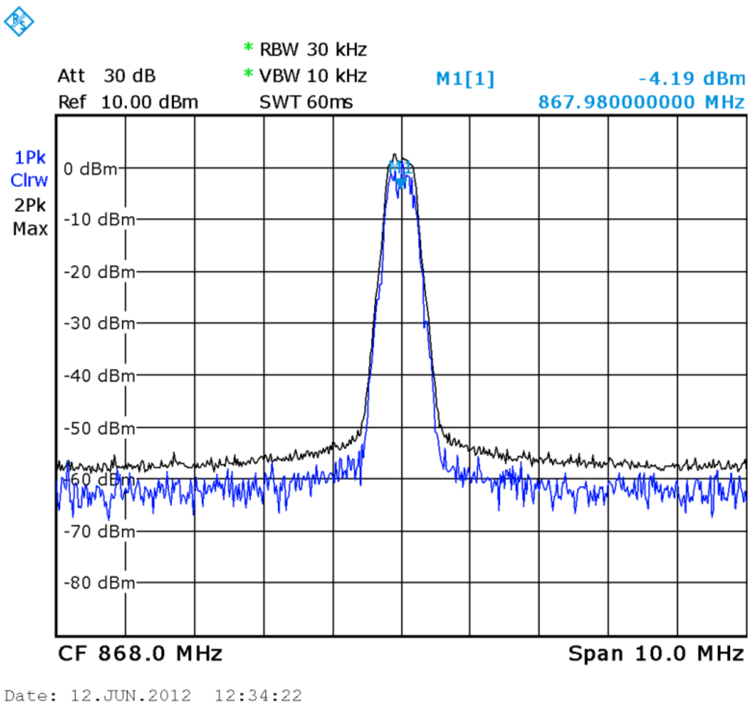
400 kHz system

Channel bandwidth	400 kHz
Frequency tolerance	±0.005% (transmitter) ±0.005% (receiver)
Transmitter radiated power (ERP)	10 mW
Transmitter field strength @30m	88 dBμV/m
Transmitter out of band emission @30m	70 dBμV/m, 200 kHz from carrier, narrowband 40 dBμV/m, 1 MHz from carrier, wideband
Transmitter modulation (indicative)	4GFSK @250 kbit/s, ±80 kHz maximum deviation (outer symbols), BT = 0.5
Transmitter duty cycle (indicative)	15-25% for one audio channel
Receiver sensitivity, direct inject	–80 dBm or better
Receiver selectivity	30 dB minimum, adjacent channel 40 dB minimum, alternate channel, image channel and above
Receiver blocking rejection	50 dB minimum, ±2 MHz separation

Example transmitter mask (average and max hold) (note measurement noise floor at -55 dBm) Nominal 400 kHz bandwidth	 Date: 12.JUN.2012 12:00:49  Date: 12.JUN.2012 12:01:04

600 kHz system

Channel bandwidth	600 kHz
Frequency tolerance	±0.005% (transmitter) ±0.005% (receiver)
Transmitter radiated power (ERP)	10 mW
Transmitter field strength @30m	88 dBμV/m
Transmitter out of band emission @30m	70 dBμV/m, 300 kHz from carrier, narrowband 40 dBμV/m, 1 MHz from carrier, wideband
Transmitter modulation (indicative)	4GFSK @500 kbit/s, ±120 kHz maximum deviation (outer symbols), BT = 0.5
Transmitter duty cycle (indicative)	10-20% for one audio channel
Receiver sensitivity, direct inject	–80 dBm or better
Receiver selectivity	30 dB minimum, adjacent channel 40 dB minimum, alternate channel, image channel and above
Receiver blocking rejection	50 dB minimum, ±2 MHz separation

Example transmitter mask (average and max hold) (note measurement noise floor at –55 dBm) Nominal 600 kHz bandwidth	 

ANNEX 2

System characteristics

From the information below there is a wide vairity of tuning ranges but there is no single suitable world wide tuning range which would enable the development of a single system for international traveller.

1 ~~Radio induction-field~~ HF radio systems

~~An operational induction-field radio hearing aid system has been developed.~~

~~Evaluation of the system has indicated it provides substantial benefits including:~~

~~greatly improved speech discrimination in noisy environments;~~

~~virtual elimination of the problems of co-channel interference from adjacent systems as a result of the FM capture effect;~~

~~1. greater flexibility for educational use. For example, with careful placement of pupils, a single frequency can be used in open plan class-rooms with more than one teacher;wireless enabled hearing aids.~~

~~the number of channels required in locations where there are many groups of users is reduced to four. Four channel transmitters and receivers have been developed for this purpose which also:~~

~~simplify frequency changes;~~

~~enable children to use the devices in different class-rooms by selecting the appropriate frequency;~~

~~overcome difficulties associated with mixing groups of children with devices operating on different frequencies.~~

~~Some interference to reception has been experienced on the 3 175 kHz frequency (the frequency of the single channel devices) from high powered (10 kW) transmitters operating on 3 184 kHz at distances up to 30 km. This has been resolved by using four channel devices on other frequencies and in one case by changing the frequency of the high powered transmitter.~~

~~There has also been interference to the reception of signals on 3 175 kHz from the seventh harmonic of intermediate frequency (7 × 455 kHz = 3 185 kHz). This spurious signal is generated within the receiver and degrades the quality of the received signal-to-noise ratio by adding to the receiver noise level. The problem has been overcome by altering the circuit board layout to minimize the interaction between the radio frequency and the audio frequency signals.~~

~~The parameters are as follows:~~

~~Transmission medium: Magnetic dipole induction field~~

~~Modulation: FM~~

~~Frequency deviation: ± 12.5 kHz~~

~~Carrier frequencies: 3 175, 3 225, 3 275, 3 325 kHz~~

~~Frequency tolerance: ± 20 Hz~~

~~Audio frequency range: 100 Hz-5 kHz~~

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~~Audio pre-emphasis: 6 dB/octave~~

~~Transmitting antenna: Ferrite rod, 127 mm x 10 mm, disposed vertically~~

~~Transmitter final stage power: 60 mW~~

~~Field strength produced at 3 m: 11 mV/m (measured at a frequency of 3 175 kHz)~~

~~Transmitter radiated power: 38 nW (calculated from above)~~

~~Transmitter spurious emission: Undetectable, but calculated as 0.1 pW~~

~~Transmitter dimensions: 145 mm × 53 mm × 18.5 mm~~

~~Receiving antenna: Ferrite rod, 57 mm × 10 mm, disposed vertically~~

~~Receiver type: Single conversion superheterodyne~~

~~Receiver dimensions: 80 mm × 53 mm × 18.5 mm (four channel device) 70 mm × 53 mm × 18.5 mm (single channel device)~~

~~Intermediate frequency: 455 kHz~~

~~System range: 12 m (subject to environment)~~

~~The low carrier frequency, which is specified to ensure that transmission takes place via an induction field, confers other benefits. It assists in keeping the receivers' battery consumption low and allows good image rejection to be obtained without recourse to double conversion superheterodyne techniques.~~

~~The use of a self-contained ferrite rod antenna is particularly convenient in a transmitter designed to be handed informally to another person.~~

1.1 3-11 MHz (Not implemented in all regions)

Channel bandwidth	300-400 kHz
Frequency tolerance	<± 1%
Transmitter field strength @10 m	< –20 dBμA/m
Transmitter modulation (indicative)	FSK @300 kbit/s
Transmitter duty cycle (indicative)	30-50% for one audio channel

2 VHF and UHF radio systems

Systems have successfully shared ~~the 27.5-39 MHz, 72-76 MHz, 88-108 MHz and the 173-175 MHz~~various frequency bands in the range 169-220 MHz for many years, with the type of radio services to which these frequency bands are allocated by the Radio Regulations. With the introduction of ALD systems for public spaces which can be controlled from a database better sharing with broadcast services could be expected.

2.1 27.5-3972-76 MHz (Not implemented in all regions)

Antenna length and man-made noise are an issue.

Channel bandwidth: 40 kHz

Frequency tolerance: 2.5 kHz (transmitter)

Transmitter radiated power: 50 mW

Spurious emissions (transmitter): 4 nW (25-1 000 MHz)
20 nW (above 1 000 MHz)

Spurious emissions (receiver): 2 nW (30-1 000 MHz)
20 nW (above 1 000 MHz)

2.2 72-76 MHz

Channel bandwidth:	50 kHz for a narrow-band device 200 kHz for a wideband device
Frequency tolerance:	± 0.005% (transmitter)
Frequency stability:	± 0.005% (receiver)
Field strength produced at 30 m:	Not to exceed 8 000 μV/m
Transmitter radiated power:	1 170 μW (calculated from above)
Modulation requirements for FM:	± 20 kHz maximum (narrow-band) ± 75 kHz maximum (wideband)
Out-of-band emissions:	± 25 kHz or more from carrier, no more than 150 μV/m at 30 m for narrow-band ± 150 kHz or more from carrier, no more than 150 μV/m at 30 m for wideband
Receiver selectivity:	40 dB minimum, adjacent channel
Receiver image rejection:	40 dB minimum

2.3 88-108 MHz

Channel bandwidth:

200 kHz

Field strength produced at 15 m:	Not to exceed 50 μV/m
Transmitter radiated power:	0.011 μW (calculated from above)
Out-of-band emissions:	100 kHz or more from the carrier, no more than 40 μV/m at 3 m
Receiver standards:	Comply with normal receiver standards for this band

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2.2 169 MHz band (Europe and Japan only)

Analogue FM fixed channel system with 100% Duty Cycle

Channel bandwidth: <50 kHz

Transmitter radiated power:	10 mW or <500mW Public Systems (Europe only), individual Licence required
Spurious emissions (transmitter):	4 nW (41-68, 87.5-118, 162-230, 470-872 MHz) (250 nW elsewhere below 1 000 MHz) 20 nW (above 1 000 MHz)
Spurious emissions (receiver):	2 nW (100 kHz-1 000 MHz) 20 nW (1 000-4 000 MHz)

2.34 173-175 MHz (in some European countries)

Analogue FM fixed channel system with 100% Duty Cycle

Channel bandwidth:	<50 kHz
Frequency tolerance:	± 5 kHz
Transmitter radiated power:	2-10 mW
Spurious emissions (transmitter):	4 nW (41-68, 87.5-118, 162-230, 470-872 MHz) (250 nW elsewhere below 1 000 MHz) 20 nW (above 1 000 MHz)
Spurious emissions (receiver):	2 nW (100 kHz-1 000 MHz) 20 nW (1 000-4 000 MHz)

2.4 174-216 MHz (Europe)

Analogue FM fixed channel system with 100% Duty Cycle

Channel bandwidth:	<50 kHz
Frequency tolerance:	± 5 kHz
Transmitter radiated power:	10 - 50 mW
Spurious emissions (transmitter):	4 nW (41-68, 87.5-118, 162-230, 470-872 MHz) (250 nW elsewhere below 1 000 MHz) 20 nW (above 1 000 MHz)
Spurious emissions (receiver):	2 nW (100 kHz-1 000 MHz) 20 nW (1 000-4 000 MHz)

2.5 216-217 MHz (USA)

Analogue FM fixed channel system with 100% Duty Cycle

Channel bandwidth:	<50 kHz
Frequency tolerance:	± 5 kHz
Transmitter radiated power:	100 mW

Spurious emissions (transmitter):	4 nW (41-68, 87.5-118, 162-230, 470-872 MHz) (250 nW elsewhere below 1 000 MHz) 20 nW (above 1 000 MHz)
Spurious emissions (receiver):	2 nW (100 kHz-1 000 MHz) 20 nW (1 000-4 000 MHz)

2.6 217-220 MHz (Korea), 218-220 MHz (China)

Analogue FM fixed channel system with 100% Duty Cycle

Channel bandwidth:	<50 kHz
Frequency tolerance:	± 5 kHz
Transmitter radiated power:	10 mW
Spurious emissions (transmitter):	4 nW (41-68, 87.5-118, 162-230, 470-872 MHz) (250 nW elsewhere below 1 000 MHz) 20 nW (above 1 000 MHz)
Spurious emissions (receiver):	2 nW (100 kHz-1 000 MHz) 20 nW (1 000-4 000 MHz)

2.7 863-865 MHz Europe only

Specification ETSI EN 301 357

FM fixed channel system with 100% Duty Cycle

Channel bandwidth:	<200KHz
Transmitter radiated power:	10 mW
Spurious emissions (transmitter):	4 nW (41-68, 87.5-118, 162-230, 470-872 MHz) (250 nW elsewhere below 1 000 MHz) 20 nW (above 1 000 MHz)
Spurious emissions (receiver):	2 nW (100 kHz-1 000 MHz) 20 nW (1 000-4 000 MHz)

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PRELIMINARY Draft New [report/RECOMMENDATION] ITU-R M.[MS 14.5-15.35 CHAR] Characteristics of and protection criteria for systems operating in the mobile service in the frequency range 14.5-15.35 GHz

Document 5A/TEMP/122-E
27 May 2013
English only

Working Party 5A
(Sub-Working Group 5A-4)

~~WORKING DOCUMENT TOWARDS A~~ PRELIMINARY DRAFT NEW [REPORT/RECOMMENDATION] ITU-R M.[MS 14.5-15.35 CHAR]

Characteristics of and protection criteria for systems operating in the mobile service in the frequency range 14.5-15.35 GHz

Scope

This [Report/Recommendation] specifies the characteristics of and protection criteria for systems operating in the mobile service in the frequency range 14.5-15.35 GHz. These technical and operational characteristics are to be used as a guideline in analyzing compatibility between systems operating in the mobile service with systems in other services.

The ITU Radiocommunication Assembly,

considering

a) that antenna, signal propagation, and large bandwidth characteristics of mobile systems to achieve their functions and requirements are optimum in certain frequency bands;

b) that the technical characteristics of systems operating in the mobile service are determined by the purpose of the system and vary widely within frequency bands;

c) that representative technical and operational characteristics of systems operating in frequency bands allocated to the mobile service are required to determine the feasibility of introducing new types of systems;

d) that procedures and methodologies are needed to analyse compatibility between systems operating in the mobile service and systems in other services;

e) that mobile systems in the 14.5-15.35 GHz frequency range are used for a variety of purposes including land mobile ground-to- ground data links used to convey voice, data, or video, *noting*

a) that the frequency range 14.5-15.35 GHz is allocated worldwide on a primary basis to the mobile service and fixed services;

b) that the frequency band 14.5-14.8 GHz is allocated worldwide on a primary basis to the fixed-satellite services (Earth-to-space) limited to feeder links for the broadcasting satellite service for countries outside Europe;

c) that the frequency range 14.5-15.35 GHz is allocated worldwide on a secondary basis to the space research service,

recommends

1 that the technical and operational characteristics of the systems operating in the mobile service described in Annex 1 be considered representative of those operating in the frequency band 14.5-15.35 GHz;

2 that the technical and operational characteristics of the systems operating in the mobile service described in Annex 1 should be used for sharing and compatibility studies involving the frequency band 14.5-15.35 GHz;

3 that the criterion of interfering signal power to mobile system receiver noise power level, I/N, of –6 dB should be used as the required protection level for the mobile systems, and that this represents the protection level for aggregate interference if multiple interferers are present.

ANNEX 1

Technical and operational characteristics of systems operating in the mobile service in the frequency range 14.5-15.35 GHz

1 Introduction

In the frequency band 14.5-15.35 GHz mobile systems support a variety of useful functions including reliable transmission of large amounts of data for land mobile to land mobile voice, data, and video wideband links.

2 Technical characteristics of mobile systems in the frequency band 14.5-15.35 GHz

The technical parameters of representative mobile systems operating in the frequency range 14.5-15.35 GHz are presented in Table 1.

TABLE 1

Mobile system characteristics in the band 14.5-15.35 GHz

Characteristics	System 1	System 2	System 3	System 4	System 5	System 6	Units
Frequency Range	14.5-15.35	14.5-15.35	14.5-15.35	14.5-15.0	14.5-15.30	14.6-15.35	GHz
Platform type	Land-mobile vehicle	Handheld	Land-mobile vehicle	Land-mobile vehicle	Land Mobile vehicle	Land Mobile vehicle	
Modulation	8-QAM, QPSK	BPSK	FSK	FSK	BPSK/OQPSK	BPSK/QPSK/QAM	
Emission Designator	50M0G1D	18M5F9W	4M60F9W	20M0G7W	2M46G1D	40M0G7W	
Transmit peak power	15	5	25	18	40W(mean)	0.5W(mean)	W
Maximum data rate	140	10	5	19	1.024/3.072	108	Mbps
Output device	Solid State	FET	FET	FET	FET	Gallium Arsenide Field Effect Transistor	
Antenna pattern type	Directional	Directional	Directional	Directional	Directional	Directional	
Antenna type	Electronically scanned circular array	Stacked Microstrip Patch	Stacked Microstrip Patch	Stacked Microstrip Patch	Stacked Microstrip Patch	Phased-array	
Antenna polarization	Right-hand Circular	Linear	Linear	Linear	Horizontal and Vertical	Left Hand Circular	
Antenna gain	18	4	23	25	24	28	dBi
Antenna horizontal beamwidth	10	60	3	2.1	2.2	1.9	degrees
Antenna vertical beamwidth	15	40	3	2.1	2.2	1.9	degrees
Antenna 1st side-lobe level	8	0	10	12	11	NA	dBi
Antenna height	4 - 18	2	4 - 14	4 - 13	[TBD]	[TBD]	m
Receiver IF –3 dB bandwidth	55	21	4	23	3	35	MHz
Receiver noise figure	4	3	3	4	4	5	dB
Minimum Sensitivity	-93	-98	-105	-97	-106	-94	dBm
Transmitter RF emission bandwidth: –3 dB/-20 dB	30/55	10/20	3/6	12/22	1.5/2.4	20/38	MHz

NA = Not available.

3 Characteristics of mobile systems in the frequency range 14.5-15.35 GHz

[*Editor's Note: A section on the interrelationships of the systems in Table 1 may be addressed in future contributions to this document*]

3.1 Introduction

Technology advancements in signal processing, complex modulations, antenna design, and solid-state components are enabling the design and manufacture of communication systems in the 14.5-15.35 GHz frequency range that are intended to be used as hand-held devices or on ground-based mobile vehicles that can inter-operate with other ground-based vehicles while one or both of the vehicles are in motion.

Some Administrations use this band for mobile ground data links that convey voice, data or video, for example, in situations where there is a need to establish and maintain wideband communication among mobile vehicles and personnel providing relief and public safety to an area subjected to a catastrophic natural disaster. Platforms equipped with these data links can be deployed anywhere within a country whose Administration has authorized their use.

The wide available bandwidth and relative ease of propagation when obstacle-free conditions exist in this frequency range allow mobile systems with data rates up to many 10's of Mbps.

Largely because of these mission requirements, the mobile systems using or planned to use the band 14.5-15.35 GHz tend to possess the following general characteristics:

– they typically use solid-state power-amplifier transmitters that are usually able to tune through the frequency band and use digital modulations;

– an increasing number of these systems have antenna main beams that are steerable in both azimuth and elevation using electronic beam steering techniques.

Table 1 summarizes technical characteristics of representative mobile systems deployed or planned to be deployed in the whole or portions of the band 14.5-15.35 GHz. This information is sufficient for general calculation to assess the compatibility between these mobile systems and other systems. Some or all of the mobile systems whose characteristics are presented in Table 1 possess the properties above, although they do not illustrate the full repertoire of attributes that might appear in future systems.

3.2 Transmitters

The mobile systems operating or planned to operate in the 14.5-15.35 GHz band typically use digital modulations. A given transmitter may be capable of radiating more than one waveform. Solid-state power amplifier output devices are typically used in the transmitters. The trend towards use of solid-state transmitters in new mobile systems will continue for the foreseeable future due to the wide bandwidth, low level of generated spurious emissions, low power consumption, and reliability of these devices.

Typical transmitter RF emission (3 dB) bandwidths of mobile systems operating or planned to operate in the band 14.5-15.35 GHz range from about 4 MHz to 50 MHz. Current transmitter peak output powers range from 5 W (37 dBm) to 25 W (44 dBm). However, advances in solid state modules will enable systems in the near future to generate peak power outputs of 70 W – 130 W in this frequency range.

3.3 Receivers

The newer-generation mobile systems in the 14.5-15.35 GHz use digital modulations to enhance system performance.

The signal processing in the newer generation of mobile systems use digital phase, frequency, or amplitude modulation techniques.

3.4 Antennas

A variety of different types of antennas are used by systems in the 14.5-15.35 GHz band. Antennas in this band are generally of a variety of sizes and thus are of interest for applications where mobility and lightweight are important. The directional antenna pattern for mobile systems must be able cover 360° in the horizontal plane either electronically or mechanically. Sectored horn or circular phased arrays may be used to obtain 360 degree horizontal coverage. Flat-plate electronically steered antennas may require several facets or sub-antennas to achieve 360° horizontal coverage. Both horizontal and vertical polarizations are used.

Typical antenna heights for ground-based mobile vehicle systems range from 4 m to 15 m above surface level. The 4 m height is typical for operations when the antenna is configured in a stowed or retracted position while the vehicle is in motion. The 13-18 m height is typical when the vehicle is halted and an antenna mast can be extended.

Operations while the antenna is in the stowed position while the vehicle is on the move may limit the signal strength of the desired signal due to its propagation along non-line of sight paths with various obstructions. In this frequency range selection of antenna locations on elevated terrain is desirable to mitigate the effects of, e.g., foliage and buildings, etc., on electromagnetic propagation to maximize communication distances when the vehicle is operating when halted.

4 Protection criteria

Under noise-limited conditions, a protection criteria of I/N = –6 dB limits the increase in the noise level in the receiver to about 1 dB and corresponds to an $(I + N)/N$ ratio of 1.26. The 1 dB increase in the noise level could be manifested as, e.g., a decrease in the available fade margin, a decrease in the effective coverage area where a maximum given bit error rate (BER) must be maintained, or receiver desensitisation, which would constitute significant degradation for digital receivers that must operate with very low bit error rates. The 1 dB increase represents the aggregate effect of multiple interferers, when present; the received level of interference from an individual interferer depends on the interferer geometry and other factors, and needs to be assessed in the course of analysis of a given scenario. The specified tolerable I/N ratio is referenced to the mobile receiver input and requires taking in to account all sources of interference. If a single interference source is present, protection of the mobile systems requires that this criterion is not exceeded due to the interference from the single source. If multiple interference sources are present, protection of the mobile systems requires that this criterion is not exceeded due to the aggregate interference from the multiple sources.

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work plan for further studies on cognitive radios systems (CRS)

Source: Appendix 2 to Annex 3 to Doc. 5A/198, 285	**Document 5A/TEMP/147-E**
Subject: Question ITU-R 241-2/5, Resolution ITU-R 58	**29 May 2013**
	English only

Working Party 5A
(Sub-Working Group 5A5-1)

WORK PLAN FOR FURTHER STUDIES ON COGNITIVE RADIOS SYSTEMS (CRS)

Title	Work plan for further studies on CRS
Document type	Report(s)
WP 5A Lead Group	WG New Technologies
SWG Chairman	Marja Matinmikko
Editor	TBD
Focus for scope and work	The scope of this work is to study CRS in accordance with Question ITU-R 241-2/5 and Resolution ITU-R 58. On this basis the work should address the implementation and use of CRS by considering: - operational and technical requirements at a high level; - characteristics; - performance; - possible benefits; - cognitive capabilities and CRS technologies that could enhance sharing between the mobile service and other services; - cognitive capabilities and CRS technologies that could enhance coexistence of the systems in the mobile service, and - factors that need to be considered for the introduction of CRS technologies in the land mobile service including migration issues. These items should be addressed in one or more Reports.
Related Documents	Reports ITU-R M.2225, ITU-R M.2242, ITU-R SM.2152
Milestones	**Meeting No. 9 (May 2012)** Review Question ITU-R 241-2/5 and Resolution ITU-R 58 and identify items to be studied. Develop a work plan for further studies on CRS. Review and revise the working document towards [LMS.CRS2]. Prepare liaisons to relevant ITU-R groups and other appropriate external organisations, as necessary.

	Meeting No. 10 (November 2012) Consider the received input contributions related to the scope of work. Review and revise the working document towards [LMS.CRS2]. Review and revise work plan as necessary. Prepare liaisons to relevant ITU-R Groups and other appropriate external organisations, as necessary. **Meeting No. 11 (May 2013)** Consider the received input contributions related to the scope of work. Review and revise work plan as necessary. Prepare liaisons to relevant ITU-R Groups and other appropriate external organisations, as necessary (e.g. on review of the working document towards [LMS.CRS2].). **Meeting No. 12 (November 2013)** Consider the received input contributions related to the scope of work. Review and revise work plan as necessary. Consider the responses to the liaison statement for further revision and completion of the working document towards [LMS.CRS2] and transfer open issues to a new working document towards [LMS.CRS3]. Finalize the work on [LMS.CRS2]. Prepare liaisons to relevant ITU-R Groups and other appropriate external organisations, as necessary. **Meeting No. 13 (May 2014)** Consider the received input contributions related to the scope of work. Review and revise work plan as necessary. Review and revise the working document towards [LMS.CRS3]. Prepare liaisons to relevant ITU-R groups and other appropriate external organisations, as necessary. **Meeting No. 14 (November 2014)** Consider the received input contributions related to the scope of work. Complete the working document towards [LMS.CRS3] and finalize the work on [LMS.CRS3]. Prepare liaisons to relevant ITU-R groups and other appropriate external organisations, as necessary.