IEEE Standard 802.20™ MBWA

Mobile Broadband Wireless Access Systems Supporting Vehicular Mobility

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IEEE 802 STANDARDS WORKSHOP
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Introduction

- IEEE 802.20™ is a new standard for mobile broadband wireless access.
- IEEE 802.20™ was developed by the Mobile Broadband Wireless Access (MBWA) Working Group and sponsored by the IEEE 802 Local and Metropolitan Area Networks Standards Committee.

IEEE P802.20 Mission

- To develop the specification for an efficient packet based air interface that is optimized for the transport of IP (Internet Protocol) based services.
- To enable worldwide rapid deployment of cost-effective, affordable, ubiquitous, always-on and interoperable multi-vendor mobile broadband wireless access networks that meet the needs of business and residential end user markets.

IEEE Standard 802.20™-2008 Scope

- Air-interface specification of PHY and MAC layers for interoperable mobile broadband wireless access systems
- Operates in licensed bands below 3.5 GHz
- Optimized for IP-data transport
- Supports various vehicular mobility classes

IEEE Standard 802.20™-2008

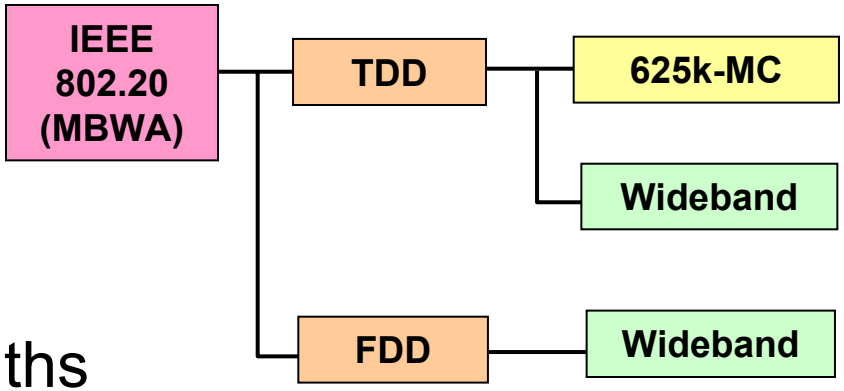
- Published in August 2008
- Liaison relationship with ARIB
  - ARIB (Association of Radio Industries and Business) of JAPAN adopted and standardized 802.20 for Japan application.

IEEE Standard 802.20™-2008 System Aspects

- The 802.20 standard intends to permit either a fixed hierarchical network (traditional to cellular architecture) or non-hierarchical network.
- The specification structure provides a versatile framework that can easily accommodate future services and capabilities while not compromising QoS.

“Wideband” and “625k-MC” Modes

- IEEE Standard 802.20™-2008 specifies two modes of operation.
- “Wideband” mode
  - OFDMA
  - FDD and TDD
  - 5 MHz to 20 MHz bandwidths
- “625k-MC” mode
  - SDMA
  - TDD
  - 625 kHz carrier spacing
  - Multi-carrier operation



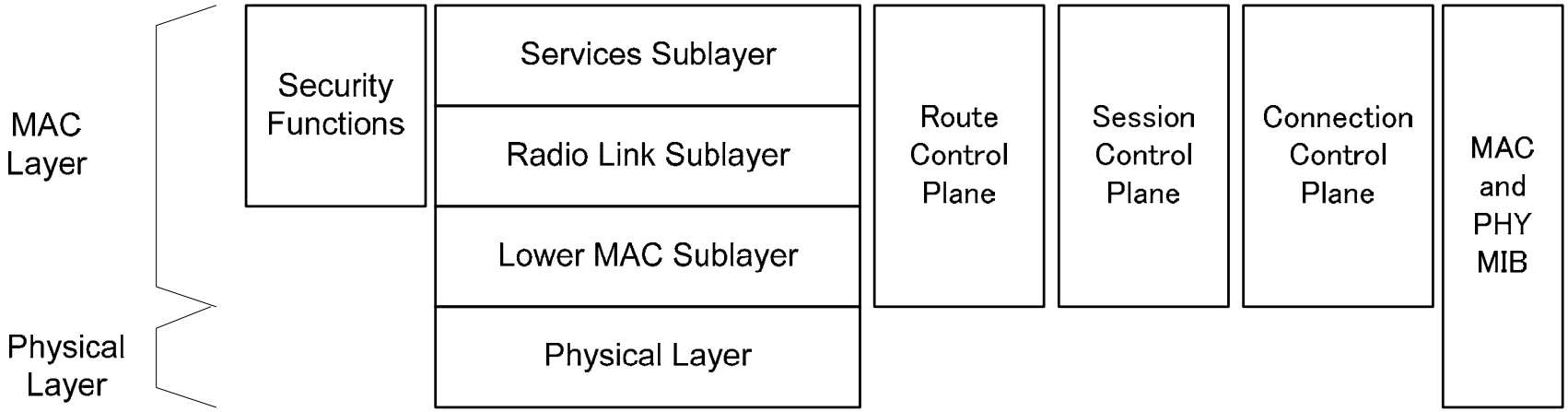
MBWA: Mobile Broadband Wireless Access

IEEE Standard 802.20™-2008 Wideband Mode

Wideband Mode Overview

- "Multi-Route" standard
  - Multiple routes (unique paths to the network) may be configured.
- Advanced interference management
  - CDMA control segment in Reverse Link (RL) for robust signaling
  - Fast RL power control to tightly manage inter-sector interference
  - Independent best serving sector selection on Forward Link (FL) and RL
  - Fractional Frequency Reuse to improve cell edge user experience
- MIMO/SDMA/Beamforming
  - Fast closed loop control
- Performance
  - Peak rate (20 MHz): FL 288 Mbps (4x4 MIMO), RL 75 Mbps (1x4)
  - Spectral Efficiency: FL 2.1 bps/Hz (4x4 MIMO), RL 1.4 bps/Hz (1x4)
  - Seamless and fast handoff: intra-cell handoff delay of 8.9 ms

Wideband Mode Layering Architecture



Functions provided:

- Physical layer (PHY): Physical parameters and protocols
- Lower MAC Sublayer: Transmit and receive procedures over PHY
- Radio Link Sublayer: QoS, reliability, Services Sublayer packets multiplexing
- Services Sublayer: Protocols for signaling and IP transport services
- Connection Control Plane: Connection establishment and maintenance
- Session Control Plane: Protocol negotiation and configuration services
- Route Control Plane: Creation, maintenance, and deletion of Routes

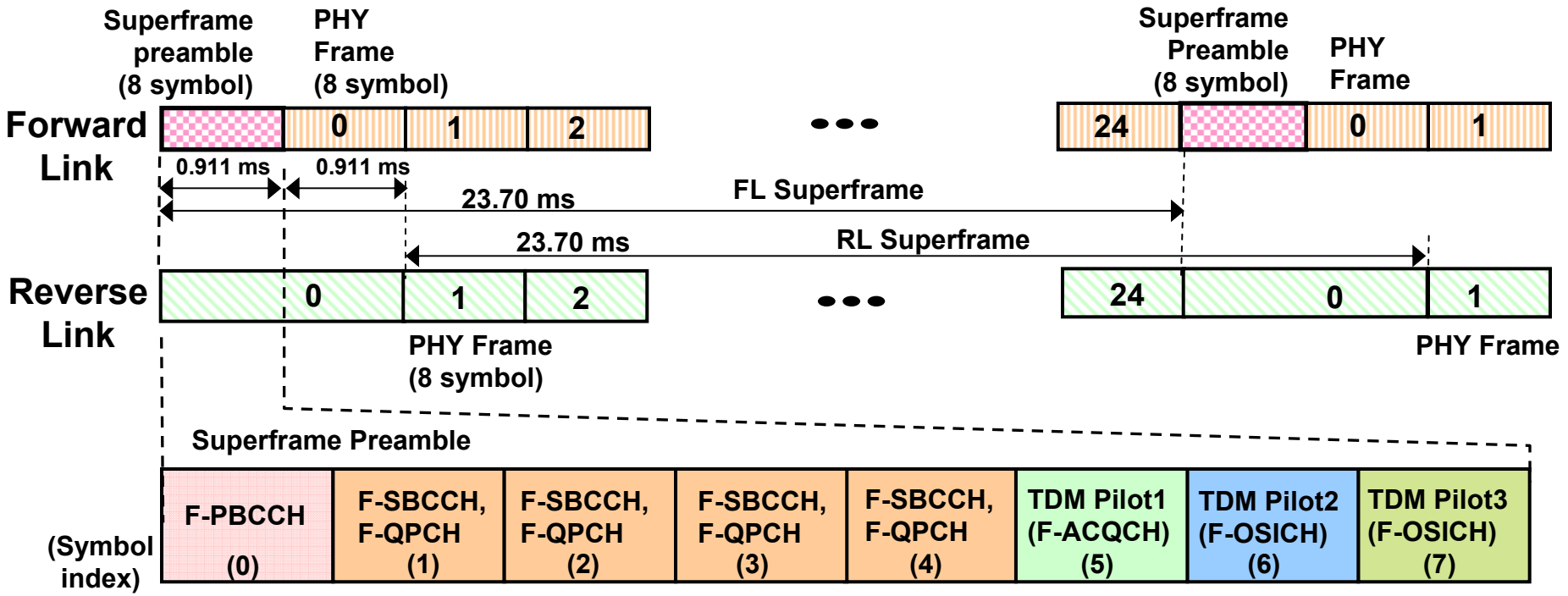
Wideband Mode OFDMA Numerology

	FFT Size			
Parameter	**NFFT = 512**	**NFFT = 1024**	**NFFT = 2048**	**Units**
Chip Rate	**4.9152**	**9.8304**	**19.6608**	**Mcps**
Subcarrier Spacing	**9.6**	**9.6**	**9.6**	**kHz**
Bandwidth of Operation	**2.5–5**	**5–10**	**10–20**	**MHz**
Cyclic Prefix	**6.51, 13.02, 19.53, or 26.04**	**6.51, 13.02, 19.53, or 26.04**	**6.51, 13.02, 19.53, or 26.04**	**μs**
Windowing Guard	**3.26**	**3.26**	**3.26**	**μs**
OFDM Symbol Duration	**113.93, 120.44, 126.95, or 133.46**	**113.93, 120.44, 126.95, or 133.46**	**113.93, 120.44, 126.95, or 133.46**	**μs**

- OFDMA with frequency hopping
- 5 MHz – 20 MHz operation
  - Multi-carrier operation for expanding bandwidth
- FDD/TDD
- Modulation signal sets up to 64 QAM with HARQ
- FEC: Convolutional code, Turbo code, LDPC (optional)

Wideband Mode Superframe Structure

[FDD Example]



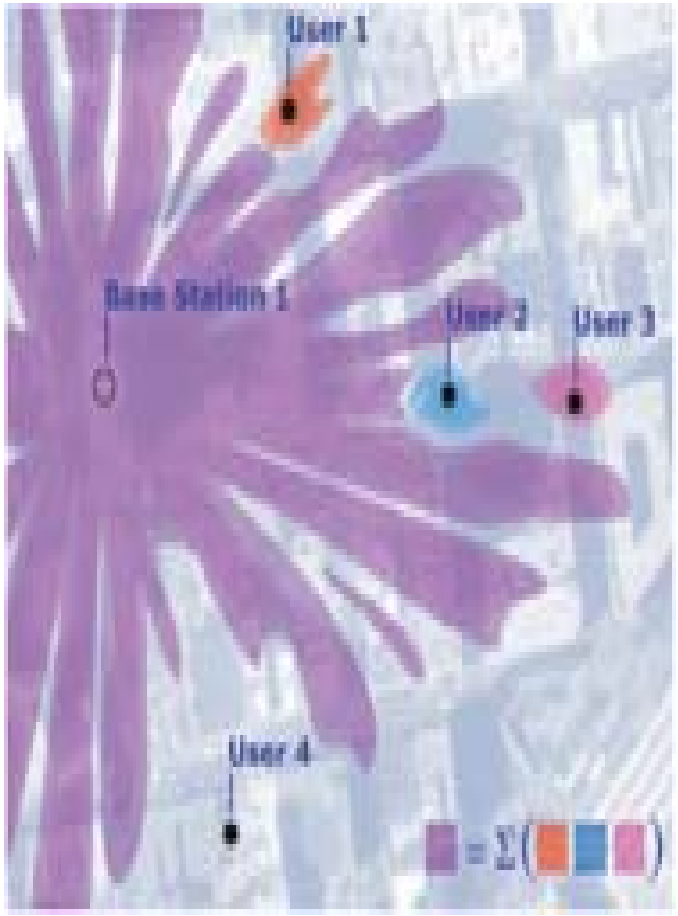
F-PBCCH (Primary Broadcast Control Channel): Deployment specific information
F-SBCCH (Secondary Broadcast Control Channel): Sector specific information
F-QPCH (Quick Paging Channel): Paging indication
TDM Pilot1 (Acquisition Channel): Initial timing and frequency acquisition
TDM Pilot2: Sector ID and other sector interference indication
TDM Pilot3: Assisting system determination information
F-OSICH (Other Sector Interference Channel): Other sector interference indication

IEEE Standard 802.20™-2008
625k-MC Mode

625k-Multicarrier (625k-MC) Mode Overview

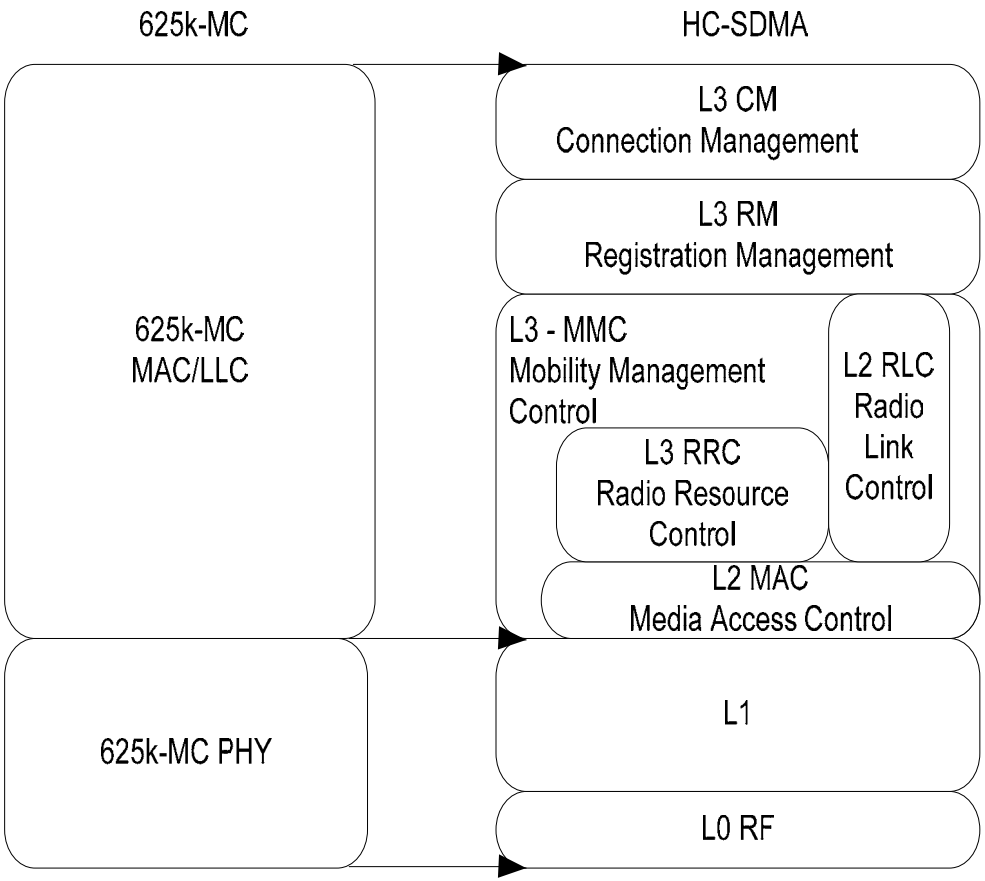
- Broadband Wireless Internet Access (IP data transport) System that achieves high capacity by application of Multiple Antenna Signal Processing and Spatial Division Multiple Access (SDMA) Technologies in Mobile environment.
- IEEE 802.20's 625k-MC mode specifies a set of enhancements to the High Capacity-Spatial Division Multiple Access (HC-SDMA) Radio Interface Standard (ATIS-0700004.2005)
- Fully backward compatible to the commercially deployed iBurst™ systems based on ATIS HC-SDMA Radio Interface Standard.
- Promises Higher peak user data rates using multiple RF (radio frequency) carriers with 625 kHz carrier spacing

625k-MC mode
“Spatial Radio Technology”



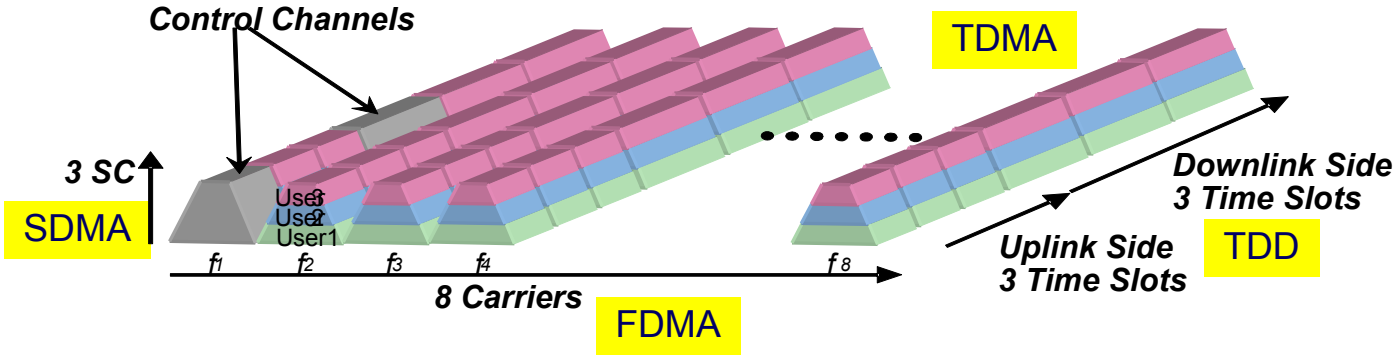
- Delivers high spectral efficiency and capacity by efficient spatial-temporal techniques
  - A TDD air interface design optimized to extract maximum benefit from adaptive, multiple-antenna signal processing and Spatial Division Multiple Access (SDMA)
  - Basic physical resource in the system is a spatial channel defined by a carrier, an uplink and downlink timeslot pair, and a spatial channel index.
  - Support multiple spatial channels simultaneously on the same conventional channel.

625k-MC Reference Architecture



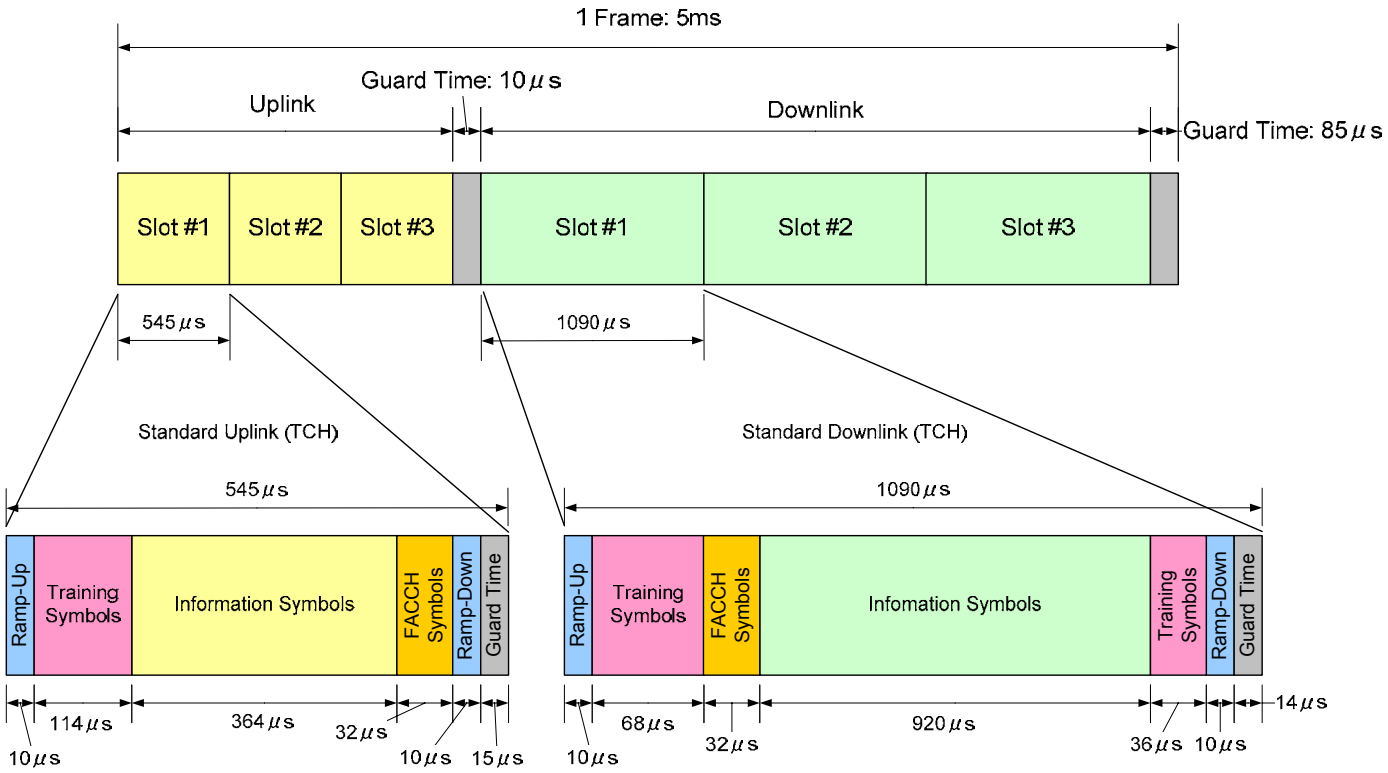
- The PHY and Data Link Layers (MAC and LLC) are optimally tailored to provide increased spectral efficiency and capacity, and wider coverage that enables economic operation even when the spectrum is as small as 5 MHz.
- Secondly, the PHY and Data Link Layers support higher data rates by enabling aggregation of multiple 625 kHz carriers.
- Creates logical sessions for the efficient transport IP data in PPP or IEEE 802.2/802.3 frames

625k-MC Layer 1 (L1) Features



- TDD/TDMA/FDMA organization with 5 ms frames
  - Multiple resources permit granular allocation, low latency
  - TDD well matched to adaptive antennas, asymmetric data
- 625 kHz carriers, constant symbol rate of 500 kSymbols/s with 25% root-raised cosine filtering
  - Low complexity spatial-temporal processing
  - Good spatial coherence properties
- Synchronized network
  - Over-the-air AT synchronization, external BS synchronization
  - Predictable inter- and intra-cell interference
- Adaptive modulation and coding
  - Provide robust link, options for inexpensive terminals
  - Link budget to match both directional, non-directional transmissions
- The peak downlink user data rates of 1.493 Mbps and peak uplink user data rates of 571.2kbps in a channel bandwidth of 625 kHz.

625k-MC Frame and Slot Structure



- Training sequences for spatial and temporal processing that maximizes adaptive antenna gain and enables efficient SDMA
- Adaptive Modulation and Coding with Multiple ModClasses

625k-MC Layer 2 (L2) Protocol Features

- L2 Defines the specifications for reliable transmission including the Radio Link Control (RLC), MAC and logical channel structures.
- L2 Medium Access Control (L2 MAC) sublayer provides dynamic radio access management and control functions to map and transport logical channels onto Physical layer bursts
- Three classes of logical channels
  - BCH: UT independent broadcast
  - CCH, PCH, RACH, FACCH: UT dependent control
  - TCH: UT dependent mixed control and data
- Burst structure, message ordering enables efficient spatial and temporal training
- All physical resources available for data and/or control
  - Except for BCH carrier/timeslot pair which enables UT's to Synchronize, determine the best BS both for initial acquisition and for handover

625k-MC Layer 3 (L3) Protocol Features

- Defines the functions for logical connection, registration management, and mobility management, which include efficient handovers and radio resource control to coordinate the power control and link adaptation necessary to maintain an RF link.
- Fast ARQ for reliable link
  - Endpoints at BS and UT to minimize retransmission time
  - Minimized Header operation to support Cell edge user and VoIP applications
- QoS support
  - Per-session priority definition based on IETF's DiffServ Policy Model
- Security
  - Robust security with air interface confidentiality and authentication.
    - Shared secret air interface parameter exchange between UT and BS using elliptic curve cryptography based PKI
    - User Terminal and Base Station Authentication is based on digital certificates using RSA algorithm
    - Encryption of TCH traffic streams is performed using either an RC4 stream cipher or AES block cipher
- Mobility support
  - Make-before-break radio handover

625k-MC Mode Features

All HC-SDMA Radio Interface Standard (ATIS-070004.2005) Features

+

Enhanced PHY/MAC (L1/L2/L3) Protocols to deliver

- **High Peak Data Rates (32QAM and 64 QAM ModClasses)**
- **Broadcast and Multicast Services**
- **Advanced and Robust Secure Communication Protocol (AES)**
- **QoS Support for VoIP and Streaming**
- **Broadcast and Multicast streaming services**
- **Sleep Mode Control and Power Conservation of UT**
- **Radio Network Quality Monitor and Control**
- **High Mobility and Make-before-Break Handover**

IEEE Standard 802.20™ Enhancements and Amendments

IEEE Std 802.20.2™-2010

- IEEE Standard for Conformance to IEEE 802.20 Systems—Protocol Implementation Conformance Statement (PICS) Proforma
  - This standard represents the Protocol Implementation Conformance Statement Proforma, per ISO/IEC 9646-7 and ITU-T X.296, for conformance specification of access nodes and access terminals based on the air interface specified in IEEE Std 802.20.

IEEE Std 802.20.3™-2010

- IEEE Standard for Minimum Performance Characteristics of IEEE 802.20 Terminals and Base Stations/Access Nodes
  - This standard specifies minimum performance parameters and the associated test methodologies for implementation of IEEE 802.20 compliant systems.

IEEE Std 802.20a™-2010

- Amendment 1: Management Information Base Enhancements and Corrigenda Items
  - This amendment enhances IEEE 802.20 Management Information Base (MIB) clauses to include additional information and MIB documentation (i.e., a discussion of security impacts, and cross references to the text for appropriate parameters within the MIB, itself) to conform with the applicable parts of the IETF's 2008 guidelines for MIBs. The amendment also corrects any errors, inconsistencies, and ambiguities associated with the MIB clause of IEEE Std 802.20-2008.

IEEE Std 802.20b™-2010

- Virtual Bridged Local Area Networks Amendment 15: Bridging of IEEE 802.20
  - This amendment specifies the mechanism for the support of bridging of IEEE 802.20 networks.

IEEE Standard 802.20™

Realizable for Commercial and Consumer Applications. Global Potential & Prospective Adopters.

IEEE 802.20 Standard Adoption in JAPAN

- ARIB STD-T97 “Mobile Broadband Wireless Access System （IEEE 802.20 TDD Wideband and 625k-MC Modes Application in Japan)”
  - Ver. 1.0 approved in Sep. 2008
  - Standard consists of Japan’s Radio Regulations and reference to IEEE 802.20 Standard 2008.
  - Specifies requirements of the mobile broadband wireless access systems for the Japanese 2.5 GHz band operation.

IEEE 802.20 625k-MC Mode Prospects

- IEEE 802.20's 625k-MC mode is an Enhanced iBurst System Based on ANSI ATIS-HC SDMA
- iBurst System (Baseline Specifications of 625k-MC Mode) has been globally adopted in both consumer and commercial markets

Global Deployment status of iBurst System

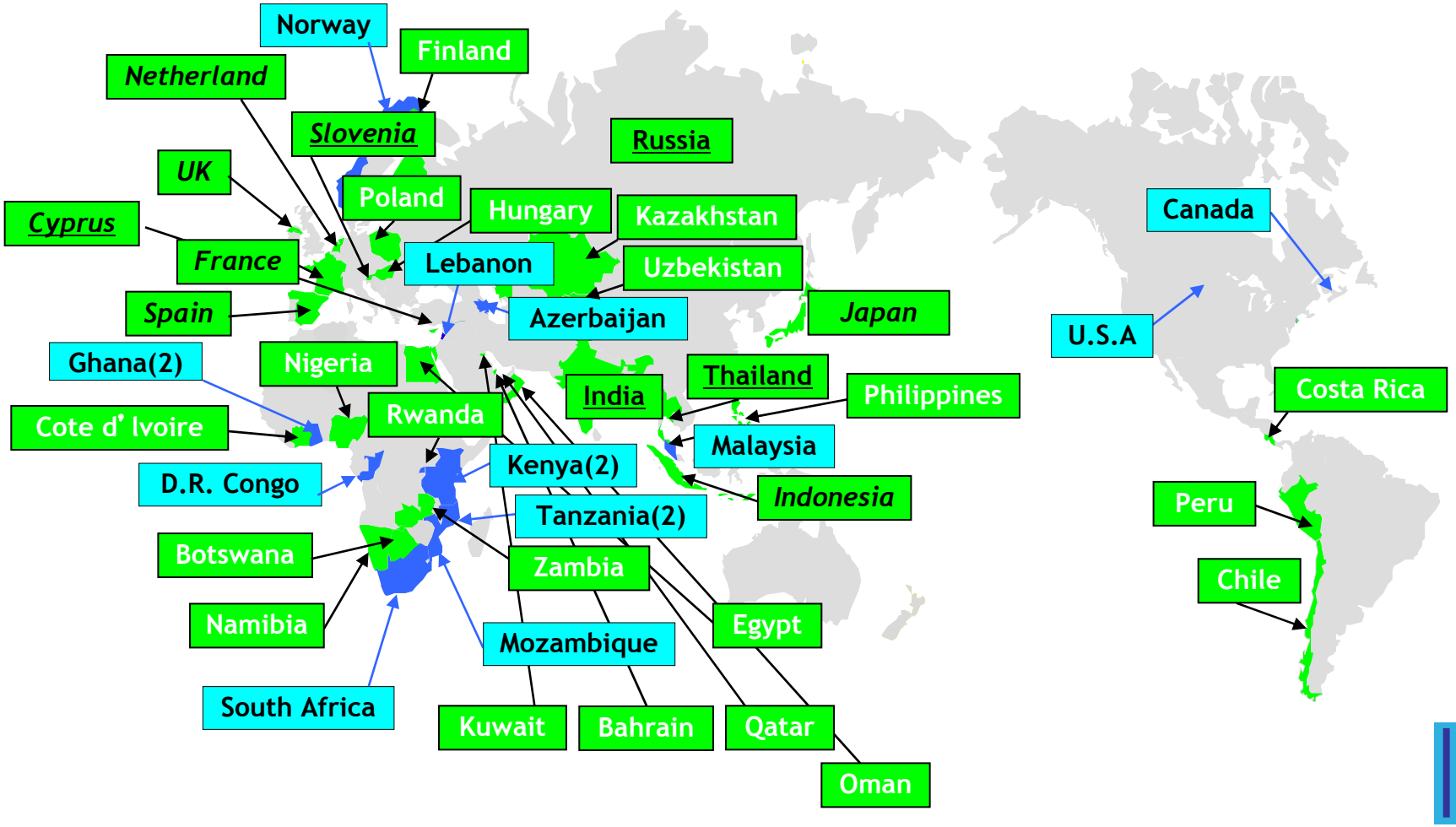
Commercial Service in 12 Countries (15 Operators) and Field Trial is being conducted or planned to conduct in many Countries.

Commercial Service

Deployment Planning

(2) Means 2 Operators existing in one country

"Underlined Black Color": "Field Trial already Conducted."
"Italic Black Color" : "Field Trial Being Conducted Now"
"White Color" : "Planning to conduct Field Trial"



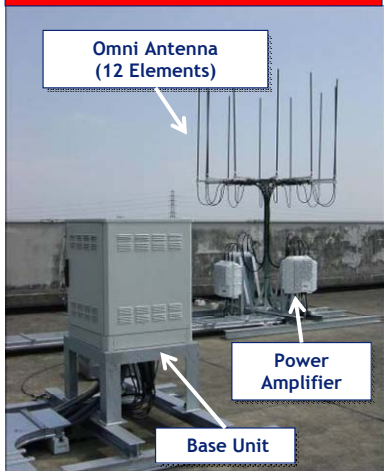
625k-MC Mode Baseline Products - Typical Realizations

iBurst

At the Office or At Home, In a Moving Car or Train, Enjoy real time Video Streaming, Web Browsing & VoIP Without any stress

- High Spectrum Efficiency
- Seamless Handover & Full Mobility
- Non Line of Sight System

Base Station



User Terminals by Kyocera

 PCMCIA Card	 Express Card 54	 USB
 1Mbps Desk Top	 2Mbps desk Top	 iBurst Phone

Summary

- The IEEE 802.20 Standard provides highly optimized solutions:
  - Wideband OFDMA
  - 625 kHz Multi-Carrier SDMA
- Significantly higher performance and flexibility than competing technologies.
- Optimized mobility and advanced QoS mechanism will enhance user experience and provide leading edge performance.
- Service providers will benefit from the use of flexible mechanism to deliver and differentiate their services.
- An implementable standard for commercial and consumer application.