IMT-2000 Regulatory and Spectrum Considerations

ITU-BDT Regional Seminar for Africa
May 9 – 12, 2005
Samantha Craig
Government Affairs

QUALCOMM Incorporated

Overview

- **Spectrum and Regulatory Objectives**
- **The ITU and IMT-2000 Spectrum**
  - Overview of the ITU
  - IMT-2000 Spectrum
  - IMT-2000 Recommendations and Frequency Band Considerations
  - World Radio Conference 2003
  - IMT-2000 for Developing Countries
- **Development of IMT-2000 in Africa**

Spectrum and Regulatory Objectives

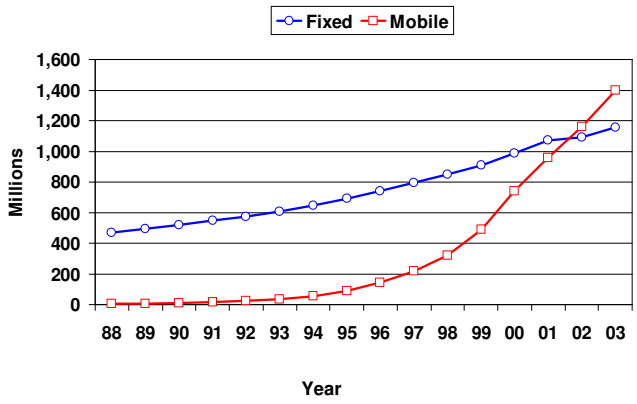
Why is spectrum so important?

Despite being a scarce resource….

- Globally, mobile phone users are overtaking fixed-line subscribers due to the affordable high-quality voice and data services that are made possible by today's technologies. Wireless-only homes are growing and there are far more mobile phones than PCs in the world.
- IMT-2000 technologies foster various levels of global connectivity – from wireless local loop to high speed mobile voice and/or data in many different licensed frequency bands.
- IMT-2000 technologies enable high quality voice, wireless broadband access and a variety of multimedia applications making telemedicine, public safety, education, business and entertainment a reality everywhere.

Mobile surpasses fixed …

Telephone Main Lines and Mobile Subscribers World Market, 1988-2003



Source: ITU World Telecommunication Indicators, 2004

5

Spectrum Regulatory Objectives

- **Advance spectrum reform by developing and implementing market-oriented allocation and assignment reform policies.**
- **Vigorously protect against harmful interference.**
- **Conduct effective and timely licensing activities that encourage efficient use of the spectrum.**
- **Provide adequate spectrum and improve interoperability for better public safety and commercial purposes.**

http://www.fcc.gov/spectrum/

6

Other Regulatory Objectives

- **Ensuring Technology Neutrality**
- **Responsibility for Efficient Use of Radio Spectrum**
- **Promoting Consolidation with Existing Telecoms Infrastructure**
- **Defining Fixed Wireless vs. Limited Mobility**
- **Enabling Convergence**

Role of Regulators – Very Crucial

7

Technology Neutrality

- Spectrum availability dictates technology choice
  - Appropriate spectrum enables innovative/different technology selection
  - Spectrum efficiency and 3G data benefits should be leveraged
  - Economies of scale should be leveraged
- No Specification of Technology
  - Let the Best Business Case Win
  - Limited Specification of Spectrum Allocation Plans

Choice of Technologies Enables Cost-Effective Telecoms Access

8

Convergence Licensing

- Convergence Happening at the Device Level
  - Licensing policy needs to address this
  - Allow Carriers to Offer Fixed (e.g., WLL), Mobile, Data, Broadcast, etc. Services
- Fixed →Limited Mobility →Full Mobility Convergence
  - e.g. India's "Unified License" regime
- Promote Carriers in Providing Different Tiering of Service Plans
- Converged licenses Possible at Network Facility, Services, ISP, Content layers

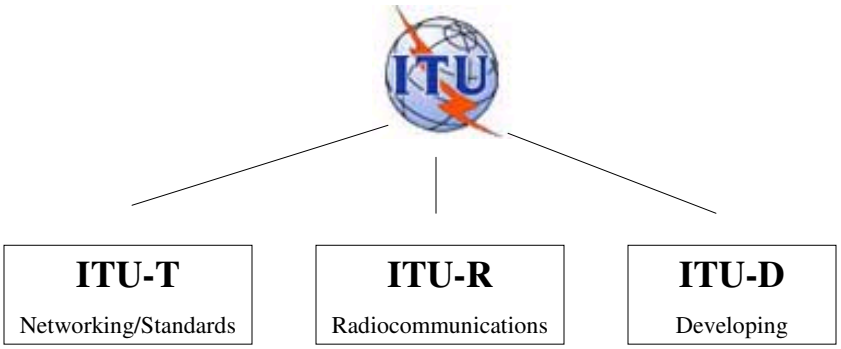
Convergence is Future

9

The ITU and IMT-2000 Spectrum

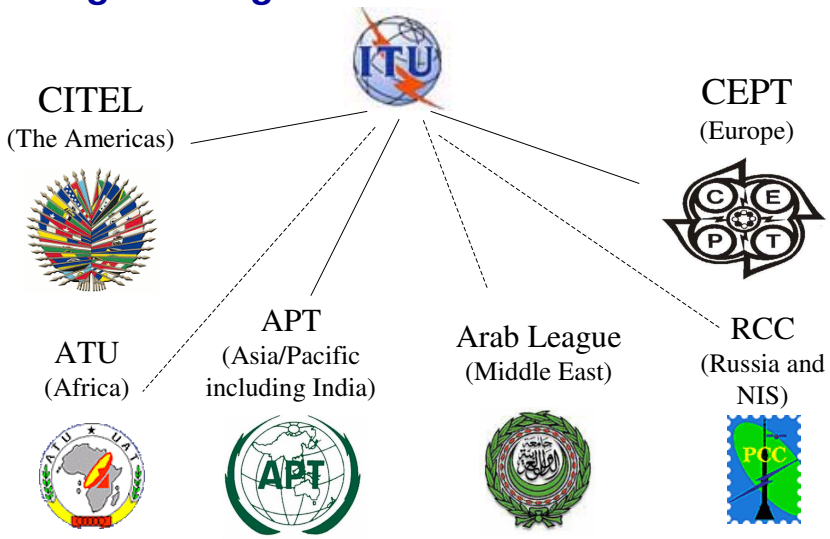
10

ITU Structure



11

ITU/Regional Organizations



12

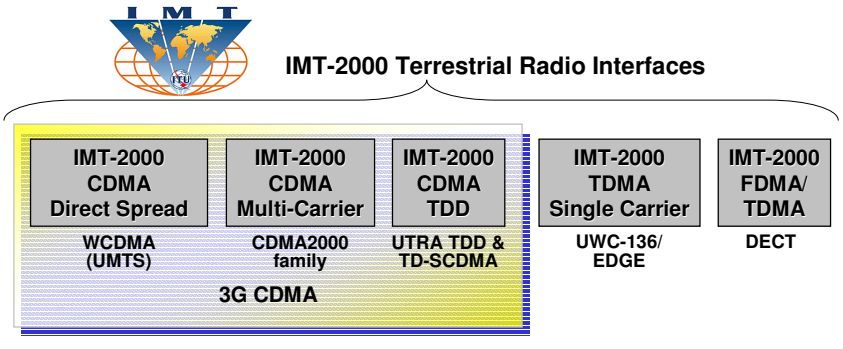
IMT-2000 Background

- **International Mobile Telecommunications-2000 (IMT-2000)** is the global standard for third generation (3G) wireless communications, defined by a set of interdependent ITU Recommendations.
- IMT-2000 provides a framework for worldwide wireless access by linking the diverse systems of terrestrial and/or satellite based networks and takes advantage of the synergies between digital mobile telecommunications technologies and systems for fixed and mobile wireless access systems.
- The IMT-2000 original minimum requirements for radio technology evaluation:
  - **144 kbit/s (for vehicular high speed),**
  - **384 kbit/s (for medium speed), and**
  - **2048 kbit/s (for indoor, low speed)**

13

IMT-2000 Radio Air Interfaces

- **The ITU has approved five radio air interface standards (ITU-R Recommendation M.1457) and has identified multiple frequency bands for IMT-2000.**
- **There are five ITU IMT-2000 recognized air-interfaces: WCDMA (IMT-DS), CDMA2000 (IMT-MC), TD-SCDMA (IMT-TD), DECT (IMT- FT), EDGE (IMT- SC).**



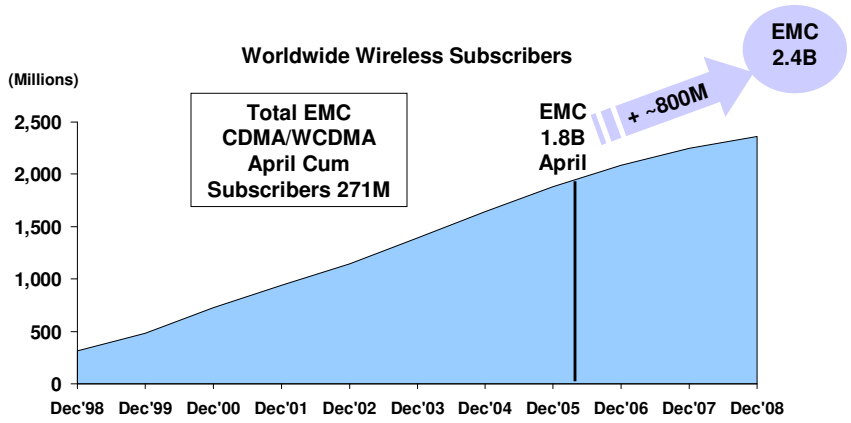
Although there are five terrestrial standards, most of the attention and energy in the industry has been toward the CDMA standards

14

IMT-2000 is Well Established and Growing

3G CDMA Technologies: CDMA2000® and WCDMA

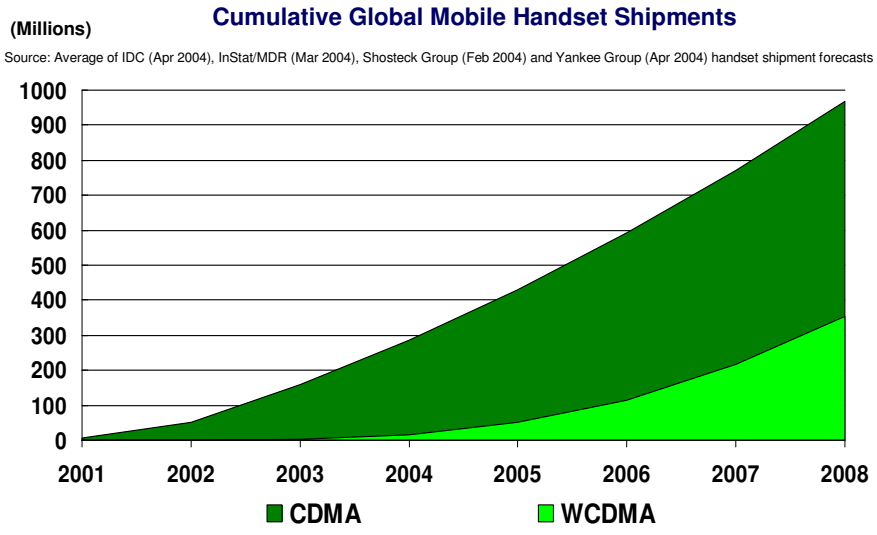
Over 170M Subscribers, 150 Operators, 77 Countries, 660 Handsets, 56Vendors



Source: EMC as of April, 2005; 3gtoday.com as of April 2005; CDG as of April, 2005

15

Economies of Scale From 3G CDMA Deployments



16

3G CDMA Solutions Supporting Global Connectivity

- **The different 3G CDMA technologies are being deployed in various spectrum bands around the world.**
- **QUALCOMM is continuously developing solutions for the market that serve to bridge the divide between different technologies that are deployed across varying spectrum bands.**
  - Tightly integrated roaming solutions enable end users to roam between 2G and 3G networks, and between CDMA2000® and WCDMA (UMTS) networks.
  - QUALCOMM's MSM6500™ Mobile Station Modem (MSM™) chipset and system software solution supports CDMA2000® 1X, CDMA2000 1xEV-DO and roaming on GSM/GPRS systems.
  - The MSM6200™ Mobile Station Modem (MSM™) chipset and system software solution is QUALCOMM's second-generation WCDMA (UMTS) solution that also supports GSM/GPRS.
  - QUALCOMM's MSM6275™ Mobile Station Modem (MSM™) chipset and system software solution supports High-Speed Downlink Packet Access (HSDPA), a next-generation feature of the WCDMA (UMTS) standard, and GSM/GPRS/EDGE.

17

IMT-2000 Spectrum Facts

The ITU has approved five radio air interface standards and has identified multiple frequency bands for IMT-2000:

- **The IMT-2000 technologies are frequency agnostic**
- **The dominant IMT-2000 standards, CDMA2000 and WCDMA, are being deployed in multiple frequency bands**
- **The CDMA2000 standard is defined for twelve different frequency bands, of which the 800 MHz and 1900 MHz are most widely used**
- **The WCDMA standard is defined for the 1800, 1900 and 2100 MHz**
- **The decision in which bands IMT-2000 technologies are first deployed depends on regulatory decisions, the marketplace, and political considerations**

18

IMT-2000 Frequency Bands Identified by the ITU

IMT-2000 will operate in the frequency bands identified in the Radio Regulations (RR) as intended for use on a worldwide basis by administrations wishing to implement IMT-2000, as follows:

- **WARC-92 identified the bands:**
  - 1 885 - 2 025 MHz
  - 2 110 - 2 200 MHz
- **WRC-2000 identified the bands:**
  - 806 - 960 MHz
  - 1 710 - 1 885 MHz
  - 2 500 - 2 690 MHz

for possible use by IMT-2000 systems, noting (in accordance with RR No. 5.388) that identification of these bands does not establish priority in the RR and does not preclude use of the bands for any other services to which these bands are allocated. Also, some administrations may deploy IMT-2000 systems in bands other than those identified in the RR.

Source: Recommendation ITU-R M.1036-2, "Frequency arrangements for implementation of the terrestrial component of International Mobile Telecommunications-2000 (IMT-2000) in the bands 806 - 960 MHz , 1 710-2 025 MHz, 2 110 - 2 200 MHz and 2 500 - 2 690 MHz"

19

ITU Recommendation on IMT-2000 Spectrum

Recommendation ITU-R M.1036 "Frequency arrangements for implementation of the terrestrial component of International Mobile Telecommunications - 2000 (IMT-2000) in the bands 806 - 960 MHz , 1 710-2 025 MHz, 2 110 - 2 200 MHz and 2 500 - 2 690 MHz"

- **Recognizes that Administrations may implement IMT-2000 in any band allocated for the mobile service**
  - Today, IMT-2000 systems have been deployed in bands designated for mobile service for many years, such as the 450 MHz band (NMT-450), 800 MHz (cellular), 1900 MHz band (PCS).

- **Encourages Administrations to allow existing pre-IMT-2000 systems (i.e. IS-95A) to migrate to IMT-2000**
  - Example: the first commercial IMT-2000 systems were implemented by upgrading existing cellular and PCS systems in the 450, 800, 1700 and 1900 MHz bands.

20

IMT-2000 Frequency Arrangements: 806-960 MHz Band

Frequency arrangements	Mobile station transmitter (MHz)	Centre gap (1) (MHz)	Base station transmitter (MHz)	Duplex separation (2) (MHz)
A1	824-849	20	869-894	45
A2	880-915	10	925-960	45

NOTE 1 – Due to the overlap of base station transmitter and mobile station transmitter bands and the different usage of the bands 806-824 MHz, 849-869 MHz and 902-928 MHz between Regions, there is no common solution possible in the near- and medium-terms.
(1) *Centre gap* – the frequency separation between the upper edge of the lower band and the lower edge of the upper band in an FDD paired frequency arrangement.
(2) *Duplex band frequency separation* – the frequency separation between a reference point in the lower band and the corresponding point in the upper band of an FDD arrangement.

Source: Recommendation ITU-R M.1036-2, "Frequency arrangements for implementation of the terrestrial component of International Mobile Telecommunications-2000 (IMT-2000) in the bands 806 - 960 MHz , 1 710-2 025 MHz, 2 110 - 2 200 MHz and 2 500 - 2 690 MHz"

21

IMT-2000 Frequency Arrangements: 1710 - 2200 MHz Band

Frequency arrangements	Mobile station transmitter (MHz)	Centre gap (1) (MHz)	Base station transmitter (MHz)	Duplex separation (2) (MHz)	Un-paired spectrum (e.g. for TDD) (MHz)
B1	1920-1980	130	2110-2170	190	1880-1920; 2010-2025
B2	1710-1785	20	1805-1880	95	
B3	1850-1910	20	1930-1990	80	1910-1930
B4 (harmonized with B1and B2)	1710-1785 1920-1980	20 130	1805-1880 2110-2170	95 190	1900-1920 2010-2025
B5 (harmonized with B3 and parts of B1 and B2)	1850-1910 1710-1755 1755-1805	20 50 305	1930-1990 1805-1850 2110-2160	80 95 355	1910-1930
B6 (harmonized with B3 and parts of B1 and B2)	1850-1910 1710-1770	20 340	1930-1990 2110-2170	80 400	1910-1930

Source: Recommendation ITU-R M.1036-2, "Frequency arrangements for implementation of the terrestrial component of International Mobile Telecommunications-2000 (IMT-2000) in the bands 806 - 960 MHz , 1 710-2 025 MHz, 2 110 - 2 200 MHz and 2 500 - 2 690 MHz"

22

IMT-2000 Frequency Arrangements: 2500 - 2690 MHz Band

Frequency arrangements	Mobile station transmitter (MHz)	Centre gap (1) (MHz)	Base station transmitter (MHz)	Duplex separation (2) (MHz)	Un-paired spectrum (e.g. for TDD) (MHz)
C1	2 500–2 570	50	2 620–2 690	120	TDD
C2	2 500–2 570	50	2 620–2 690	120	FDD DL (external)
C3	Flexible FDD/TDD				

Source: Recommendation ITU-R WP8F Temp 151 Rev 2 "Frequency arrangements for implementation of the terrestrial component of International Mobile Telecommunications-2000 (IMT-2000) in the bands 806 - 960 MHz , 1 710-2 025 MHz, 2 110 - 2 200 MHz and 2 500 - 2 690 MHz"

23

Considerations in Assigning Frequencies (1/2)

Priorities must be ranked

- Providing a fair and equitable distribution of spectrum
- Spectrum utilization, flexible use and efficiency
- Cost of equipment (leveraging of economies of scale)
- Capacity to meet projected demand for universal telephony and Internet access
- Advanced services to be provided (high-speed Internet access, multimedia, etc.)
- Evolution of existing pre-IMT-2000 systems (leveraging investments)
- Competing uses for frequencies and cost of relocation of existing systems

24

Considerations In Assigning Frequencies (2/2)

Technology and frequency selection make a difference

- Today, economies of scale for wireless infrastructure and subscriber equipment for CDMA systems exist in several frequency bands, specifically the 800 MHz (cellular) and 1900 MHz (PCS) bands
- There is growing momentum and interest for CDMA2000 in the 450 MHz band worldwide.
- CDMA is the foundation for 3G networks and QUALCOMM has licensed the technology to all the main telecom manufacturers. Licensees include:
  - 33 Infrastructure equipment manufacturers
  - 92 Subscriber equipment manufacturers
  - 22 Test equipment manufacturers
- Spectrum will continue to be a scarce and valuable resource
- Utilization of spectrally efficient technologies will continue to be critical

25

World Radio Conference 2003 Results

- **The World Radio Conference 2003 (WRC-03) approved plans for the future development of IMT-2000, and created a new item for attention on IMT-2000 for WRC-07 (Agenda Item 1.4):**
  - **"To consider frequency-related matters for the future development of IMT-2000 and systems beyond IMT-2000 taking into account the results of ITU-R studies in accordance with Resolution 228. (Rev. WRC-03)"**
  - **Res. 228 (Rev.WRC-03) invites further studies of lower frequency bands for IMT-2000. Specifically, resolution 228 invites ITU-R "to conduct regulatory and technical studies on the usage of frequencies below those identified for IMT-2000 in No. 5.317A for the future development of IMT-2000 and systems beyond IMT-2000".**
- **Several developing countries requested language to be included in the report for WRC-03 that encouraged the Conference to consider the benefits of using the bands below 600 MHz for IMT-2000 and consider the identification of these bands at WRC-07.**

26

Identification of the 450-470 MHz band for IMT-2000

- In order to ensure that the 450-470 MHz band is considered for IMT-2000 identification at WRC-07, developing countries that are interested in taking advantage of the coverage advantages associated with using lower frequency bands for IMT-2000, such as the 450-470 MHz band, should coordinate their efforts within ITU-R Working Party 8F to encourage technical studies to highlight the advantages of these band.

27

ITU-R WP8F Activities

- In preparation for the World Radio Conference in 2007, the ITU sent out two questionnaires that were developed in ITU-R Working Party 8F.
  - ITU-R Doc. CACE/329 "Questionnaire on Candidate frequency bands for the future development of IMT-2000 and systems beyond IMT-2000" Administrative Circular CACE/329
  - ITU-R WP8F Doc. 142 Rev.2 "Services and Market Questionnaire" http://www.itu.int/ITU-R/study-groups/rsg8/rwp8f/docs/144_2e.doc
- Responses to these questionnaires will be used to determine the total frequency requirement and the candidate frequency ranges for the future development of IMT-2000 and systems beyond IMT-2000.
- Responses are due by May 2005 in time for June 2005 meeting of WP 8F.
- Please contact myself or Molly Gavin this week if your administration in interested in filling out an 8F Questionnaire.

28

Coverage Advantages of Lower Frequency Bands for IMT-2000 in Developing Countries

- **Several developing countries, including Cameroon and Cote d'Ivoire, have indicated that they would like to explore the advantages of lower frequencies bands, such as the 450 MHz band, for the deployment of IMT-2000.**
- **Due to the favorable propagation characteristics of lower frequencies and their associated coverage benefits, there may be significant cost advantages associated with deploying a wireless system in the 450 MHz band.**
- **The 800 MHz (cellular) band offers both economies of scale and favorable propagation conditions.**
- **These cost advantages will be important considerations for developing countries, which may have several different frequency bands available, but may not have the resources to deploy nationwide systems in the higher frequency ranges identified by the ITU for IMT-2000.**

29

Importance of IMT-2000 for Developing Countries

- Means to achieve universal service/access goals
- Diversification of the telecommunications services offering
- Provision of new services
- Factor of integration in the Information Society
- Development of connectivity
- Fast provision of voice and non voice services in uncovered regions

30

Objectives to be met by IMT-2000 to Meet the Needs of Developing Countries

- **Recommendation ITU-R 819-2 describes the objectives to be met by IMT-2000 to match the needs of developing countries.**
  - Provide in both urban and rural areas, economical services of high quality and integrity comparable to those of fixed networks;
  - Be capable of serving a wide range of user densities and coverage areas as well as remote regions;
  - Take account of the need to match, efficiently and economically, spectrum usage to local conditions where there are only a few users and where severe propagation conditions are encountered;
  - Be modular in the IMT-2000 design to allow a system to be introduced with minimum initial investment, permitting flexible growth in terms of number of users, coverage areas and types of services;
  - Allow for a large cell size

31

Development of IMT-2000 in Africa

32

Development of IMT-2000 in Africa

- IMT-2000 has an important role to play in achieving universal access in Africa.
- Mobile technology, and IMT-2000 in particular, have the potential to have a strong impact on the economy of African Countries:
  - **Creation of jobs**
  - **Growth in overall economy**
  - **Improved standards of living in rural areas**
  - **Economic and social development**
    - Reduced transactions costs
    - Democratic processes
    - Facilitating access to health and emergency services

IMT-2000 Related Activities in Africa: Results of the Douala Seminar, Denis Ngae, Ministry of Posts and Telecom.; Cameroon; December 2003.

Development of IMT-2000 in Africa

- **Two of the main objectives to be achieved for the development of IMT-2000 in Africa are the following:**
  - use of IMT-2000 in urban and rural areas to provide economical, high-quality and high-security services comparable to those of the fixed network. The systems in question must be capable of serving a wide range of user concentrations and coverage areas, including isolated regions;
  - taking account of the need for efficient and economical adaptation of frequency spectrum use to local conditions, when the number of users is limited and propagation conditions are difficult.

Source: Republic of Cameroon; Proposal for the Work of WTDC 2002; ITU; 11 January, 2002.

Development of IMT-2000 in Africa

- **Most developing countries, particularly those of the Africa region, have the following main characteristics: scattered population, low traffic density (in both urban and rural areas) and a high demand for narrow-band services.**
- **Therefore, there are some special requirements for African Nations with respect to the development of IMT-2000:**
  - good quality of service at an affordable price; this means economical infrastructures (access and transport networks). An operator can provide national coverage economically by installing a small number of base stations;
  - use of large cells with a range of roughly 50 km: such cells can be established only with frequencies below 600 MHz;
  - availability of equipment and terminals at an affordable cost
  - Sufficient quantity of spectrum (at least 3 x 2 x 5 MHz) in appropriate bands for forest, mountainous, desert and/or coastal environments

Source: Republic of Cameroon; Proposal for the Work of WTDC 2002; ITU; 11 January, 2002.

35

Final Remarks

- **Maximizing spectrum efficiency and providing a level playing field for competitors are key regulatory considerations**
- **The ITU has identified several frequency bands for 3G to aid spectrum harmonization**
- **African administrations have special requirements with respect to IMT-2000 that need to be taken into consideration**
- **African administrations should work together to identify frequencies below 600 MHz for the next WRC Conference in 2007.**
  - **This is an important action item since the lower frequencies can help African countries meet some of their special requirements for IMT-2000**

36

Helpful Sources

- www.itu.int/home/
- www.3GToday.org
- www.cdg.org
- www.fcc.gov/spectrum/
- www.fcc.gov/3G/
- www.ntia.doc.gov/ntiahome/threeg/
- www.450world.org/
- www.outlook4mobility.com/main.htm
- www.qualcomm.com

37

THANK YOU FOR YOUR ATTENTION!

Samantha Craig
Government Affairs
QUALCOMM Incorporated

scraig@qualcomm.com
Tel + 1-858-663-7947
Fax + 1-858-651-2590

38