

## **Advances in Software Defined Radio**

**23 October 2003**

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## ***Regulatory Definition***

- Software control of:
  - Modulation
  - Frequency
  - Power
- After manufacture software/functional changes
- Initially vertical integration of hardware/software (same manufacturer)
  - Later, horizontal integration and possibly third party software

## *SDR Benefits*

- **Increased compatibility between dissimilar standards**
- **Eases technology insertion and generational changes**
  - Allows incremental deployment and upgrade
- **Hardware and software can evolve separately**
- **May reduce number of waveforms (and if it doesn't, it will make them easier to cope with)**
- **Shorter time to market; fewer hardware platforms in inventory**
- **Significantly reduces impact of software bugs**

## **Cost of Software “Bug” Fixes – A Real Example**

- **Examples of recent recalls of one manufacturer’s commercial wireless phones:**
  - February 2001 - Network operator 1: 420,000 phones recalled (software problem)
  - May 2001 - Network operator 2: 126,000 phones recalled (software problem)
  - July 2001 - Network operator 2: 560,000 phones (design flaw)
- **Cost estimate of handset recalls - an example:**
  - Manufacturer’s estimate for cost of recall: \$95 M
  - Independent analyst’s estimate of cost of recall: \$160 M
- **Cost per terminal of the recall: \$115 per terminal**

## *Quote from the SDR Forum Chair—*

- Software defined radio is beyond the education and initiation phase. The industry is addressing the needs of reconfigurable radio technology development, implementations and application in a variety of marketplaces. Regulatory decisions are being formulated to facilitate SDR adoption and deployment.  
—Stephen Blust -- Cingular Wireless (USA)

## *Progress*

- 5 years ago—
  - Philosophy, projections, possibilities, proselytizing, potential, and plans
  - Heavy dose of education
- Today –
  - The topics are about implementation, applications, progress, and bringing products to market
- 5 years from now--
  - It will be about continued progress, commercial applications, compatibility of third party products, and economic effects

## *Moore's Law Marches On*

### **Personal Computer**

Then	Now
3.5 MHz	3 GHz
128 Kb	128 Mb
10 MB	60 GB
\$4k	\$1k

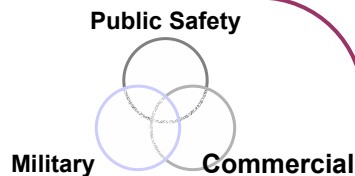
### **Cell Phone**

Then	Now
8 lb bag	4 oz
Car battery	3 days on a charge
Only in Chicago	Multiple systems
\$1k	Free

## *Advances in Enabling Technology*

- Reconfigurable logic
  - High speed DSPs
  - FPGAs
  - Proprietary logic
- A/D
  - Low power
  - High bit rate
  - Fast
- Software
  - Portable/reuseable software-- CORBA, Java

## *SDR Product Availability*



- Military Products (base, mobile, portable, handheld) are available now
  - Less sensitive to: size constraints, power limitations; antenna real estate
- Commercial Base Stations are available now
  - Similar criteria as military products
    - AirNet
    - Vanu test in Texas
- Commercial Handheld units coming soon
  - Public Safety
  - Commercial Wireless ??

## **Recent Headlines Featuring SDR Forum Members**

- **Vanu, Inc.** Is Demonstrating The First Hand-Held Software Radio
- **Morpho Technologies** Demonstrates 3G SDR Running In Silicon
- **PicoChip** Makes 3G Call With Software-Defined Base Station
- NASA Taps **Spectrum Signal Processing** For Software-Defined Radio Technology
- **Intel** Tips Plans For Reconfigurable Radio Architecture
- **Radical Horizon** Signs an MOU With Mitsubishi Electric ITE-TCL To Speed The Development Of SDR
- Morphy Richards First To Announce The Selection Of **RadioScape's** New RS200 DAB Module
- **Xilinx** Streamlines SDR And Digital Communications Design With New IP Library
- **Altera** Ships The Industry's First FPGA With 20 High-Speed
- SDR Developer **Sandbridge** Raises \$19.5 Million
- **HYPRES** Awarded Contract To Develop Digital Channelizer
- **Motorola** Showcases Programmable And Cost-Effective Alternative For Wireless Infrastructure Signal Processing

## *Regulatory Environment*

- Europe
  - UK Radiocommunication Agency international workshop - September 03
  - TCAM Questionnaire
- Americas
  - US FCC
    - Report and Order on Class 3 permissive changes and electronic labeling
    - Workshop on cognitive radio technology May 03
  - Industry Canada
  - Interest from Brazil
- Asia
  - Download security proposal from Japan
  - Interest from Korea
  - Workshop in Taiwan

## *The Over Expectation of SDR Technology for Spectrum Solutions*

- Technology is not a substitute for policy.
  - The two should work hand in hand.
  - To suggest, for example that SDR as a technology, would obviate the need for globally harmonized frequency bands for commercial wireless services is impractical. It imposes too much of a supposition and burden on technology and ignores practical reality of product realization in the consumer focused commercial marketplace.
- SDR technology should be considered as an implementation technique
  - that can facilitate, within the scope of a given set of radio interfaces and a known set of harmonized bands, the realization of consumer focused products that can operate worldwide –
  - the catch is that the technology application has to be balanced against the market realities.
- Sensible spectrum identification coupled with the capabilities/restraints of the technology can expand the market
  - SDR can potentially overcome the fact that even while seeking harmonized spectrum, the spectrum may be disparate in the future due to the differing services that must be supported ranging from high mobility to stationary applications covering narrow to wide bandwidth radio interfaces.
  - which of necessity may be placed in spectrum from below 1GHz into the 10's of GHz. The spectrum may be globally harmonized, but is not necessarily service harmonized.

## *A Rational View of SDR Technology*

- SDR is a better fit for creating service/radio air interface harmonization than for making unconstrained frequencies appear “harmonized”
  - SDR does not replace the need for standards – the scope of the “radio interface family” cannot be too broad or the capability of practical SDR is exceeded
  - SDR has finite limits in the ability to span a multitude of diverse frequency bands
    - Easier to support multiple personalities in the signal processing than what can be done in filter structures, front ends, amplifiers and those areas that are still predominately hardware constrained
- Differing perspectives, capabilities, architectures, cost structures also apply in the implementations and impact applicability of solution
  - Fixed vs. Mobile
    - Base stations and terminal issues
  - Application within the device
    - Radio filters, front ends, and amplifiers (hardware focused)
    - Radio back end and signal/baseband processing (software focused)
  - Market place perspective
    - Commercial wireless (consumer)
    - Military
    - Specialized markets (e.g. public safety...)
  - Licensed vs unlicensed spectrum
- SDR is not a “miracle drug” for wireless but it should not be ignored
  - SDR is a realizable technology that must be matched to the applications.
  - Capability of SDR will increase in the future but has finite limits

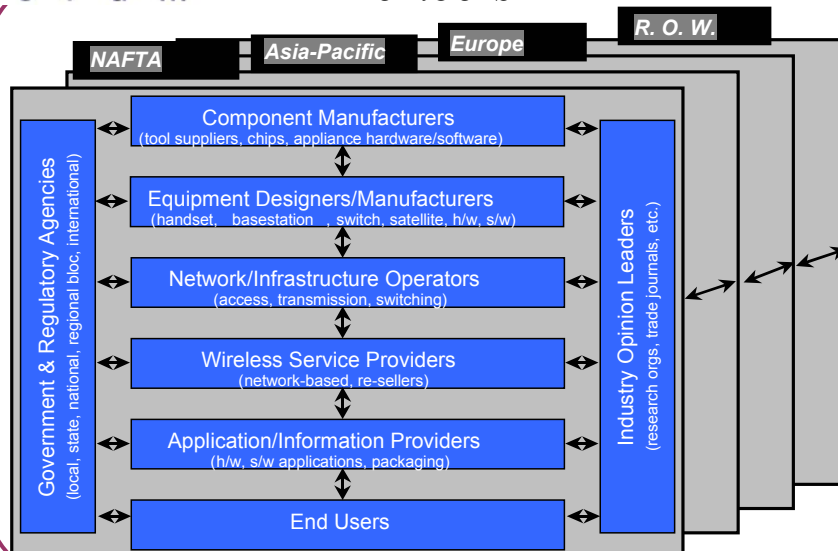
## *On-going challenges*

- Antennas
  - Efficient, broadband, small
- Radio Front Ends
  - Filters, amplifiers,.....
- AD Converters
  - Faster, cheaper, more power efficient
- Batteries/power usage
  - Size and weight are important
- Hardware, Architectures , Software
  - Open interfaces, APIs, ...
- Regulatory environment
  - “Common regulatory principles” to address SDR and its increasing capabilities over time
- Download security
  - Key to after manufacture reconfigurability

## *What is the SDR Forum's role?*

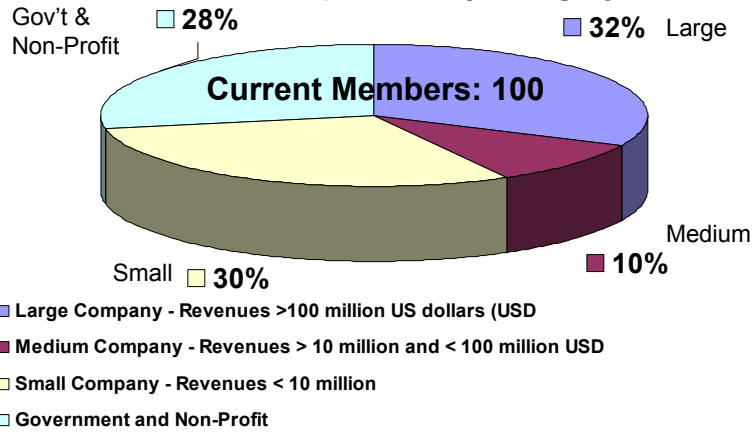
- A venue to discuss common problems and to promote industry standards
- Regulators' resource for industry opinion to facilitate creation of rules to facilitate the application and adoption of SDR
- Create concepts and influence/develop standards for implementation
- Industry water cooler or chat room-- it's a place to learn about the state of the art

## *Members*

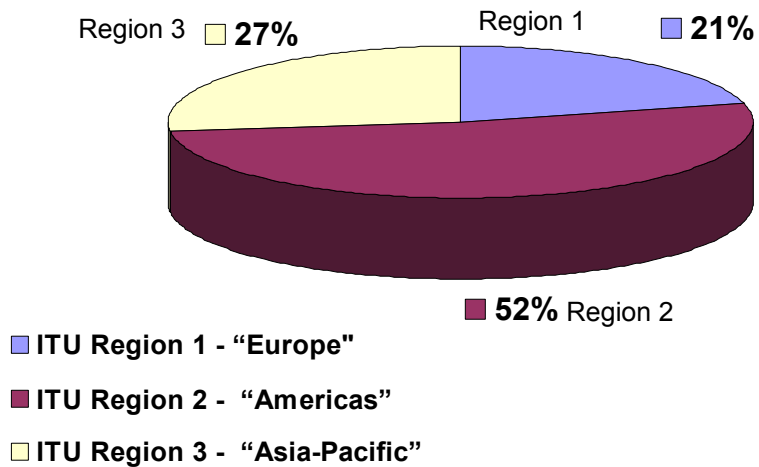


Source: SDR Forum

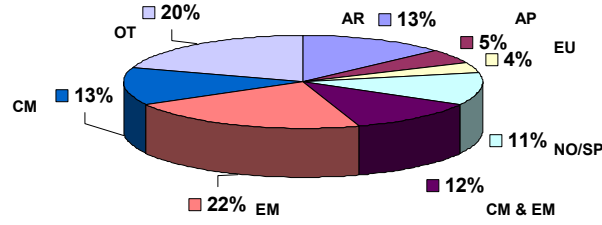
**Members Composition By Category**



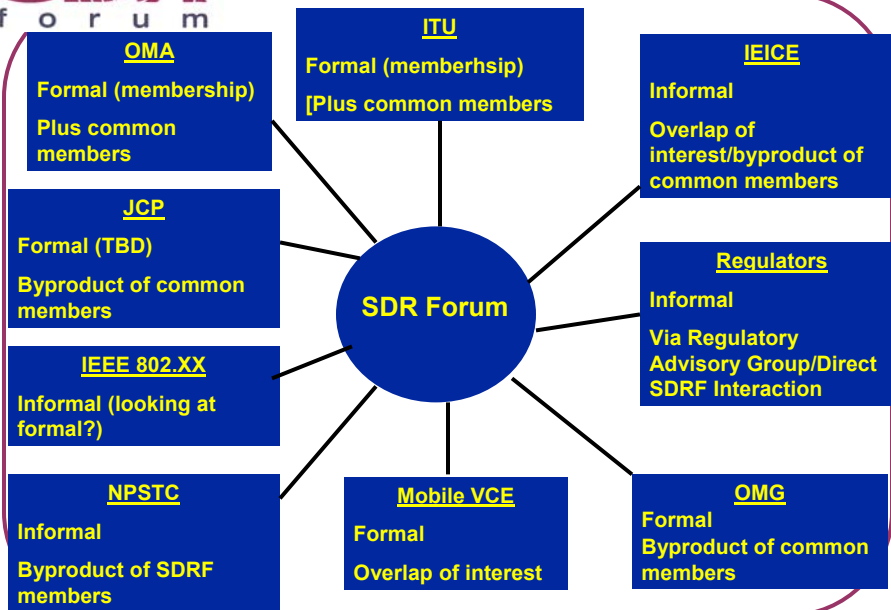
**Members Composition By Global Region**



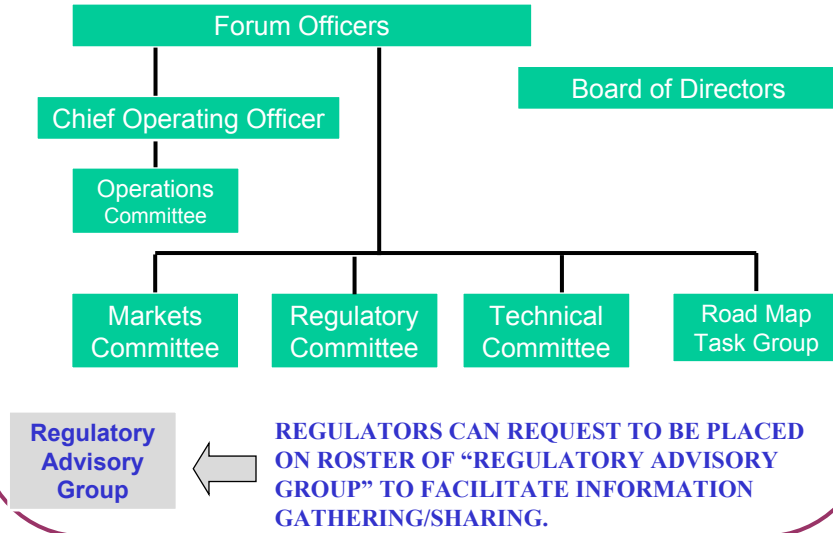
**Members Composition By Segment**



- AR - Academia and Research
- AP - Application/ Information Providers
- EU - End Users
- NO/SP - Network Operators/Service Providers
- CM & EM - Both Component & Equipment Designers/Manufacturers
- EM - Equipment Designers/ Manufacturers
- CM - Component Manufacturers
- OT - Other



## SDR Forum Structure



## Activities of the SDR Forum

- Standards Recommendations
  - FCC Report and Order on Software Defined Radios
  - Download Security Report
  - Java-based SCA Reference Implementation
  - ITU Recommendation
- Market Survey
  - Purchased reports
    - Forward Concepts infrastructure report
    - Pioneer Consulting market report
  - Commissioned reports
    - Survey report by Gartner Group last year
    - Update on international projections
- Reports and Publications
  - Information and Proposed Actions Relative to ITU-R Document on Software Defined Radio
  - Business Model for Wireless PCS
  - Operator Requirements Questionnaire
  - Preliminary Assessment of Operator Requirements
  - API Position Paper
  - Download Definitions (DL-DFN)
  - ITU input on PDNR
- Roadmap and workplan
- Seminars, Workshops, Expositions
- Liaison with other international organizations
  - MVCE, 3GPP, EC/TCAM, IEICE, ITU, OMA, APT etc

## ***SDR Forum Workshops and Conference***

- *International Technical Conference and Product Expo*
- *Co-sponsored MPHPT workshop with IEICE Study Group*
- *Workshop on Reconfigurable Logic*
- *Workshop on Smart Antennas*
- *Workshop with SCOUT*
- *Workshop in Taipei*
- *Workshops with regulators around the world*

## ***Meetings and Working Methods***

- **Five Major Meetings Per Year**
  - **January - Winter Meeting, generally held in Americas**
    - January 2004 Los Angeles
  - **April - Spring Meeting**
    - April 2004 Mainz Germany
  - **June - Summer Meeting, generally held in Americas**
    - June 18-20, 2004 Toronto
  - **September - Fall Meeting**
    - September 2004 Seoul Korea
  - **November - Annual Business Meeting, generally held in North America**
    - November 17-20 2003 (Technical Conference) Orlando
- **Interim Committee or Working Group Meetings as Required**
  - Globally as appropriate
- **Conference Calls**
  - Globally as appropriate
- **Electronic Working Methods**
  - E-mail, reflectors, website.....

## ***Technical Committee***

*(Dr. John BARD – Space Coast Communications)*

- R&D Working Group–  
Identify technologies to fulfill needs of marketplace
- Commercial Handset Working Group  
Define concepts and APIs for commercial terminals
- Hardware Adaptation Layer Working Group  
Identify architectures and functions to support reconfigurable radios
- Commercial Download Working Group  
Study technical aspects of over-the-air software download to change operating characteristics
- System Interface Working Group  
Identify, maintain, and promote standards for services and interfaces

## ***Regulatory Committee***

*Richard Shrum*

- SDR Interface with Regulatory Agencies
  - MPHPT (Japan)
  - RegTP/TCAM Germany)
  - FCC (US)
  - Industry Canada
  - Radio Research Lab (South Korea)
  - Radiocommunications Agency (UK)
  - IDA (Singapore)

## *Markets Committee*

*(Mr. Lee PUCKER Spectrum Signal Processing)*

- **Charter**
  - Understand the SDR market and requirements
  - Promote the concept of reconfigurable radios
  - Publicize the activities of the Forum
- **Products**
  - Market surveys-- commissioned independent survey of market conditions and released results this year
  - Technical conference and product expo– November 2003
- **Plans**
  - Press releases
  - Trade journal articles and publications

## *SDR Forum Website*

*<http://www.sdrforum.org>*

- **Public Area**
  - General Forum information
  - Meeting information
  - Selected documents **(including Unified Workplan)**
- **Member Area**
  - ID and Password required to access
  - Reports and other deliverables
  - Used for committee and working group
    - Email reflectors
    - Completed work
    - Work in “ballot” review
    - Work in progress
- **Links of Interest**
  - General info
  - Member company links

## *Summary*

- **SDR technology is beyond the education and initiation phase.**
- **The SDR Forum is addressing the real needs of SDR development as it looks towards implementation and application of SDRs in a variety of marketplaces.**
- **The SDR Forum has an active technical specification and standards development program.**
- **The SDR Forum continues an active program to promote public policy decisions to facilitate SDR adoption and deployment.**
- **The SDR Forum is actively cultivating liaisons and interfaces with relevant external organizations.**