



A Study on the Hardware Reconfiguration Schemes and Their Applications on SDR-Based Mobile Communications

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Introduction

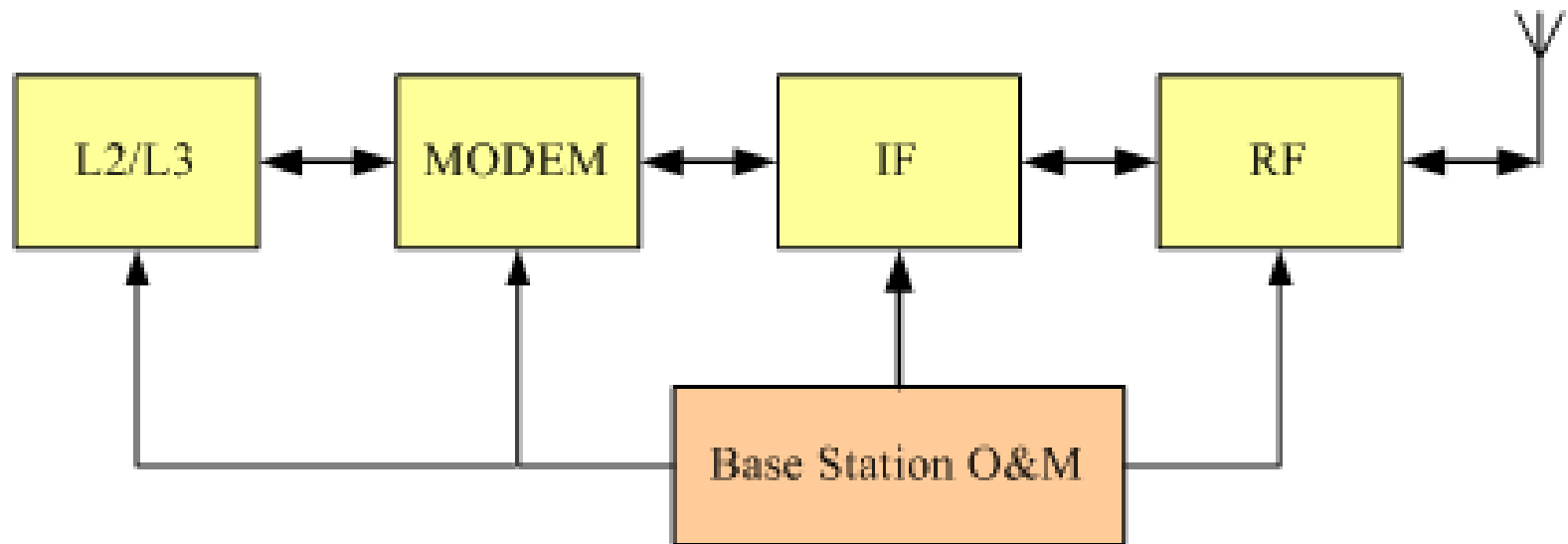
- ◆ User Demands of Increased Bandwidth for High Data Rate
- ◆ Standard Entity for next generation Mobile Telecommunication Recommends multiple profile according to services environments
 - Coverage
 - Traffic
 - User data rate
- ◆ Therefore, SDR concept have been introduced to accommodate
 - Multiple services
 - Multiple standards
 - Multiple frequency bands

Introduction

- ◆ But, In view of Reconfiguration
- ◆ Conventional Hardware architecture limit on flexibility of reconfiguration
- ◆ This paper suggest SDR-based Reconfiguration Scheme
 - URS Scheme and Its Prototype
 - Digital IF Transceiver
 - MRS Scheme and Its Prototype
 - Multiple Channel Digital Filter

Reconfiguration Schemes

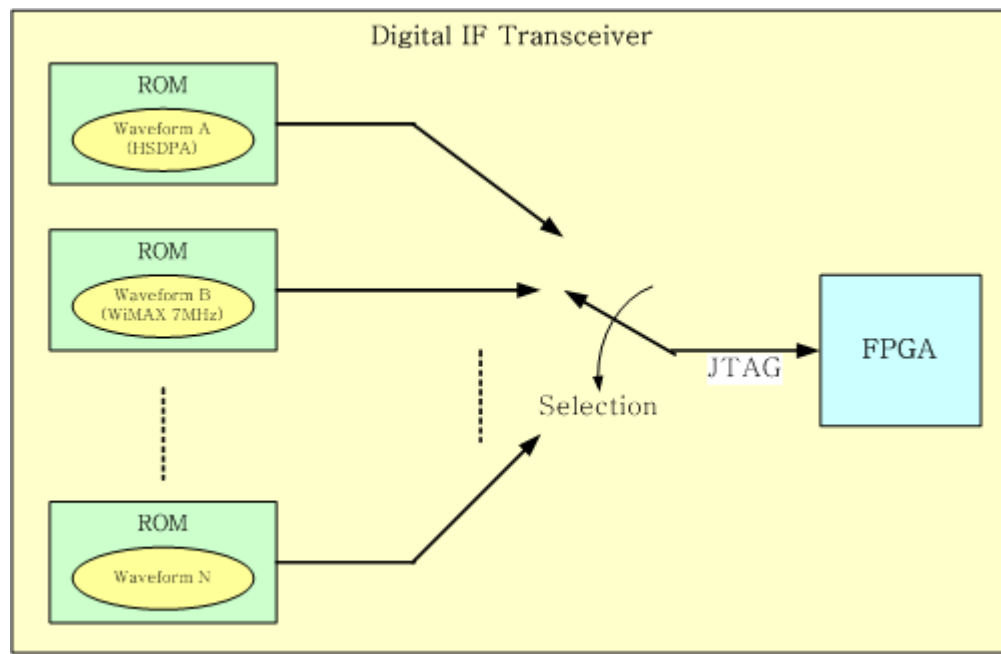
- ◆ Conventional Reconfiguration Scheme
 - Typical structure of the mobile base station



Reconfiguration Schemes

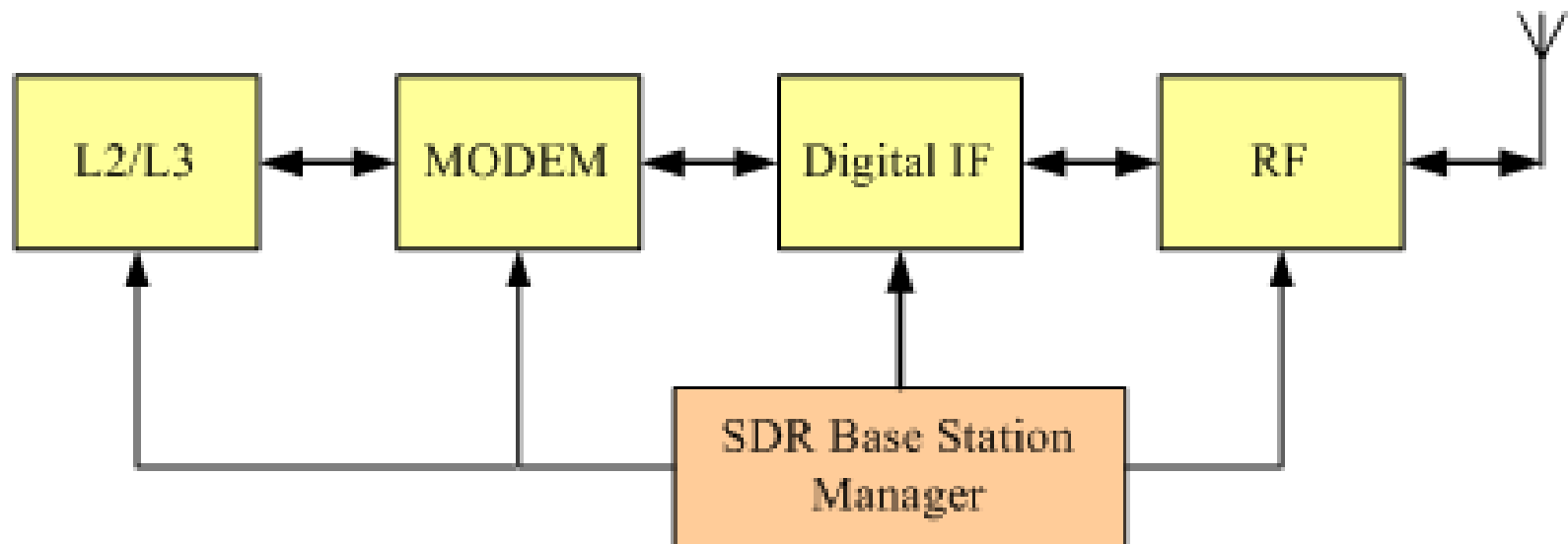
◆ Conventional Reconfiguration Scheme

- Digital IF Transceiver using ROM boot
 - Services suspended for a long time
 - The limitation of the number of service profiles by number of ROM and board size



Reconfiguration Schemes

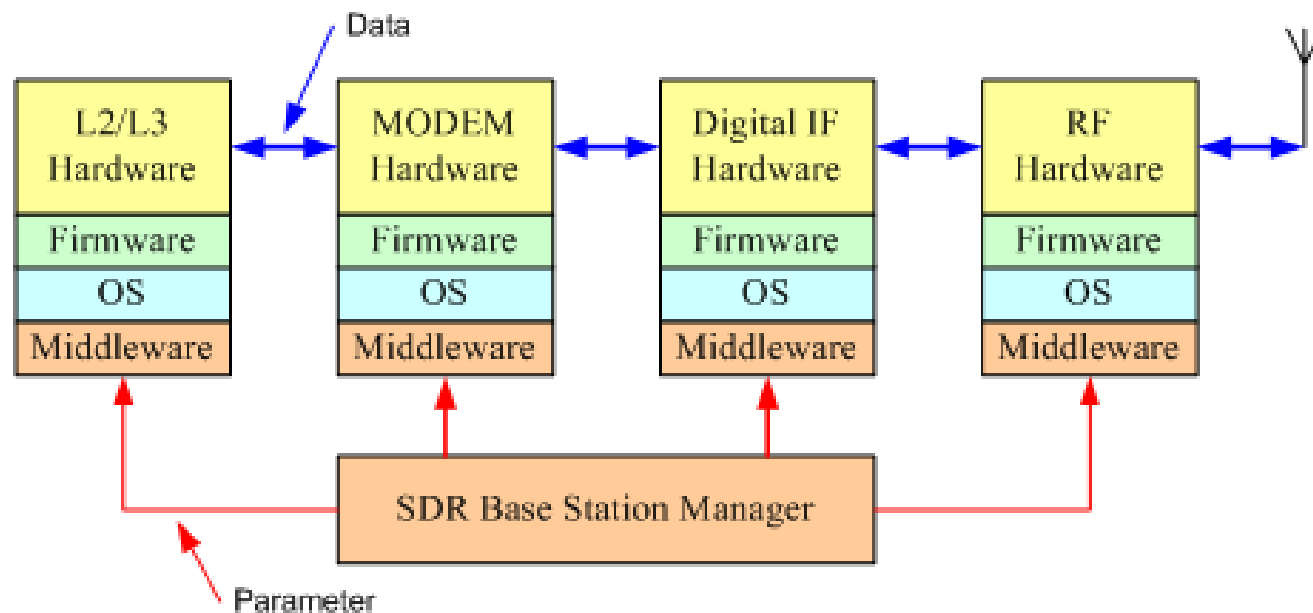
- ◆ SDR-based Reconfiguration Scheme
 - SDR-based structure of the mobile base station



Reconfiguration Schemes

◆ SDR-based Reconfiguration Scheme

- Software architecture of SDR-based base station
 - Portability
 - Reusability
 - Compatibility



Reconfiguration Schemes

◆ Example- ETRI ReMO

- Reconfigurable Mobile Convergence for 2-mode access system
- Double-mode mobile base station developed by ETRI, Korea
- Reconfigurable to
 - IEEE 802.16d WiMAX system 3 profiles
 - 7 MHz
 - 3.5 MHz
 - 1.75 MHz
 - HSDPA system

Reconfiguration Schemes

- ◆ SDR technology
 - All functional blocks are reconfigurable by software download
- ◆ ATCA architecture
- ◆ Reconfiguration Manager: RBSM
- ◆ RBSM
 - Operated on BCB board
 - SCA middleware platform
 - Reconfiguration management
 - DB operation
 - Base station O&M
 - GUI



Reconfiguration Schemes

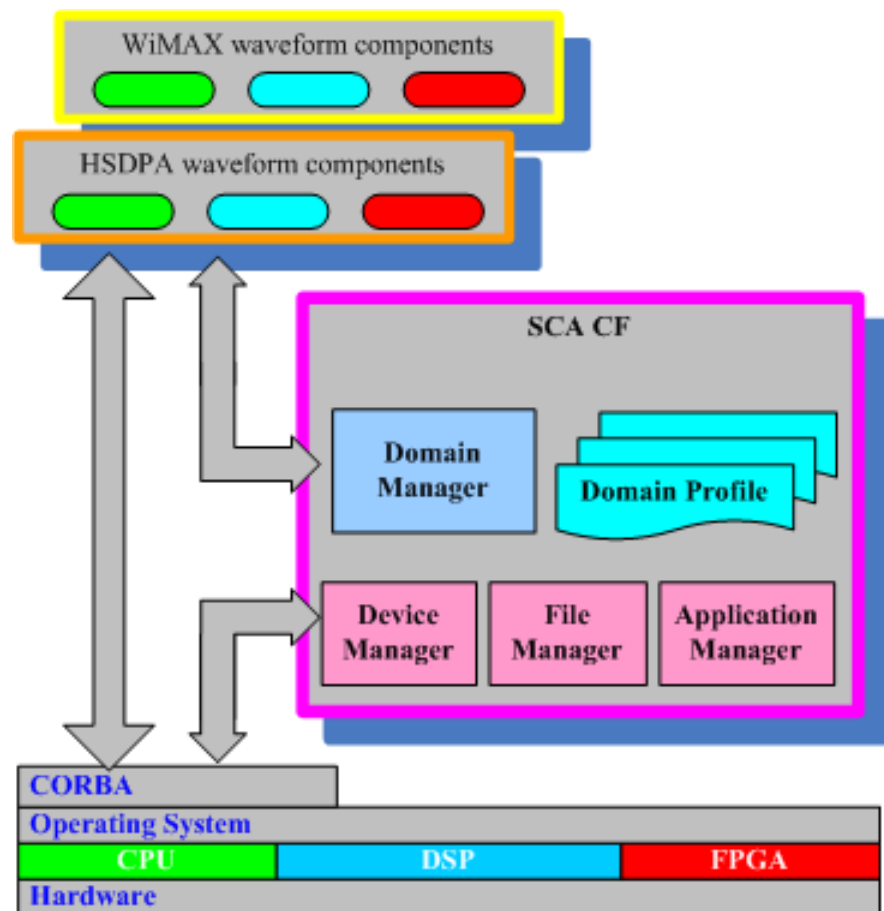
◆ Software download interface of ETRI ReMO

➤ SCA CF

- Software Communications Architecture middleware standard
- SCA based API

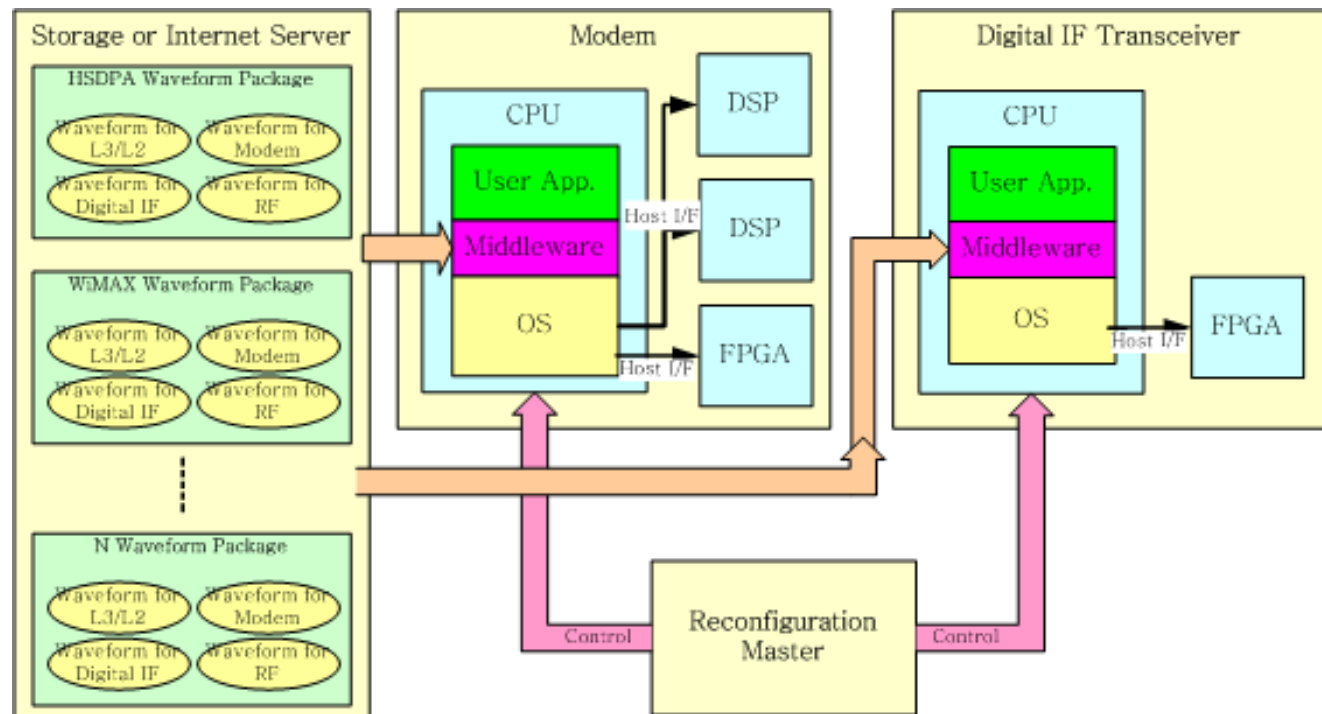
➤ CORBA

- Common Object Request Broker Architecture
- Software bus interface



Suggested Reconfiguration Scheme-URS

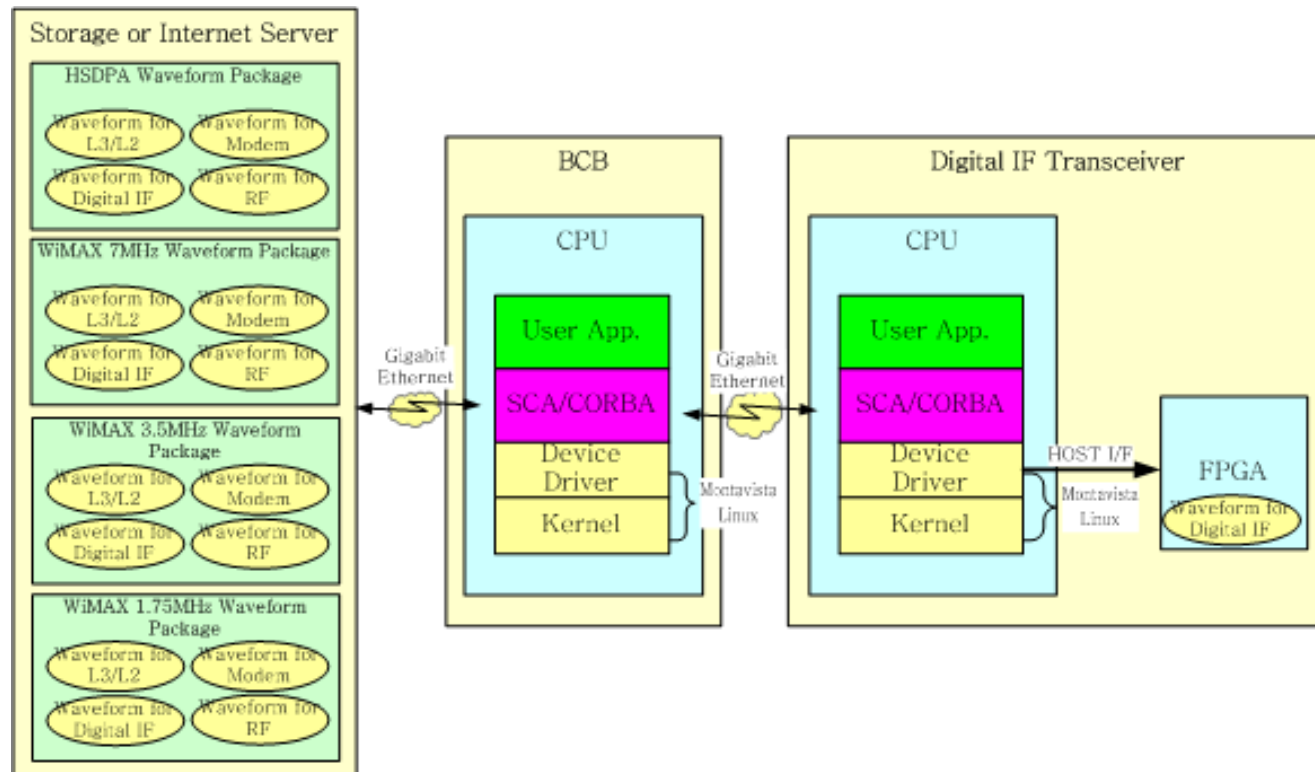
- ◆ URS (Unit-based Reconfiguration Scheme)
 - Control: File Location, Authentication, Connection Interfaces Information
 - Advantages: High flexibility, high reconfiguration speed
 - Disadvantages: High complexity, High cost



Suggested Reconfiguration Scheme-URS

◆ Reconfigurable Digital IF Transceiver

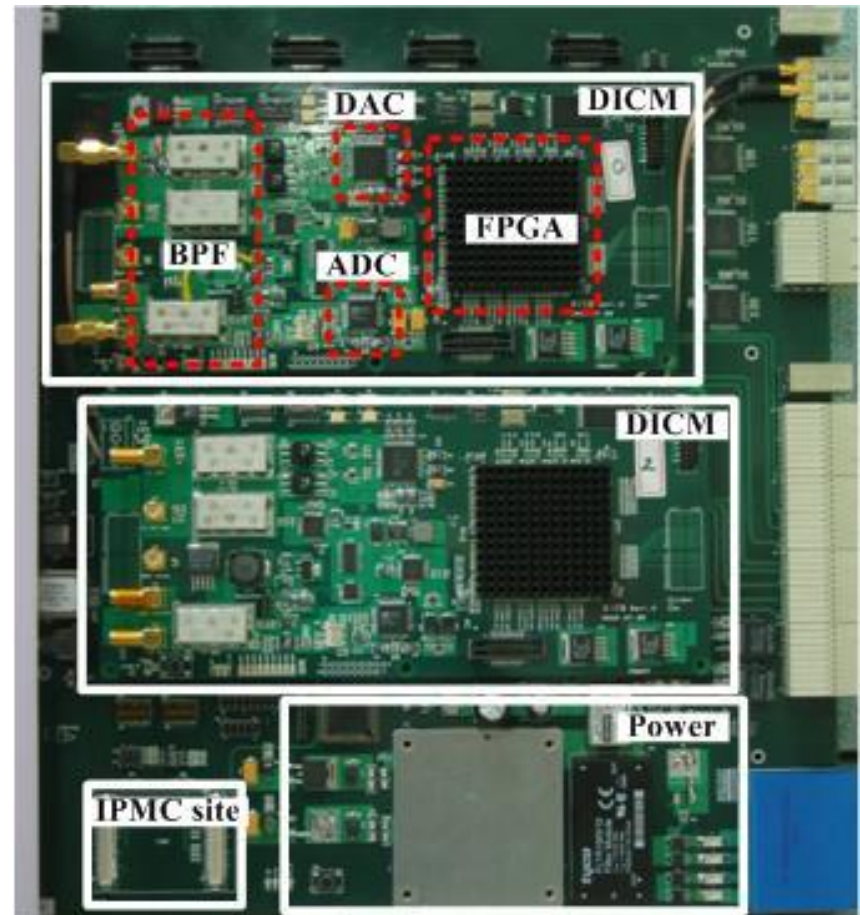
- Reconfiguration Scheme
 - Implemented using URS scheme



Suggested Reconfiguration Scheme-URS

◆ Digital IF Transceiver Hardware platform

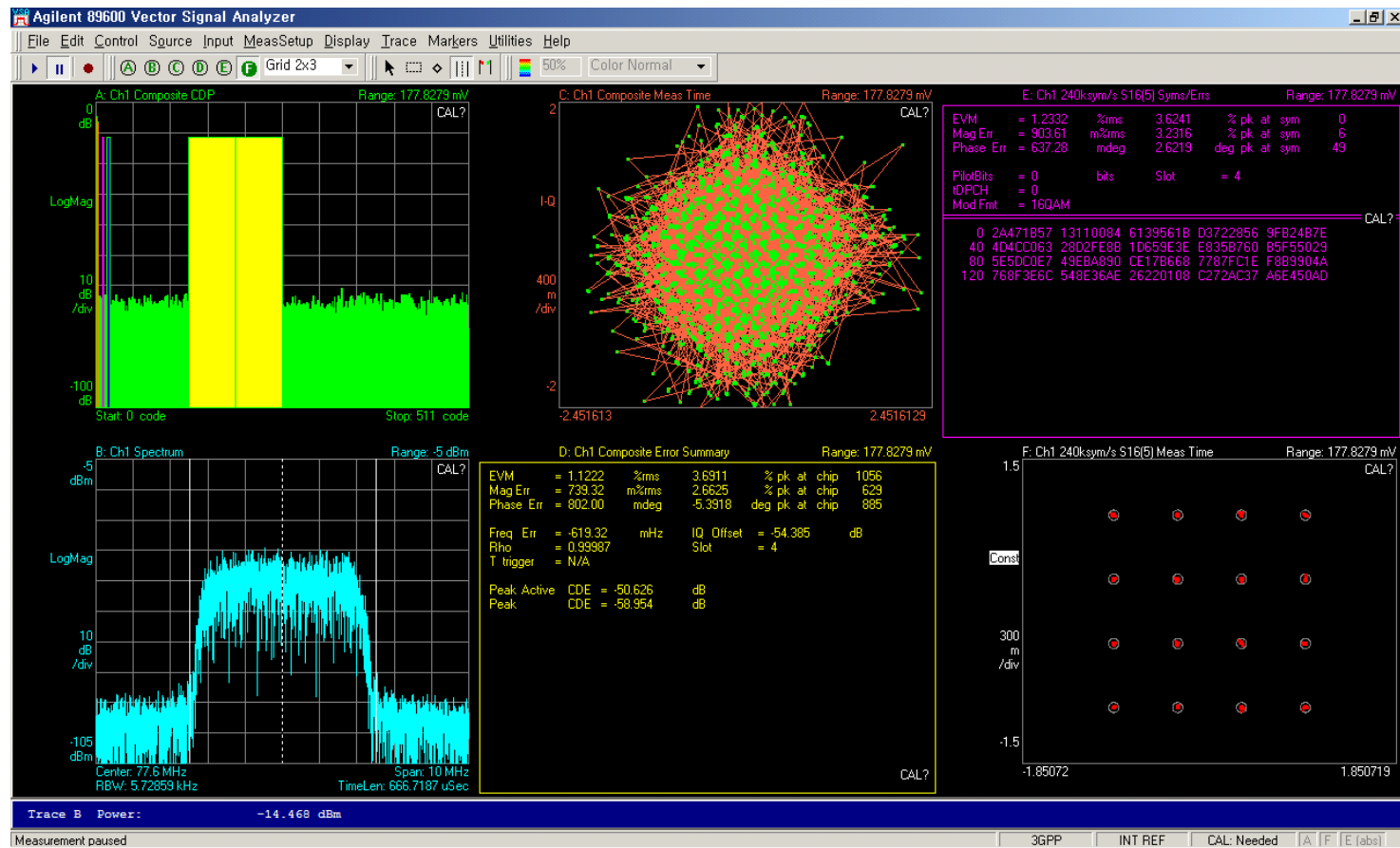
- ADCB : Analog Digital Conversion Block
- Max. 2 DICM on board
 - 2 branch diversity



Suggested Reconfiguration Scheme-URS

◆ Digital IF Transceiver Performance

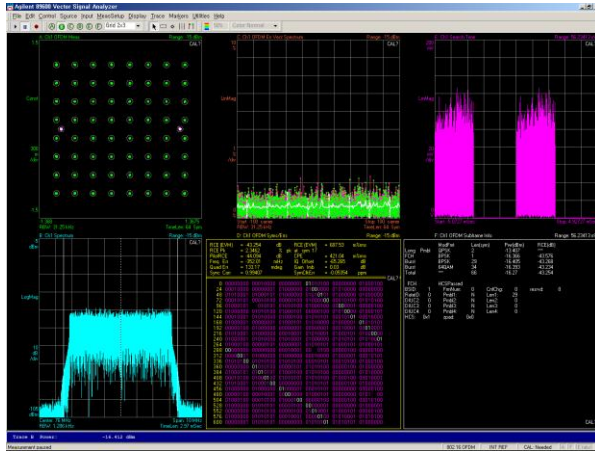
- HSDPA: EVM = -39.2 dB



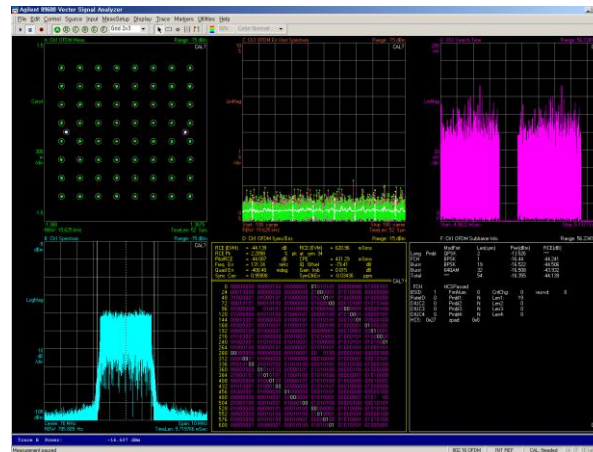
Suggested Reconfiguration Scheme-URS

◆ Digital IF Transceiver Performance

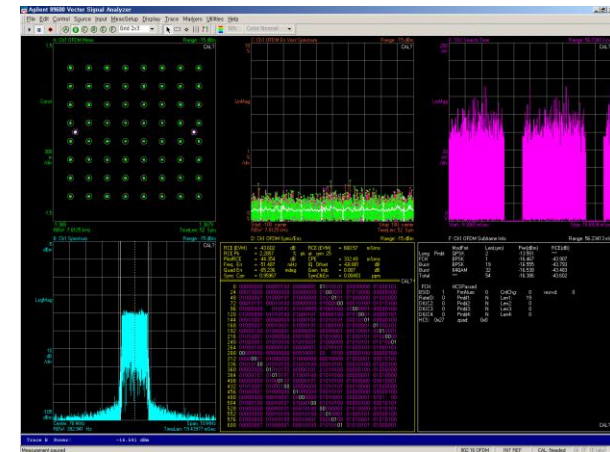
WiMAX 7 MHz:
EVM = -43.2 dB



WiMAX 3.5 MHz:
EVM = -44.1 dB

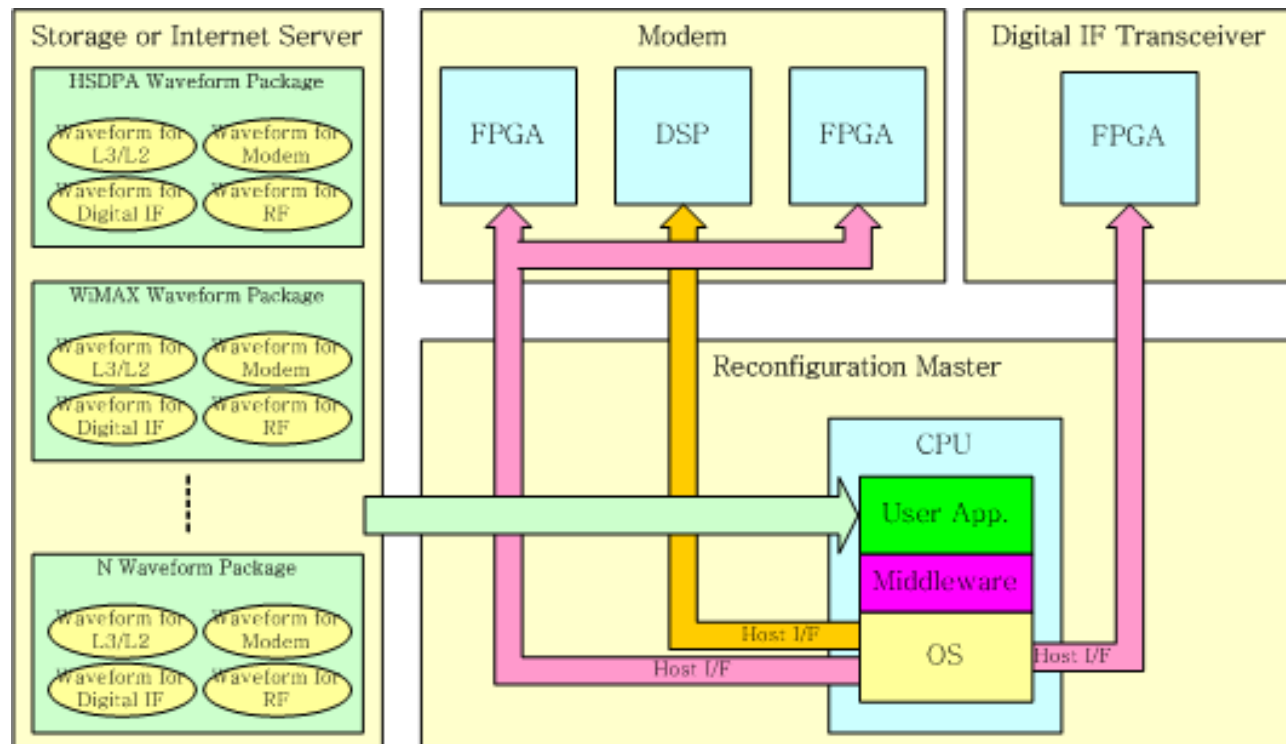


WiMAX 1.75 MHz:
EVM = -43.6 dB



Suggested Reconfiguration Scheme-MRS

- ◆ MRS (Master-based Reconfiguration Scheme)
 - Reconfiguration Master
 - Advantages: Low complexity, Low cost
 - Disadvantages: Low flexibility, Low reconfiguration speed

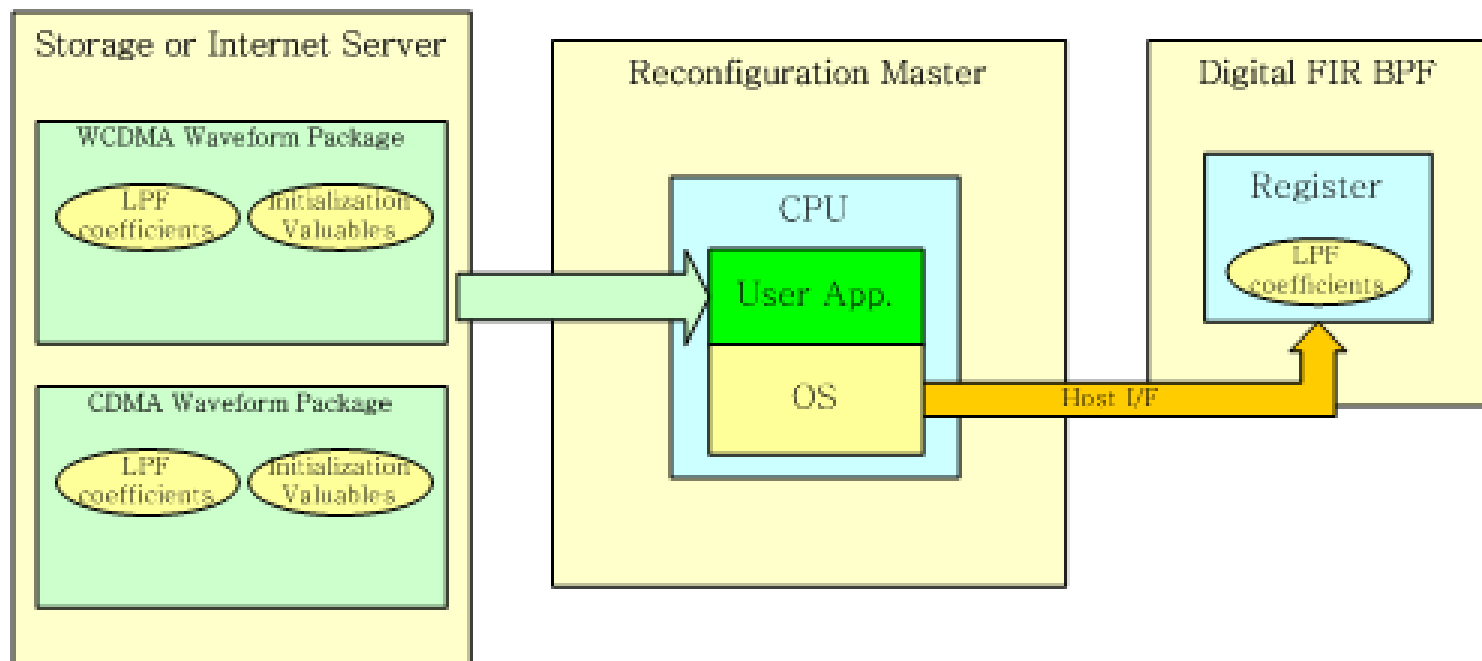


Suggested Reconfiguration Scheme-MRS

◆ Reconfigurable Multiple Channel Digital Filter

➤ Reconfiguration Scheme

- Implemented using MRS scheme
- W or w/o middleware



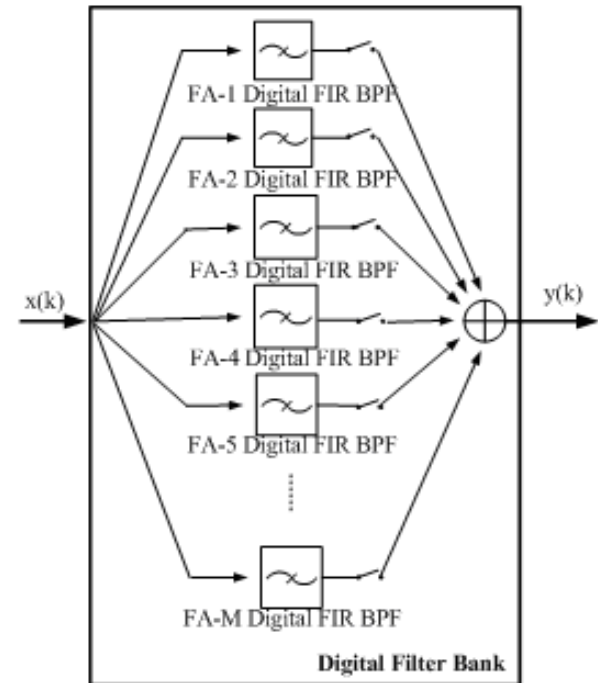
Suggested Reconfiguration Scheme-MRS

- ◆ Suggested Reconfigurable Multiple Channel Digital Filter
 - Reconfiguration of digital filter on to identical hardware using redesigning filter coefficient
 - Applicable to Multiple channel (or FA) system using BPF to filter the channel
 - Replaceable to SAW (Surface Acoustic Wave) filters in IF (Intermediate Frequency)
 - Cost-effective RF performance test
 - CDMA(IS-95)
 - WCDMA
 - Also, applicable to various OFDM systems

Suggested Reconfiguration Scheme-MRS

◆ Conventional multiple channel filter bank

- The number of BPF is equal to the number of channels
- Required number of BPFs increases as the number of processed channels increases
- Implementation complexity, size, cost also increase



$$y(k) = w_1 y_1(k) + w_2 y_2(k) + \dots + w_M y_M(k)$$
$$= w_1 \sum_{n=0}^{N-1} h_1(n) x(k-n) + w_2 \sum_{n=0}^{N-1} h_2(n) x(k-n) \dots + w_M \sum_{n=0}^{N-1} h_M(n) x(k-n)$$

$$w_m = 0, \quad \text{if } FA = \text{"OFF"}$$

$$= 1, \quad \text{if } FA = \text{"ON"}$$

Suggested Reconfiguration Scheme-MRS

◆ Suggested reconfigurable multiple channel filter

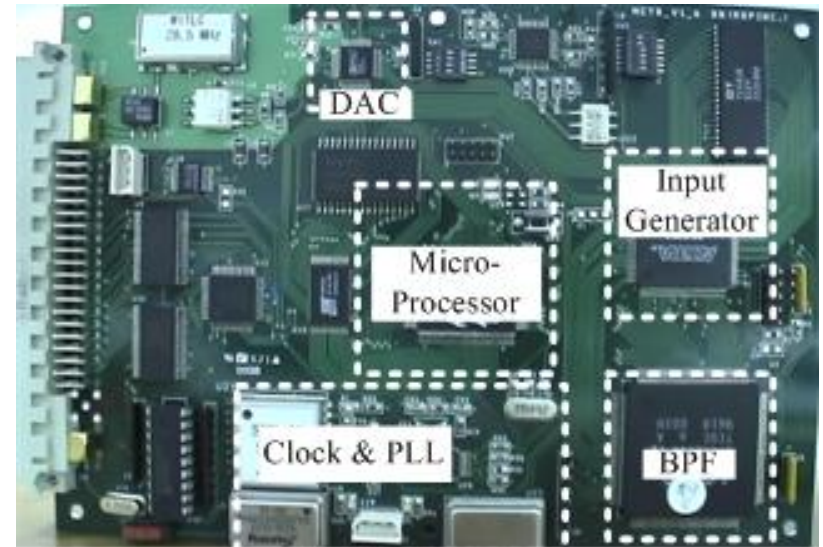
$$\begin{aligned} y(k) &= \sum_{n=0}^{N-1} \{w_1 h_1(n) + w_2 h_2(n) \cdots w_M h_M(n)\} x(k-n) \\ &= \sum_{n=0}^{N-1} h_{all}(n) x(k-n) \end{aligned}$$

$$\begin{aligned} h_{all}(n) &= \sum_{m=1}^M w_m h_m(n) & n = 0, 1, 2, \dots, N-1 \\ w_m &= 0, \text{ if } FA = \text{"OFF"} \\ &= 1, \text{ if } FA = \text{"ON"} \end{aligned}$$

$$\begin{aligned} h_m(n) &= h_B(n) \cdot f_m(n) \\ &= h_B(n) \cdot \exp(j2\pi f_m n / f_s) & m = 1, 2, \dots, M \end{aligned}$$

Suggested Reconfiguration Scheme-MRS

- ◆ Implemented multiple channel signal generator
- ◆ Hardware Assembly
 - GPP
 - Calculate filter coef. Set
 - Download filter coef. Set to BPF
 - CPLD
 - Random signal generation
 - BPF control
 - BPF
 - Filtering operation
 - COTS FIR filter chip
 - Max. 83 MHz operating speed
 - Filter coefficient resolution: 12 bits
 - DAC
 - Digital to Analog Conversion
 - Resolution: 14 bits
 - Max. 160 Msps conversion rate

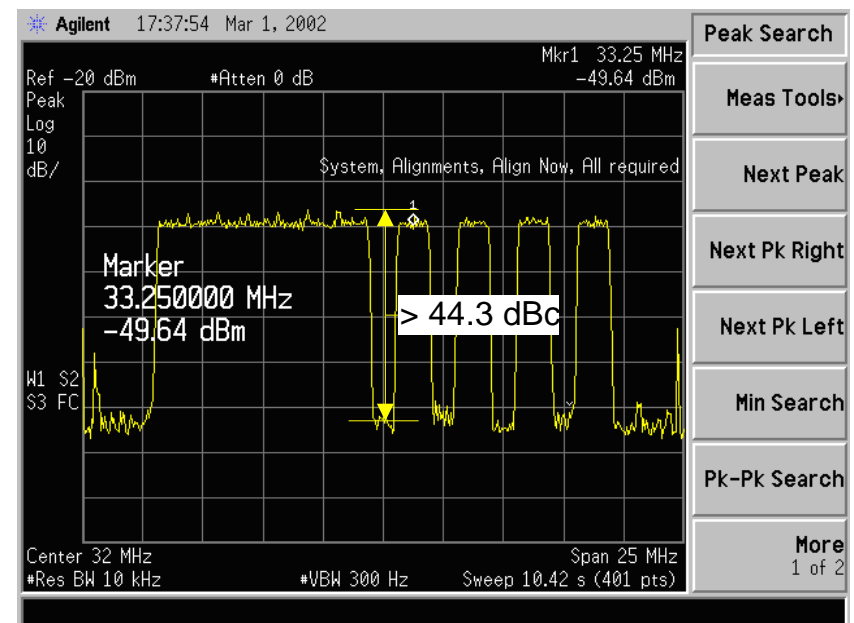
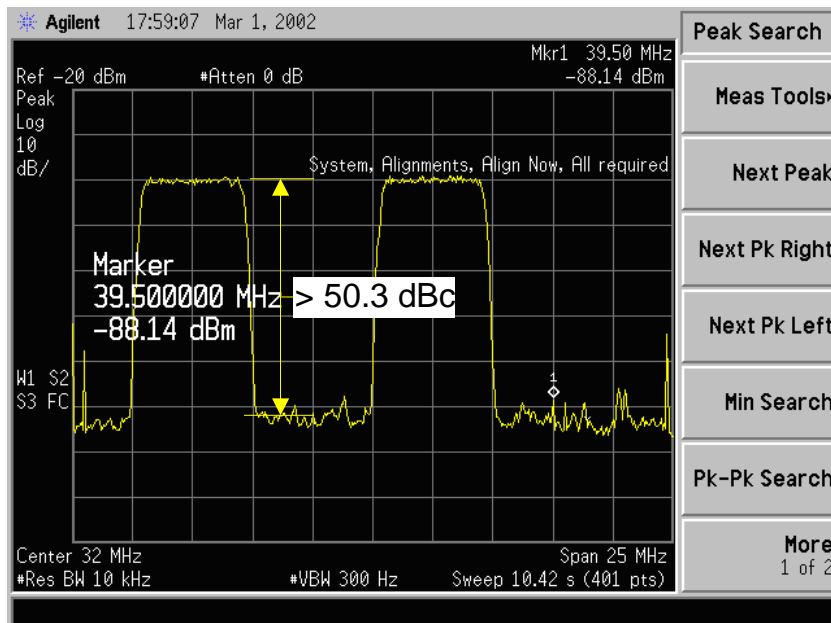


Suggested Reconfiguration Scheme-MRS

- ◆ multiple channel signal generator test results
 - Measured by spectrum Analyzer

WCDMA: ON/OFF/ON/OFF

CDMA: 1111111 1010101



Conclusions

- ◆ Suggested SDR-based Reconfiguration Scheme
 - Unit-based Reconfiguration Scheme (URS)
 - Master-based Reconfiguration Scheme (MRS)
- ◆ Verified the feasibility by implementing prototype for mobile communication systems
 - URS and Its Prototype
 - Digital IF Transceiver
 - MRS and Its Prototype
 - Reconfigurable Multiple Channel Digital Filter
 - Suggest novel SDR-based digital filtering technique



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Thank you~