3RD Generation Mobile Technology (3G)

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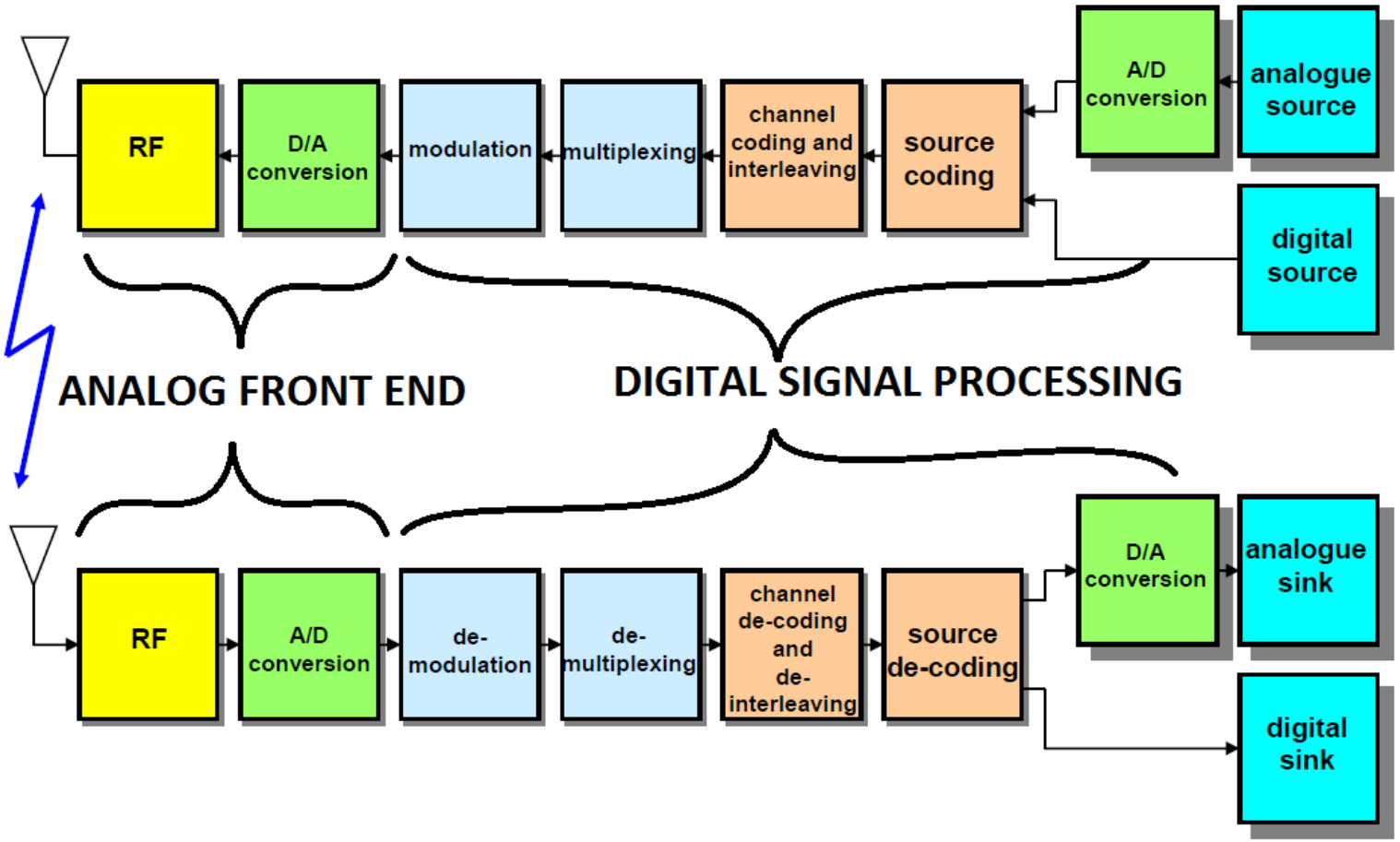
Purpose

- Enhance previous generation system qualities such as:
  - Higher data speed
  - Enhanced audio and video streaming
  - Video-conferencing
  - Web and WAP browsing at higher speeds
  - IPTV (TV via Internet)
- Typical Devices:
  - Standard Cell Phones
  - Smartphones
  - Internet sticks

System architecture of 3G device



Standardization

1. International Telecommunications Union (ITU)
    1. Creator during the 80s
2. International Mobile Telecommunications-2000 (IMT-2000)
    1. Specification standards created by ITU for 3G networks
3. 3G Partnership Program (3GPP)
    1. Collaboration between 6 international telecomm. Associations
    2. Given task by ITU with scope to create 3G phone system using 2G network architecture
    3. Scope enlarged to develop and maintain:
        1. GSM (2G) and its evolutions
        2. Evolved 3G
        3. Evolved IP Multimedia Subsystems (IMS)

Market

- The development of the smartphone (PDA + mobile phone) led to a great demand for mobile internet connectivity, making 3G very popular
- Fourth quarter in 2012 had 1.594B users globally operating on the 3G network
- 256M users in the U.S.
  - With an average plan of $40/mo, the market produces roughly $10B/mo
- Phones operating on 3G networks range from $60 basic cell phones to $600 iPhone 3G

TECHNICAL SPECS

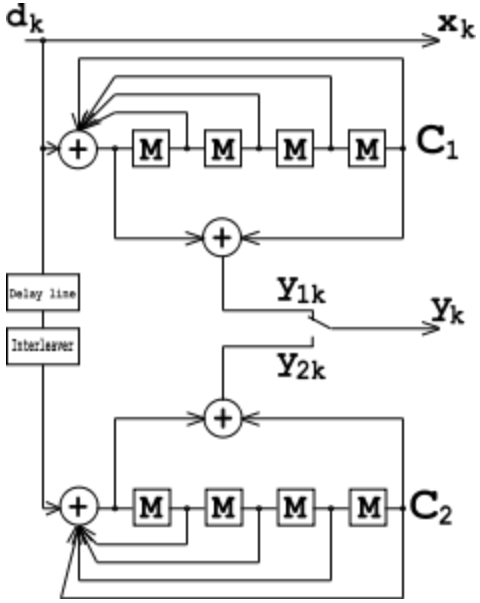
- UMTS: Universal Mobile Telecommunications System
- UTRA: UMTS Terrestrial Radio Access
- UTRA Frequency Division Duplexing
  - WCDMA based on DS-CDMA Multiple Access Method
  - 5 MHZ carrier spacing
  - 625 uS time slot duration
  - QPSK modulation
  - 4.096 Mchips/s
  - Data rates
    - 128-144 kbps for fast moving devices
    - Up to 384 kbps for slow ones (pedestrian)
    - 2Mbps on WLANs

Frequency bands

- IMT-2000 networks shall use the bands 1885-2025 MHz and 2110-2200 MHz
  - (WCDMA) UTRA/FDD is designed to operate in either of the following paired bands
    - 1920 – 1980 MHz: Uplink (Mobile transmit, base receive)
    - 2110 – 2170 MHz: Downlink (Base transmit, mobile receive)
    - 1850 – 1910 MHz: Uplink (Mobile transmit, base receive)
    - 1930 – 1990 MHz: Downlink (Base transmit, mobile receive)
  - (TD-CDMA) UTRA/TDD is designed to operate in the following bands
    - 1900 – 1920 MHz: Uplink and downlink transmission
    - 2010 – 2025 MHz: Uplink and downlink transmission
    - 1850 – 1910 MHz: Uplink and downlink transmission
    - 1930 – 1990 MHz: Uplink and downlink transmission
    - 1910 – 1930 MHz: Uplink and downlink transmission

Coding

- WCDMA spreading factor of short codes from 4 to 256
- TD-CDMA uses spreading factors of 1, 2, 4, 8, and 16
- Channel coding and interleaving techniques:
  - Block Codes
  - Convolutional Codes
  - Reed Solomon Codes
  - Turbo Codes
  - Combination of Codes



Turbo Code

Security

- KASUMI encryption
  - 128 bit algorithm
- Experts at Weizmann Institute of Science (Israel) cracked the system in less than 2 hours
- IMT-2000 under criticism for switching to KASUMI from a stronger algorithm called MISTY

Typical Link Budget

UMTS UL Link budget example, (c) UMTSWorld.com	
TX	
Mobile max power = 0.125W (dBm)	21
Body loss - Antenna gain (dB)	2
EIRP (dBm)	**19**
RX	
BTS noise density (dBm/Hz) =Thermal noise density + BTS noise figure	-168
RX noise power (dBm) =-168+10*log(3840000)	-102.2
Interference margin (dB)	3
RX interference power (dBm) =10*LOG(10^((-102.2+3)/10)-10^(-102.2/10))	-102.2
Noise & interference (dBm) =10*LOG(10^((-102.2)/10)+10^(-102.2/10))	-99.2
Process gain (dB), 12.2k voice =10*log(3840/12.2)	25.0
Required Eb/No for speech (dB)	5
Antenna gain (dBi)	17
Cable and connector losses (dB)	3
Fast fading margin (dB) =slow moving mobile	4
RX sensitivity (dBm)	**-129.1**
Total available path loss (dB)	**148.1**
Dimensioning	
Log normal fading margin (dB)	7
Indoor / In-vehicle loss (dB)	0
Softhandover gain (dB)	3
Cell edge target propagation loss (dB)	**144.1**
Okamura-Hata cell range (km) L=137.4+35.2LOG(R)	**1.55**

For more information

- http://www.engadget.com/2010/01/15/3g-gsm-encryption-cracked-in-less-than-two-hours/
- http://en.wikipedia.org/wiki/W-CDMA_(UMTS)
- http://en.wikipedia.org/wiki/KASUMI
- http://en.wikipedia.org/wiki/3G
- http://www.3gpp.org/specifications
- http://mobithinking.com/mobile-marketing-tools/latest-mobile-stats
- http://voip.about.com/od/mobilevoip/p/3G.htm
- "Basic Network Architecture and Building Blocks of WCDMA (3G) Systems"- Department of Electronics Systems, Aalborg University