RF education & research

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Wireless content in a smart phone

Cellular modem:
LTE Cat4 (150Mb/s DL & 50Mb/s UL), HSPA+, EV-DO, TD-SCDMA

Application processor

PA modules incl. Duplex filters

RFIC: 2/3/4G TRx

RFIC: 4G CA TRx

16/64/128GB NAND Flash

PMIC other

PMIC WLS

ANT tuner

Wireless content in a smart phone

https://www.ifixit.com/Teardown/iPhone+6+Plus+Teardown/29206
2G/3G/4G RF transceiver
with 8 band support
Competences of a modern RF engineer

Fundamentals

• Understand various applications of radios
• Master very well basic principles of communications
• Master very well basics of electronics design
• Excel in fundamentals of RF from Smith chart and matching to noise and non-linearity
• Prototyping and measuring RF
• Computer tools for electronics design
Competences of a modern RF engineer

Advanced
- RF transceiver architectures
- RF system design and block level partitioning
- RF control algorithms
- IC design
- Communication circuits (LNA, PA, mixers, filters, amplifiers, ADCs, DAC’s, VCO’s, PLL’s, digital for RF, …)
- Antenna design
- Radio propagation
- Various implementation technologies: fundamentals and their boundaries (CMOS, BiCMOS, SiGe, HBT, GaN, SAW, BAW, PCB, …)
- Material physics in some cases when closely involved to electronics
- Digital signal processing for wireless
- Embedded programming
- …
Competences of a modern RF engineer

Capability to co-operate and learn new things
• With and from your close colleagues
• In cross-disciplinary topics
• On your own

Team work
Prerequisites for WCE-RF

Basic courses of electronics: Understanding small signal behavior of a transistor in addition to circuit theory as prerequisite for Electronics design II & III

Preferably basic course of radio technology/microwave engineering to support further studies in Radio Engineering I & II
RF at University of Oulu

RF system analysis
RF related algorithms
RF and antenna lab
IC design
Complete platforms
Antennas
Facilities

- State-of-the-art design tools from RF system design (Agilent ADS and System Vue), RFIC design (Cadence flow), antenna design tools (CST,…) and PCB design
- Industrial and research ecosystem in Oulu region provides local facilities for all necessary electronics manufacturing (except IC that is done using MPW runs)
- Measurement capabilities for RF designs and antennas currently up to 110GHz and 2GHz bandwidth for modulated signals
- And with frequency extenders up to 325GHz
5G mmW – platform

28GHz radio module done in CWC
6G Enabled Wireless Smart Society & Ecosystem

1. Wireless Connectivity
   - Ultra-reliable low-latency communications
   - Enabling Unmanned Processes

2. Devices & Circuits
   - THz communications materials & circuits
   - Enabling Unlimited Connectivity

3. Distributed Computing
   - Mobile edge intelligence
   - Enabling Time Critical & Trusted Apps

4. Services & Applications
   - Multidisciplinary research across verticals
   - Enabling Disruptive Value Networks

- National Flagship for 2018-2026
- Volume 251M€
- Operated by University of Oulu
- Collaboration with Nokia, VTT, Aalto University, BusinessOulu, OUAS.
Focus in HW is on key enabling technologies for 6G from materials to transceivers and sensing at THz range (0.1THz onwards)
Approach from systems to HW and back
Silicon based transceiver design from blocks to systems
Integration, scalability and performance of antenna arrays including challenge of wideband modulation
New technologies and materials beyond IC core
Build on the top of 5G experience, investing in THz to meet the goals

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