*Ulrich L. Rohde, Ph.D.*
*Chairman*
*Synergy Microwave Corp.*
*Technical University Cottbus*
*Germany*
*Partner Rohde & Schwarz*

# Global Markets, Global Technology, and Global Students?

*UPDATE 2015*


UF | UNIVERSITY of FLORIDA

*A contribution to the workshop,*
*"The Future of Communications & Technology"*
*University of Florida @ Gainesville*

SYNERGY® MICROWAVE CORPORATION

# University of Florida

THE

## DEPARTMENT OF ELECTRICAL ENGINEERING

With the approval of the Faculty
hereby recognizes the permanent appointment of

# ULRICH L. ROHDE

as

Professor of Electrical Engineering

March 15, 1977

Wayne H. Chen
*Dean, College of Engineering*

Donald L. Childers
*Chairman, Department of Electrical Engineering*

# The George Washington University

THE

*DEPARTMENT OF ELECTRICAL ENGINEERING*

With the approval of the Faculty
hereby recognizes the permanent appointment of

**Ulrich L. Rohde**

as

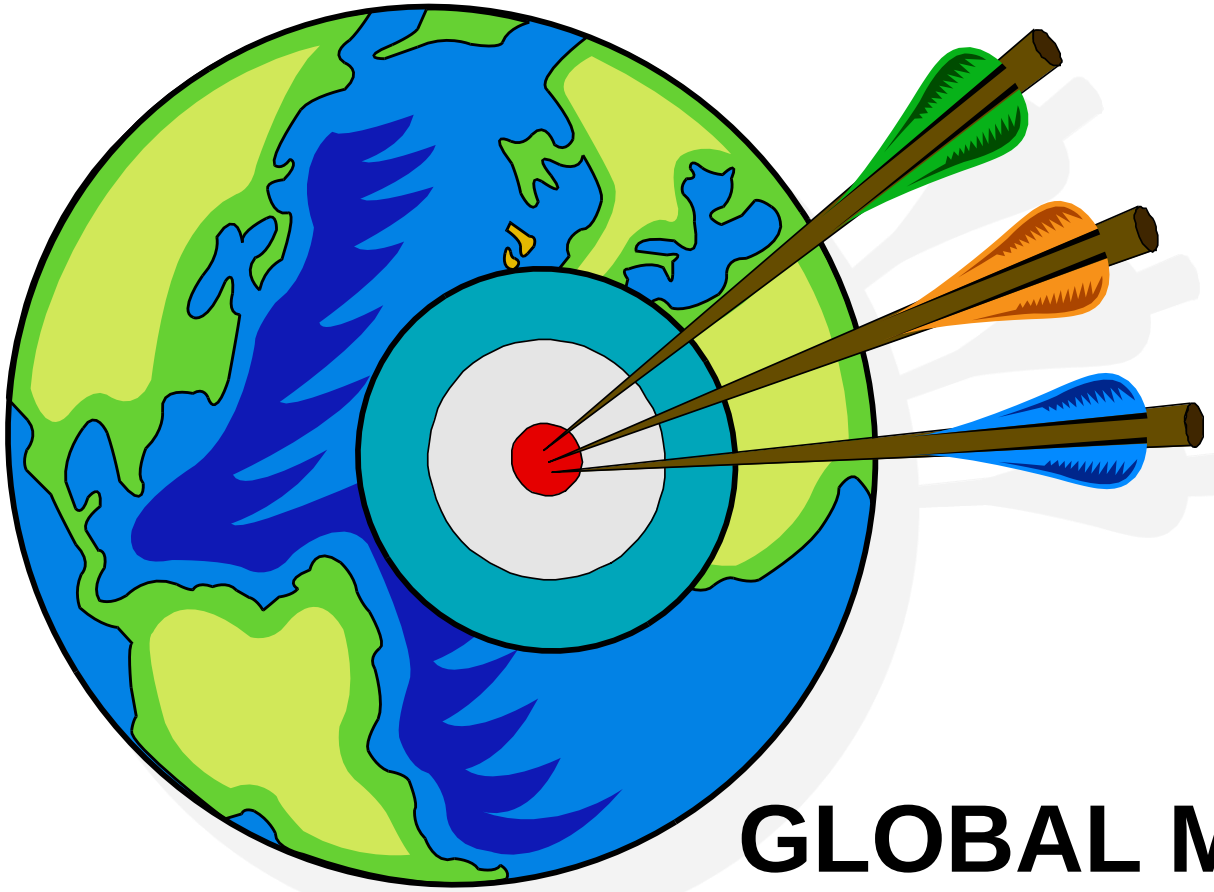
**Adjunct Professor of Electrical Engineering**

Arthur D. Friedman

May 4, 1982

Arthur D. Friedman
Chairman, Department of Electrical
Engineering and Computer Science

# OUR TOPIC:



## GLOBAL MARKETS, GLOBAL TECHNOLOGY, GLOBAL STUDENTS ?

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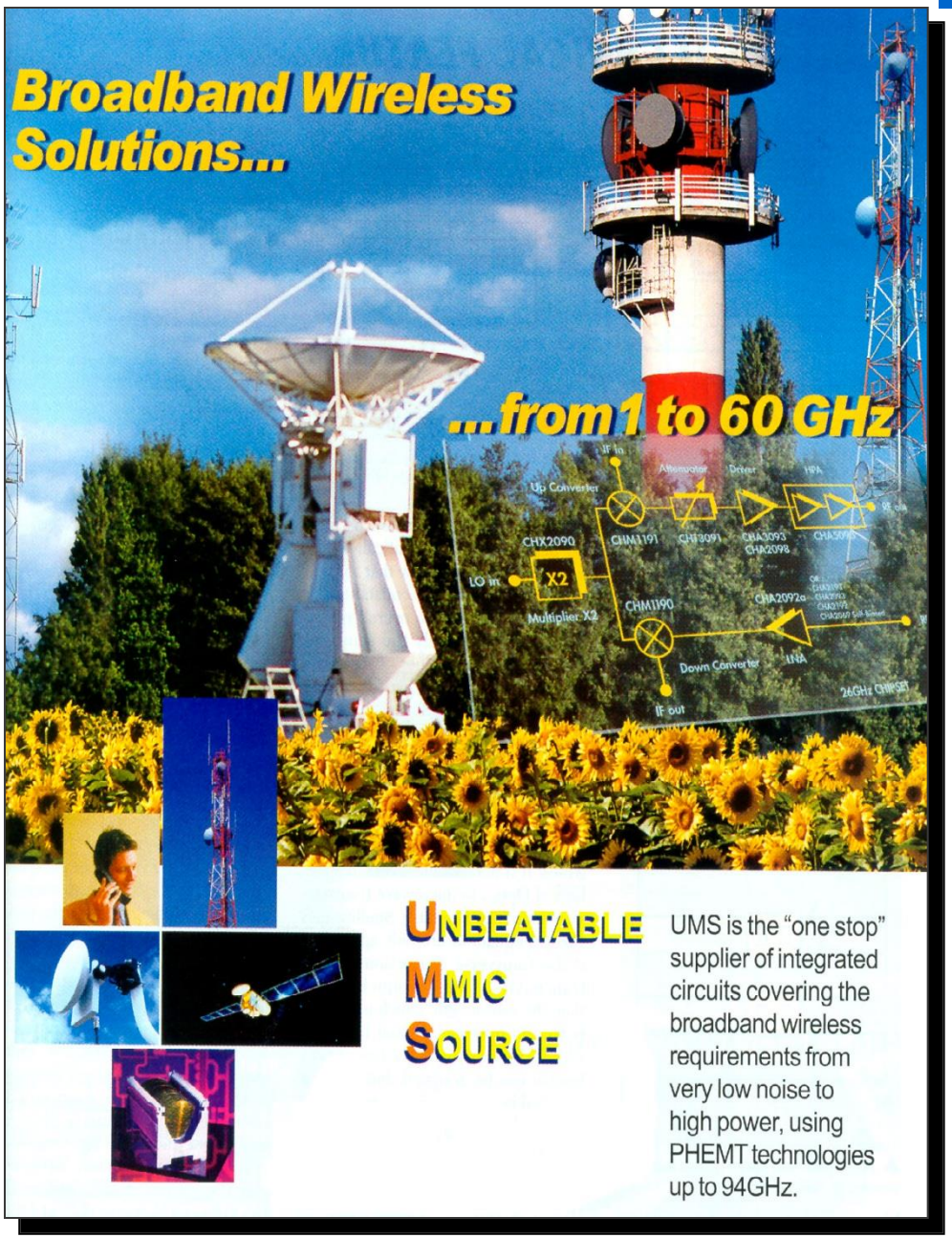
# OUR TOPIC:

- In engineering we address the international communications market.
- The technologies involved are a combination of analog and digital applications as well as passive and active components.
- The globally/universally useful student in RF engineering additionally understands A/D converters DSP, digital signal processing (DSP), microprocessor coding in C++ programming language and has some business education (MBA) and relates to innovative design with an eye for quality and reliability of the product as well as an understanding for consumer behavior.

# GLOBAL MARKETS

It mixes analog and digital techniques.

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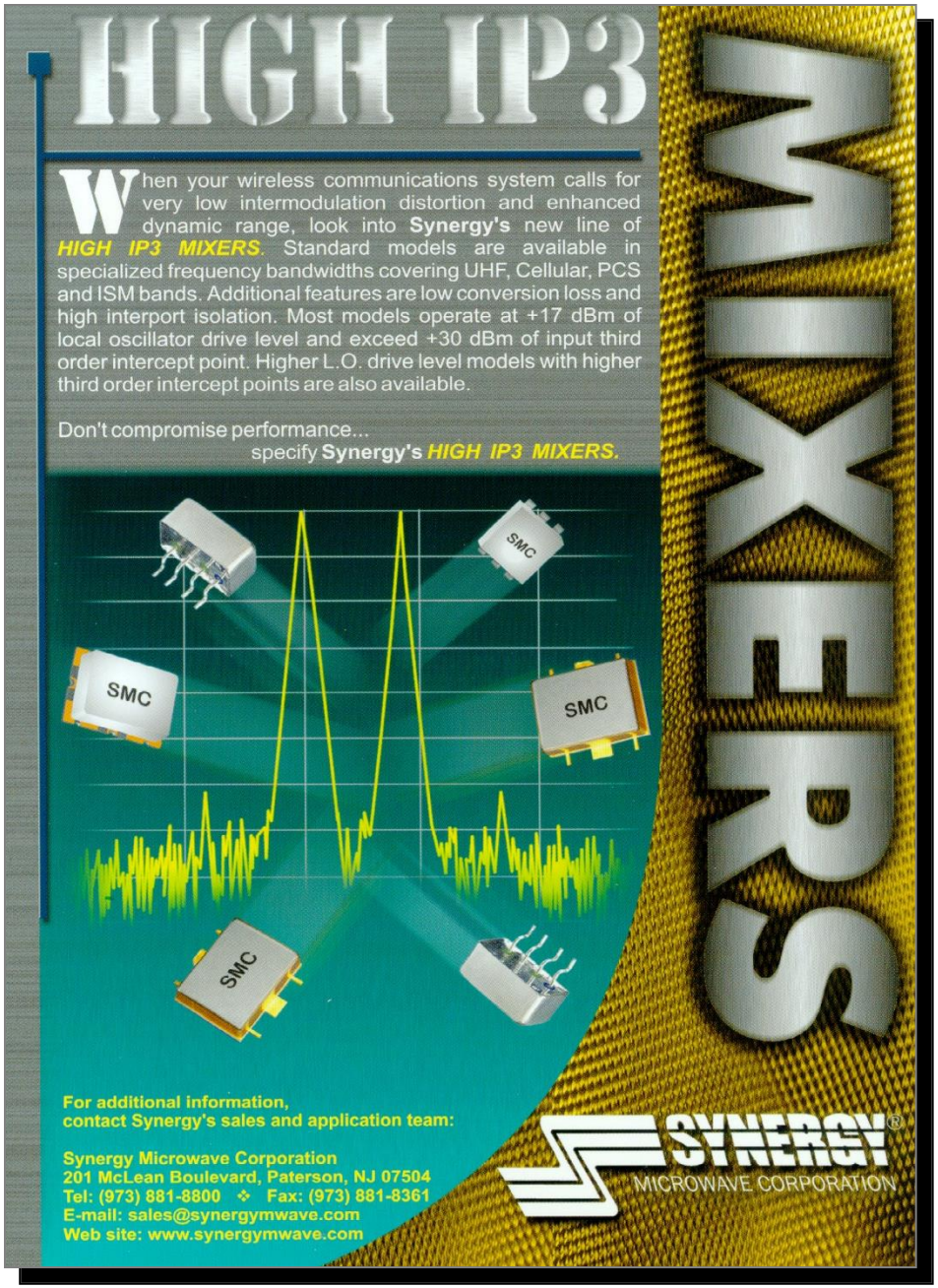
# GLOBAL MARKETS

High Performance analog techniques

An Example

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# GLOBAL TECHNOLOGY

## Analog Technology, Examples

- All RF front ends consists of analog low noise preamplifiers, “linear mixers” and PLL based high performance synthesizers and low power consumption

- Important parameters are spot noise figure, i.e.< 1dB intermodulation distortion IP3>1dBm, (3dB per dB for 3rd order products), input selectivity, low phase noise (-145dBc/Hz @ 200KHz off carrier synthesizers with fast settling speed, less than 1mS

# GLOBAL TECHNOLOGY

## Digital Technology, Example

- Optimized IF frequencies for the analog to digital converters (A/D), understand the A/D impedance matching, overload vs. noise figures.

- Choose proper IF selectivity coding, DSP implementation of composite filters using Bessel/Cauer and elliptic filters, choose appropriate DSP derived automatic gain, control minimize computational delay time and optimize other important parameters

# GLOBAL TECHNOLOGY

## Leaders & Losers

1. Samsung– World Leader in Volume,
2. Nokia– Big on “dumb phones”, Went from #1 to #7 in “Smartphones” in two years. 2014 #11 with <3% market share. In 2015 down to 2%
3. Apple– iPhone Most Appealing
4. ZTE- Chinese low cost manufacturer
5. LG- South Korean electronics company
6. In the top 10 smartphone companies, 5 are Chinese: Lenovo, Huawei, ZTE, Xiaomi, Coolpad/Yulin

- Sony Ericsson – Now Sony –Struggling to survive
- Motorola – Sold to Google for their IP rights – sold to Lenovo.
- Blackberry- Once in every business persons pocket, today <1% market share
- Siemens & Ericsson – Left the cell phone business

# CELL PHONE MANUFACTURER

## NOKIA

*Changed from a technology innovative leadership with lower cost. (production cost) to a systems integrator. Now bought by Microsoft to rescue failing Windows OS*





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# CELL PHONE MANUFACTURER

- Changed the mobile world with the introduction of the iPhone 2007
- Became the most profitable manufacturer 2009
- 2015  the worlds highest valued company
- Today has 12% of the world market with high end smart phones. Increasing volumes, regaining market shares
- Nokia went from 30% to <3% Market share from 2010 to 2014.
- Samsung went from 8% to 30% between 2010 and 2012. Loosing market share to 25% in 2014. Lost its #1 position in China to Xiaomi

# CELLULAR PHONE market

- Android was introduced 2007
- Smart phone market share
- 2009 2.8%
- 2010 33%
- 2012 75%
- 2014 81%
- 1.5 Million device activations per day
- 2013 there were 3.5 times more active smartphones&tablets then Windows based PCs

# CURRENT TECHNOLOGIES

- GSM (Simcards!) 80% Market Share, Used Internationally (3G/UMTS, > 4G) advantage is high capacity, system is upgradable, economy of scale
- LTE (erroneously called 4G, Launched 2009)
  - Evolution of UMTS
  - 2014 only 170 million subscribers
  - 75 % in the US, South Korea and Japan
- cdma2000 (formerly IS-95 System)
  - 15% Market Share (Example Sprint)
  - Qualcomm Patent

# CELLULAR PHONE MARKET

PRICE DOWN

PROFIT DOWN

NUMBER OF MODELS UP

## NOKIA


Huge volumes
Almost no profit

## ERICSSON

Merged with Sony
and then exit

## SIEMENS


(Out of Business)

## MOTOROLA

Saved by Google, sold to Lenovo

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# GLOBAL MARKETS

**Most growth potential:**

- Multimedia Communications (includes high quality video images)
  - Video is expected to increase by around 55 percent annually up until the end of 2019, Source Ericsson
  - It is forecasted to make up more than 50 percent of global mobile traffic
- Cloud based services, Facebook etc.
  - E.g. uploading pictures. The four most popular cameras on Flickr are IPhone 5S,6 &5 followed by Samsung S4 and S5
  - 4 billion camera phone owners 2014
- Hand held or pocket sized computers (phablets) using UMTS/LTE
- Internet of Things (IOT)
- WiFi important assisting technology
  - WiFi not reducing mobile data traffic from smartphones

# GLOBAL TECHNOLOGY

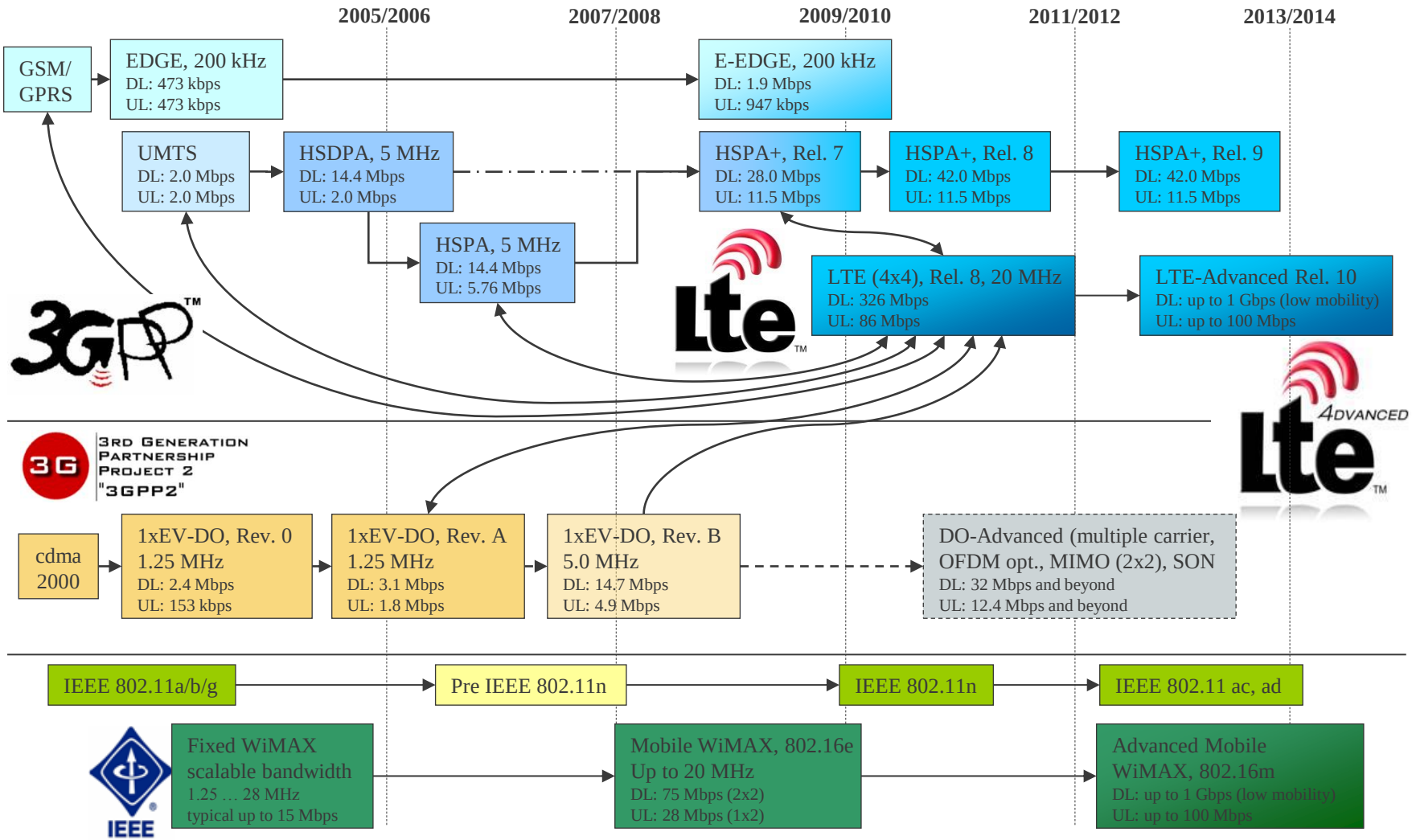
- **First Generation- Analog Cell phone System (1985)**

- **Second Generation - Digital System (1990)**
  - Voice, Text Messaging, GSM, CDMA-ONE, TDMA

- **Third Generation (3G) - UMTS-Digital System (2001)**
  - High data rate, IP based (email, web, navigation etc.)
  - Multimedia Communications

- **Fourth Generation(4G)- LTE advanced (2013)**
  - Higher speed data communication
  - Voice communication is just one use case

# TECHNOLOGY EVOLUTION PATH

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# WHAT IS UMTS?

- UMTS stands for Universal Mobile Telecommunications System
- UMTS is a member of the ITU's IMT-2000 global family of "third-generation" (3G) mobile communications systems, 4G next
- UMTS will play a key role in creating the future mass market for high-quality wireless multimedia communications that will approach 2 billion users worldwide by the year 2010
- UMTS represents the most exciting new investment opportunity mobile services for the next decade.
- UMTS is the preferred mobile delivery platform for tomorrow's content-rich services and applications.
- UMTS is more than a technology, it is a key to the delivery of new, valuable and content-rich services to the end user.

# WHY UMTS?

- UMTS will enable tomorrow's wireless Information Society, delivering high-value broadband information, commerce and entertainment services to mobile users via fixed, wireless and satellite networks

- UMTS will further speed convergence between telecommunications, IT, media and content industries to deliver new services and create fresh revenue-generating opportunities

- UMTS will deliver low-cost, high-capacity mobile communications offering data rates up to 2Mbit/sec with global roaming and other advanced capabilities

***" Technology cannot become a topic which is decided by politics."***

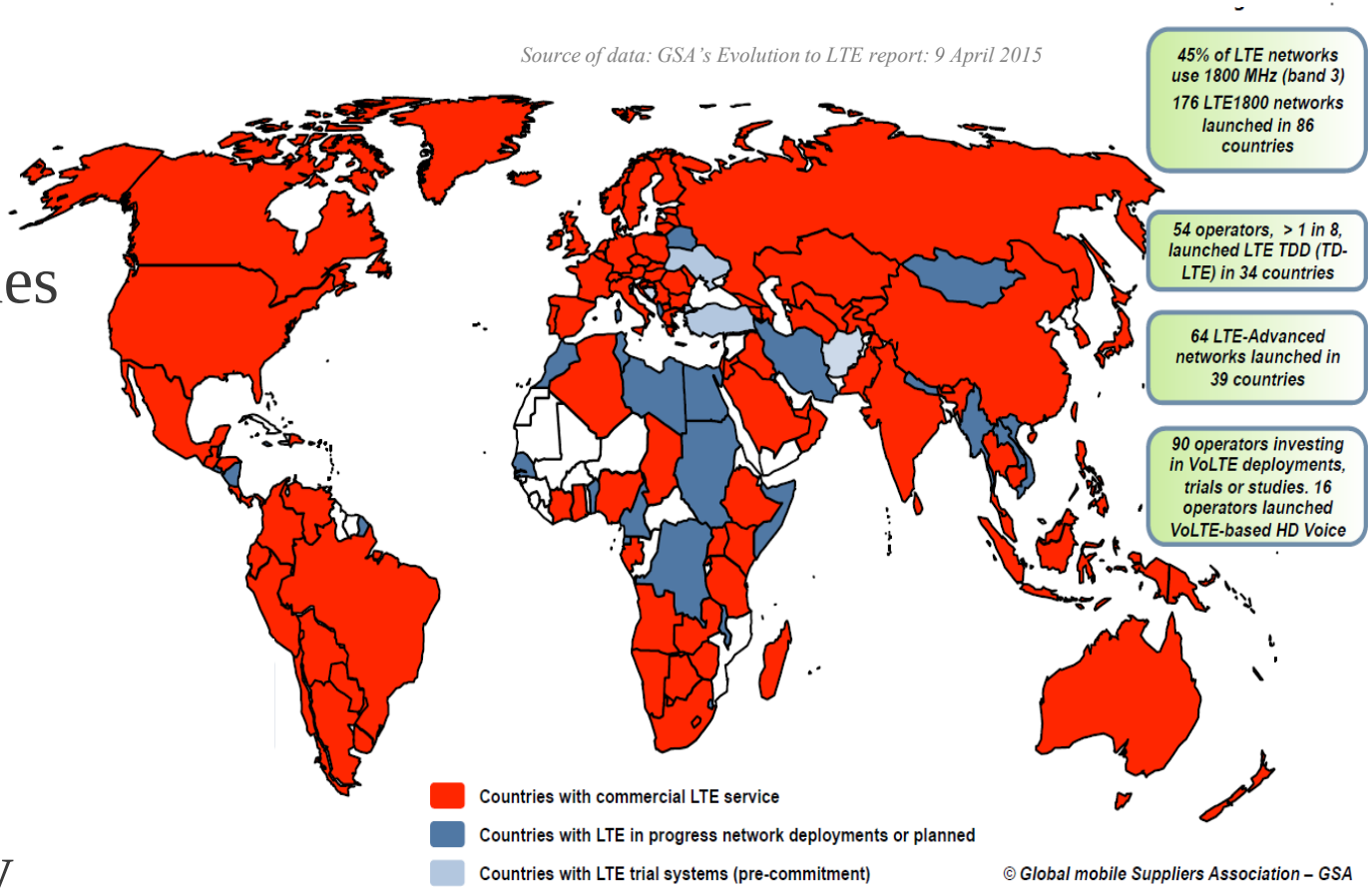
# WHY LTE?

## Ensuring Long Term Competitiveness of UMTS

- LTE is the next UMTS evolution step after HSDPA/HSUPA.
- Main targets of LTE:
  - Peak data rates of 299.6 Mbps (downlink) and 75.4 Mbps (uplink)
  - Scalable bandwidths up to 20 MHz
  - Cost efficiency
- Study was initiated in December 2004 (3GPP release 7).
- First commercial network 2009 (Telia, Sweden)

# LTE Today

- 393 commercially launched networks in 138 countries
  - 2 in 2009
  - 14 in 2010
  - 30 in 2011
  - 100 in 2012
  - 118 in 2013
  - 100 in 2014
- 460 networks estimated by E2015
- 497 million LTE subscribers by Q4/14

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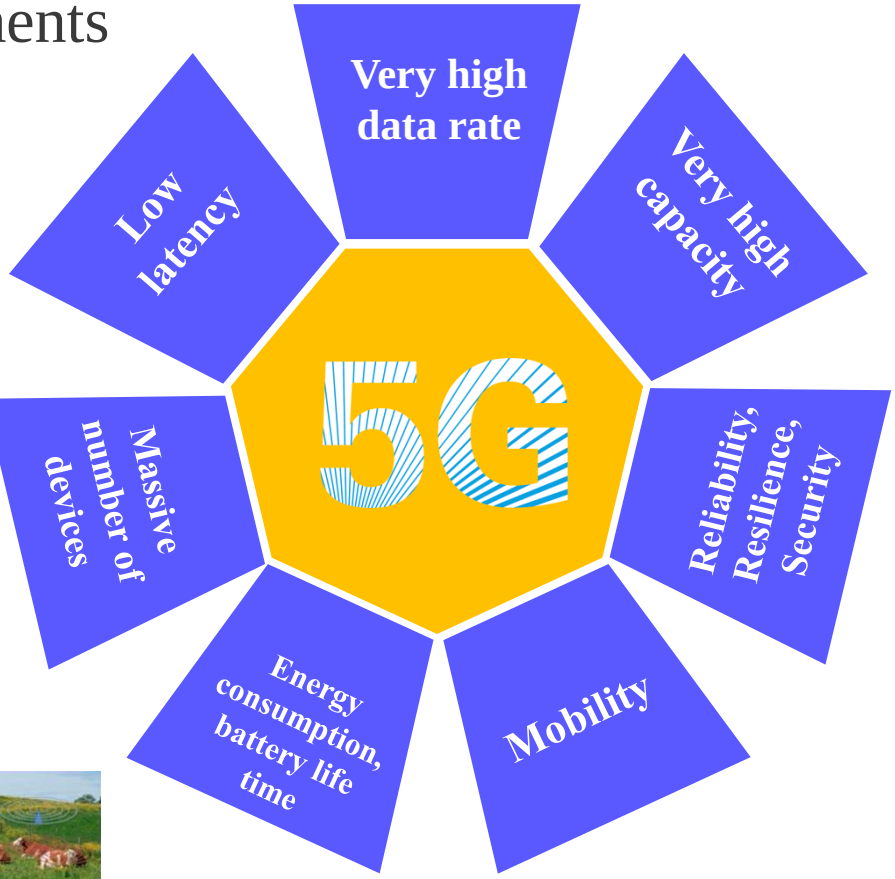
# LTE advanced

- True 4G
- Theoretical up to 3.3 Gbps downlink transmission
- Backward compatible to LTE
- First network started June, 2013 in South Korea
  - Currently offering 225 Mbps in live network

# 5G has not been defined yet

## Discussed Scenarios & Requirements




- **Dense crowd of users:**

  High data rates. high capacity, limited area.


- **Internet of Things (emergency comms, robots, …):**

  Low latency, high reliability, resilience and security; user case specific data rates/capacity.


- **Internet of Things (sensors; leisure applications, …):**

  The volume of devices and "things" will create new requirements.

  Battery life time expectation → years

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# New Frequencies are needed
# Many new challenges coming

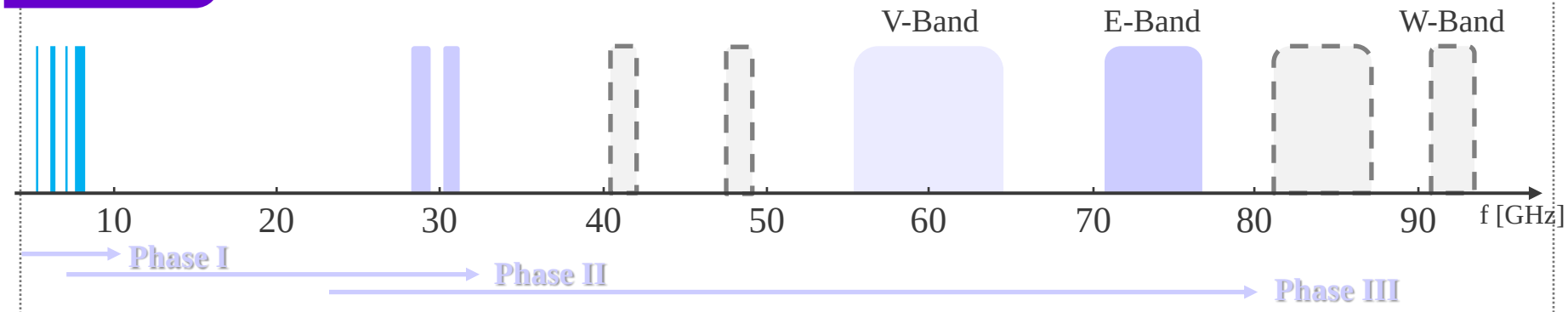
**Known characteristics: LTE-A evolution possible**

**Different propagation; may require redesign**

**Significantly different propagation**

- **Transmission through most objects is reduced but reflection is amplified.**
- **Foliage loss is severe.**
- **High pathloss component requires massive MIMO / beamforming technologies using active antennas.**

**Disruptive technology likely**

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# Rohde & Schwarz CMW500

GSM/(E)GPRS
EDGEevo
VAMOS
WCDMA
HSPA
HSPA+
CDMA2000
1xEV-DO
LTE-FDD
TD-LTE
TD-SCDMA
Mobile WiMAX
WLAN abgn
Bluetooth

## Cellular/Non-Cellular Network-Emulation

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# MOBILE SUBSCRIBERS, PHONES, AND USERS

- Planet: 7.1 Billion humans
- Mobile accounts: 6.7 Billion
  - total active subscriptions (94% of all humans)
- Phones in use: 5.2 Billion
  - including those with 2 phones (73% of all humans)
- Unique users: 4.3 Billion
  - humans who have at least one phone and account (60% of all humans)
- 1.85 Billion mobile phone handsets sold 2013

# Internet of things

## The next big thing?

- Most known example
  - Apple Watch

- Some examples
  - Car manufacturers, car2car communication for collision avoidance
  - Robots in factories
  - Farm animals
  - Healthcare

# Internet of things

## Just some examples from today WiFi:


Koubachi Plant Sensor

www.koubachi.com


Sengled Lightbulb

www.sengled.com


Amazon Dash Button

www.amazon.com

Bosch Rexroth Nutrunner

www.boschrexroth.com

Luna Mattress Cover

www.lunasleep.com

Masimo Patient Monitor

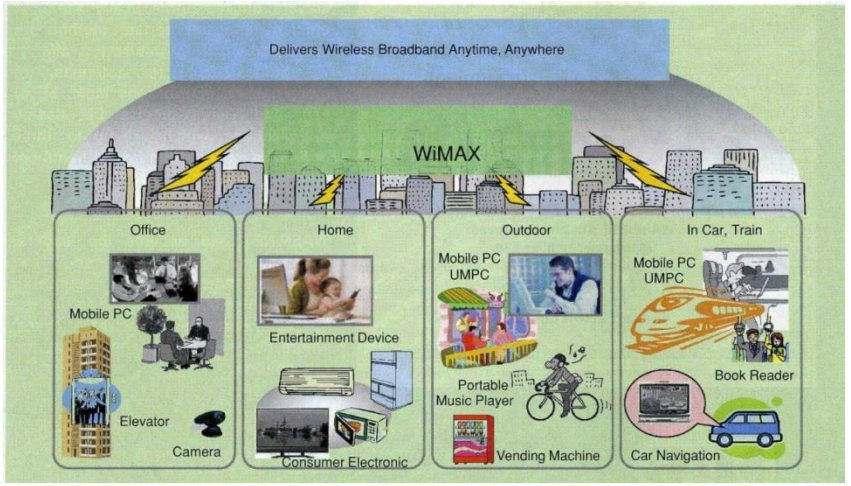
www.masimo.com

# GLOBAL ACCESS

Worldwide interoperability for microwave access (WIMAX)

Lost the battle against LTE, due to limited operator backing

Sprint will phase out WIMAX 2015

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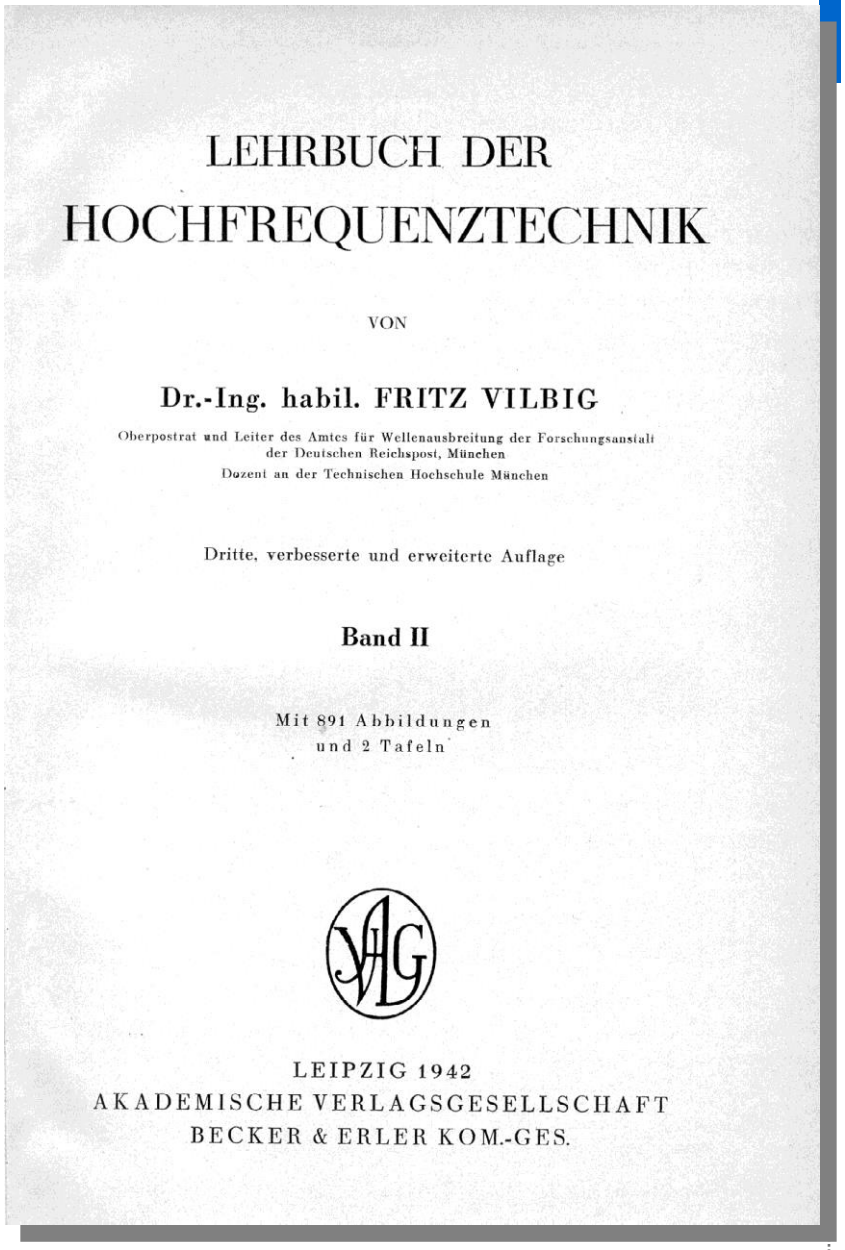
# GLOBAL STUDENTS

*- 1942 -*

- RF/Microwave Education (in German)
- Focus mostly on theory
- No international conferences
- No technology exchange or transfer due to language problems
- No digital technology (did not exist at that time)



LEHRBUCH DER
HOCHFREQUENZTECHNIK

VON

Dr.-Ing. habil. FRITZ VILBIG

Oberpostrat und Leiter des Amtes für Wellenausbreitung der Forschungsanstalt der Deutschen Reichspost, München
Dozent an der Technischen Hochschule München

Dritte, verbesserte und erweiterte Auflage

Band II

Mit 891 Abbildungen
und 2 Tafeln

LEIPZIG 1942
AKADEMISCHE VERLAGSGESELLSCHAFT
BECKER & ERLER KOM.-GES.

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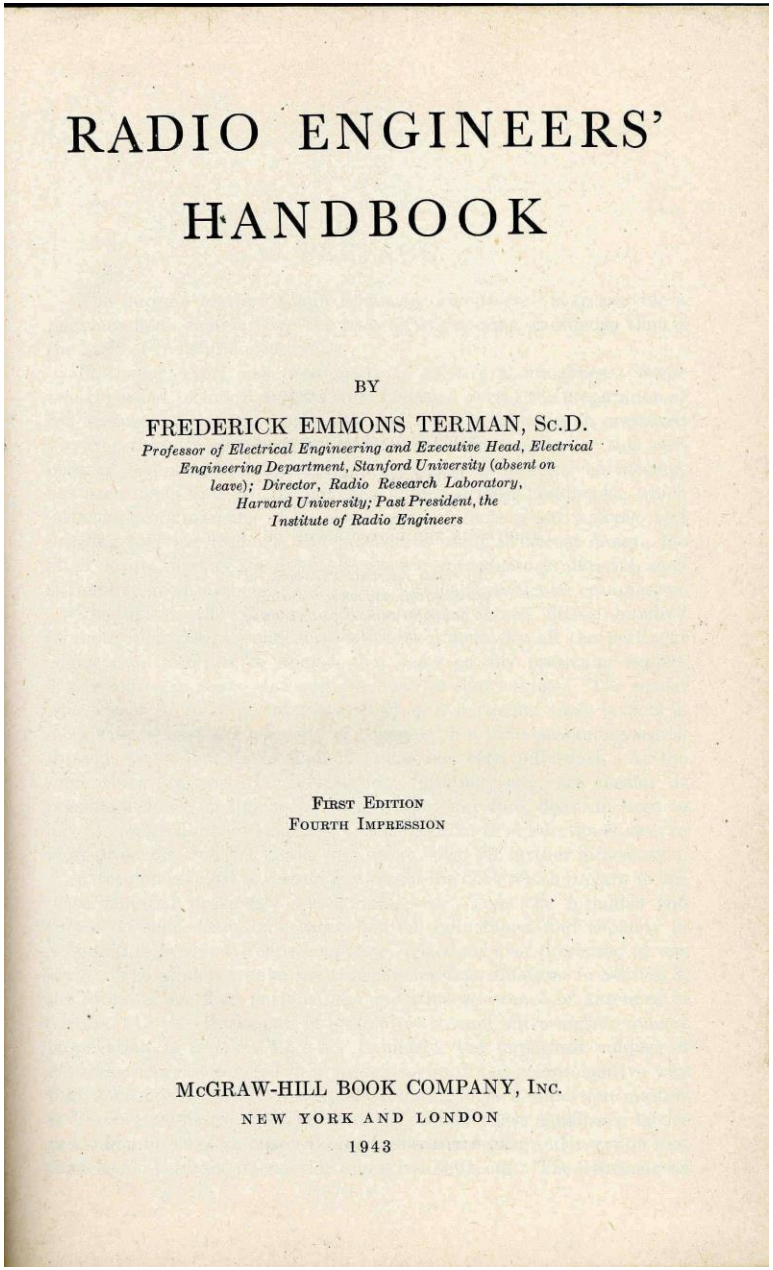
# GLOBAL STUDENTS

*- 1943 -*

- Then State of the Art text book for radio engineering
- Probably the best comprehensive US radio electrical engineering book ever written. Used in all English speaking countries.
- Contains only analog circuitry
- Digital technology did not exist at that time



RADIO ENGINEERS' HANDBOOK

BY

FREDERICK EMMONS TERMAN, Sc.D.

*Professor of Electrical Engineering and Executive Head, Electrical Engineering Department, Stanford University (absent on leave); Director, Radio Research Laboratory, Harvard University; Past President, the Institute of Radio Engineers*

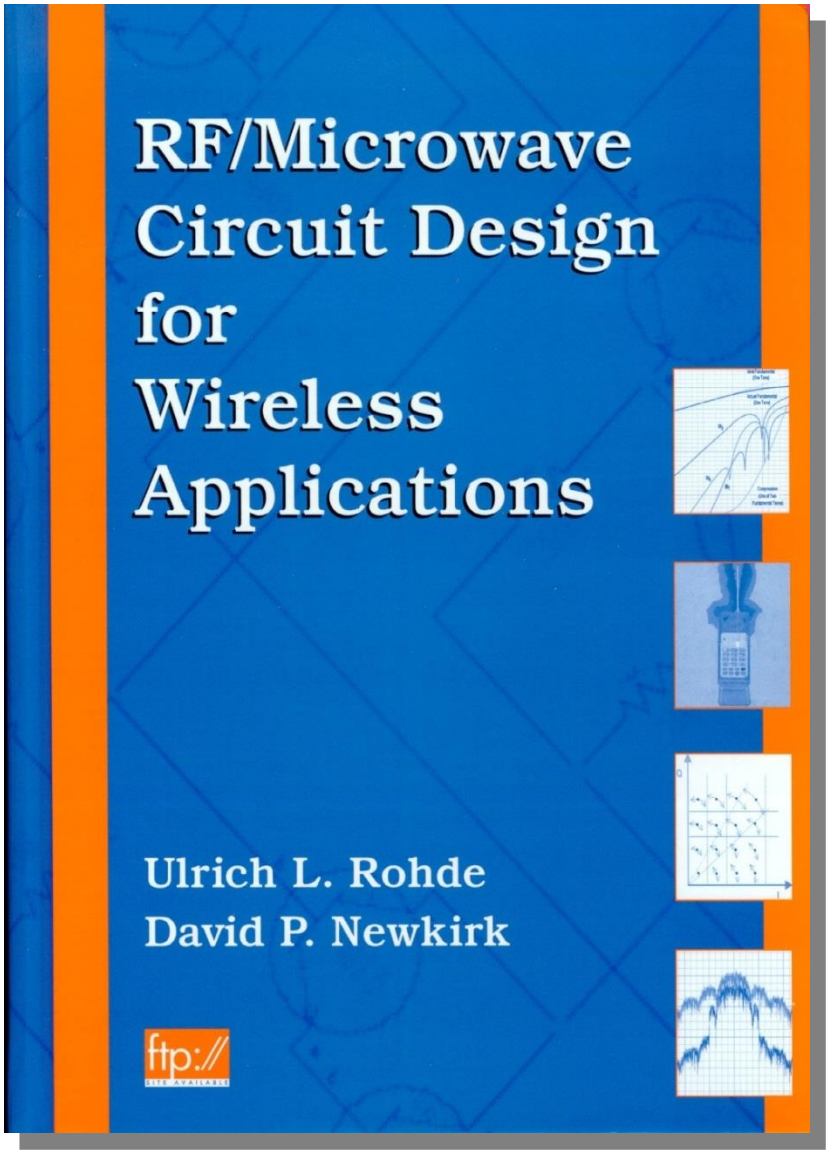
First Edition
Fourth Impression

McGRAW-HILL BOOK COMPANY, Inc.
NEW YORK AND LONDON
1943

# GLOBAL STUDENTS

*- 2001 -*

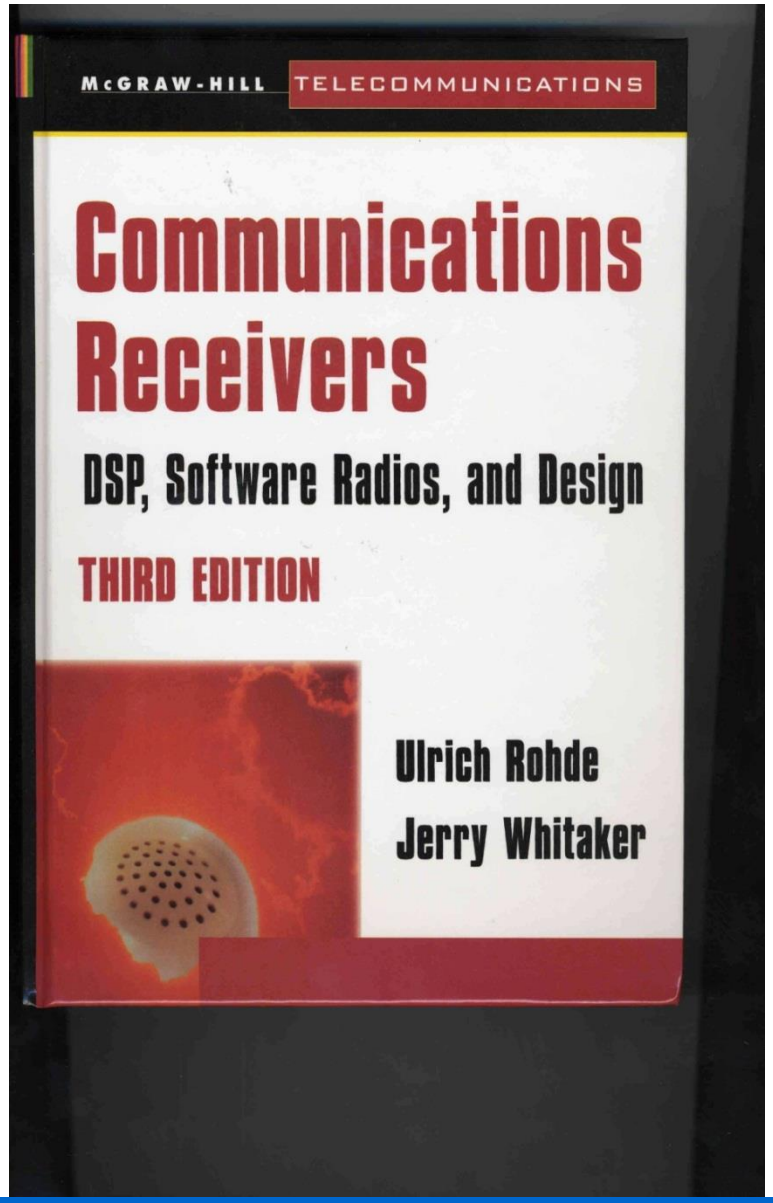
- Education in English international technology language
- Focus on theory and real life application
- Material presented at international conferences
- Result of technology exchange or transfer
- Covers modern cellular radio technology, analog and digital



# GLOBAL STUDENTS

*- 2001 -*

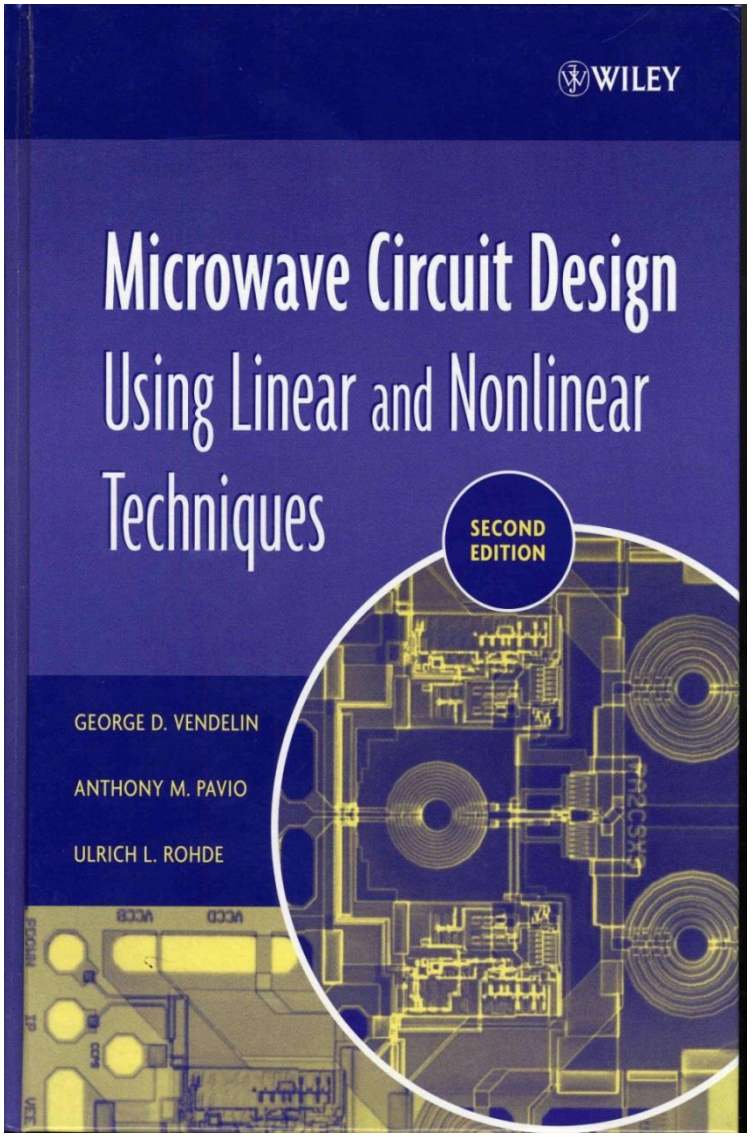
- State of the art communication technology
- Covers high performance application
- Good reference for past and modern design



# GLOBAL STUDENTS

*- 2005 -*

- Linear and nonlinear circuit analysis treatment 2nd edition
- Best in class
- Covers all relevant material
- Ideal reference material

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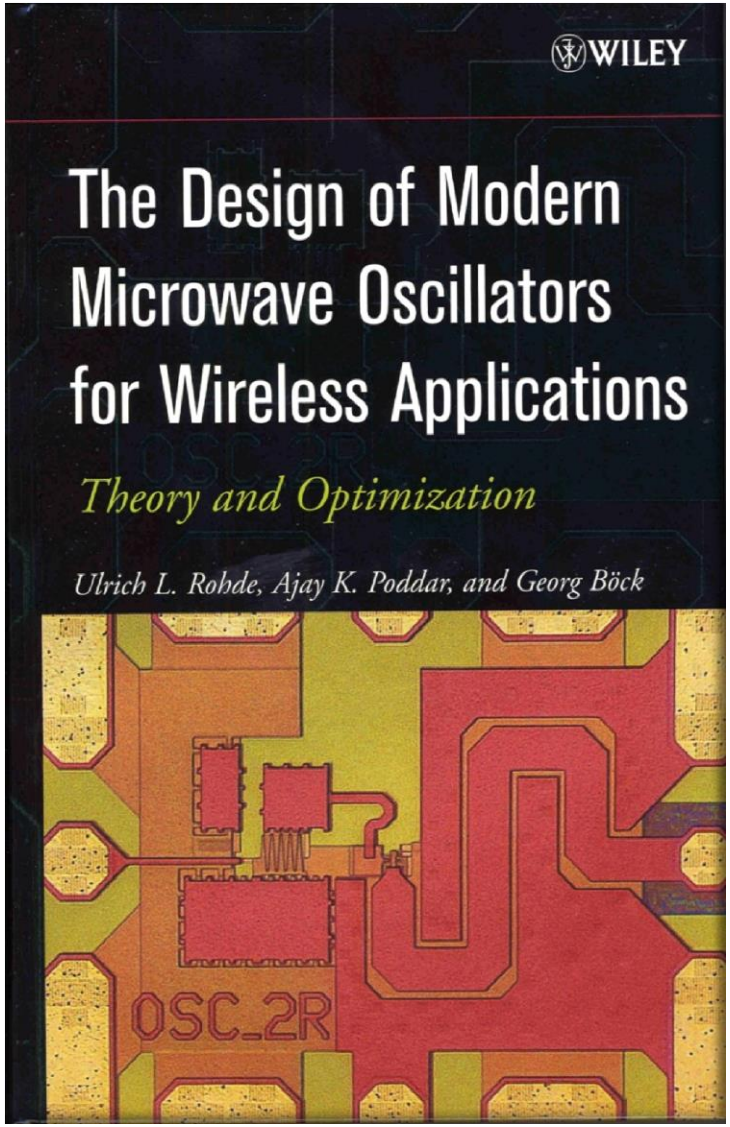
# GLOBAL STUDENTS

*- 2005 -*

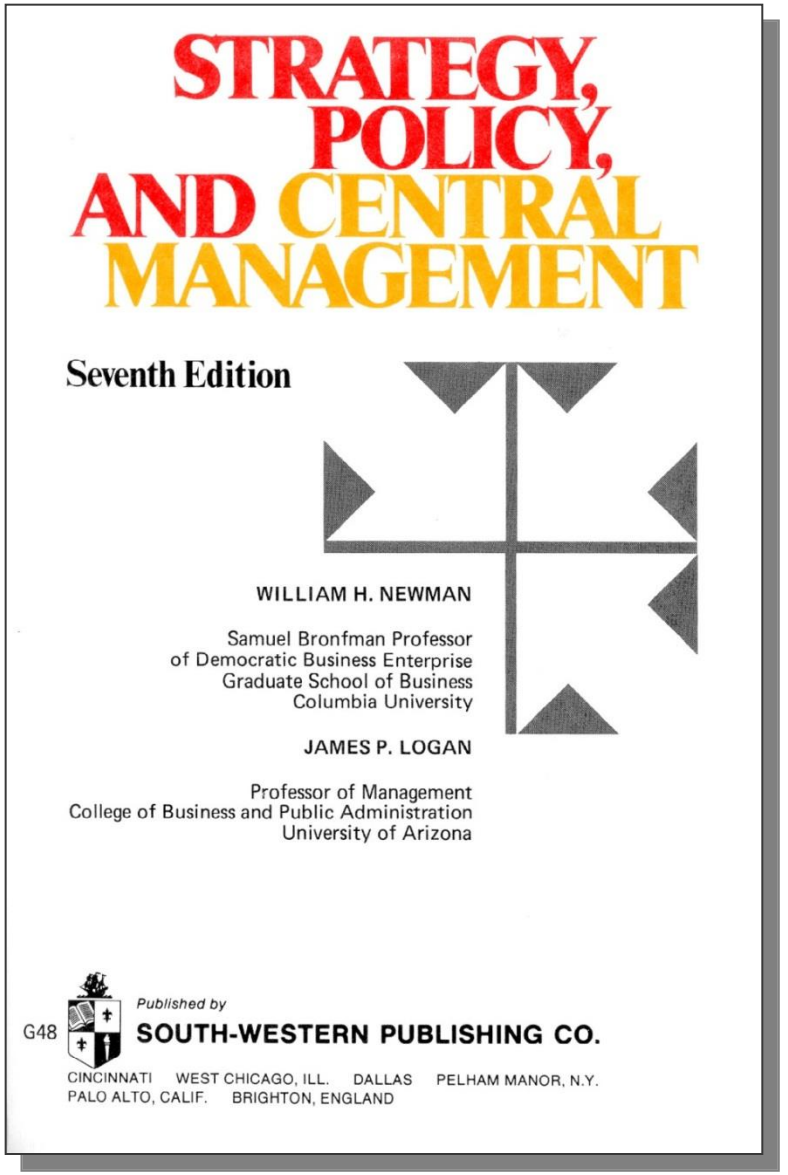
- Oscillator performance can make or break a system performance
- Covers RF to millimeter wave circuits
- Most advanced test book on this topic
- Ideal reference material



# GLOBAL STUDENTS

*- 2009-*

- Success by implementing strategy, policies and central management
- Focus on market needs and cost effective manufacturing
- Watch your competitors at international conferences and adapt products
- Learn from technology exchange

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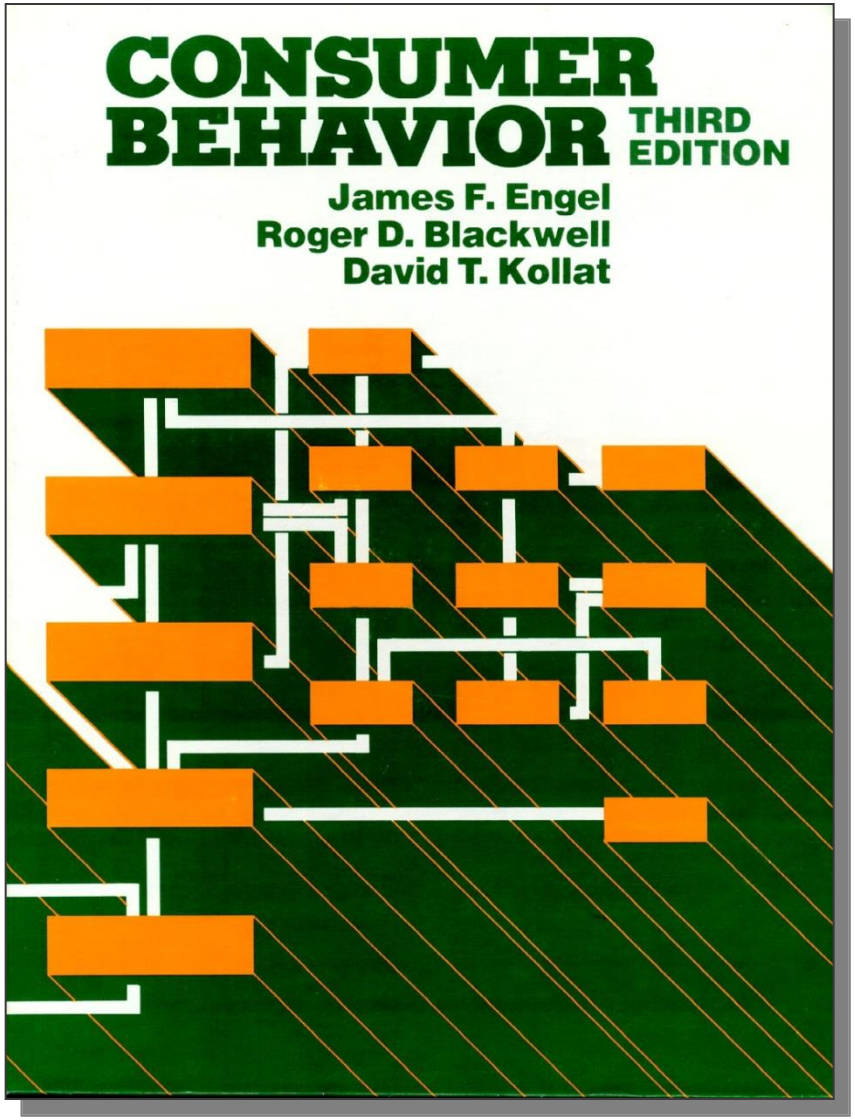
# GLOBAL STUDENTS

*- 2009 -*

- Success by watching consumer behavior
- Listen to the customers needs
- Decisions are made on perceptions more often than reality
- Compatibility with existing technologies or products is key to success

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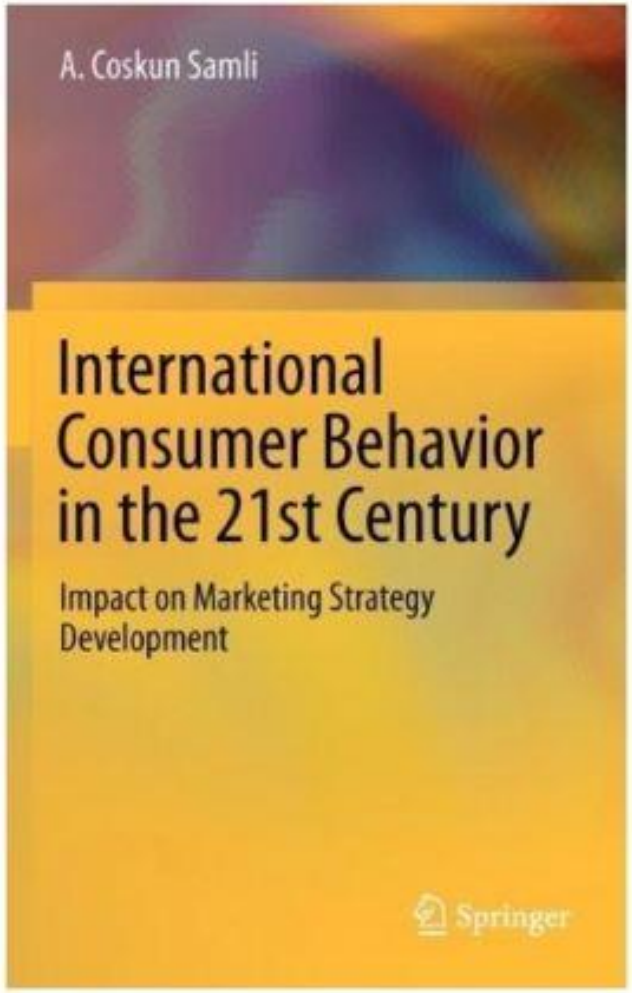
# GLOBAL STUDENTS

*- 2012-*

- Coping with increasing international competition
- Adjusting strategic marketing for different countries/ cultures
- International consumer information for gaining a competitive edge



# GLOBAL STUDENTS

- The book by Christina Gessner focuses on the radio access network and the radio aspects of LTE, i.e. the air interface from the mobile station and base station point of view.

- ISBN: 978-3-939837-11-4

# GLOBAL STUDENTS

## Requirements For Modern Adaptive Students

Fewer young people nowadays choose engineering education, and what is even more worrisome is the fact that the most gifted students decide to study at the faculties of computer science and engineering, choosing zeros and ones over microwaves or curl and divergence. The said zeros and ones are significantly easier to comprehend than the area of curl and divergence.

# GLOBAL STUDENTS

## Requirements For Modern Adaptive Students

Therefore, as a consequence, the computer students score higher than those who study the microwaves area, while putting, in fact, less effort into their learning. Difficult curriculum and fewer opportunities to obtain high grades cause the students to lose interest in microwaves.

# GLOBAL STUDENTS

## Requirements For Modern Adaptive Students

"The only person who is educated is the one who has learned how to learn and change"

The general demand to master new skills results from constantly modernizing technologies.

"The world does not pay for what a person knows. But it pays for what a person does with what he knows."

Reference: Josef W. Modelski, President of IEEE
IEEE Microwave Magazine, August 2008

# GLOBAL STUDENTS

- The Professional -

- You need a good mix between tradition and society demands
- Students come from all countries and become global professionals
- Country barriers are disappearing
- Success lies in education and commitment to excellency