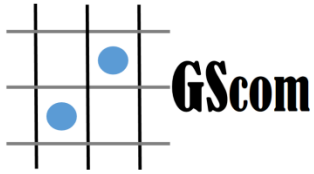


Business Development for Broadband 4096-QAM Modem

Business Background

- **Today's life style:**
  - Rich contents of life
    - Real time video, IoT, rich multimedia applications
    - Health care, safety, & Artificial Intelligence, etc.
    - Home entertainment & self amusement
    - Public safety, traffic and network control

- **Today's Communications:**
  - Any time and any place connection
  - Tons of information & Data
  - Personal communications
  - Public and safety communications
  - Gigabit speed with almost zero latency communications

Business Background

- **With the advent of Wi-Fi, WiMax, LTE in 4G & Beyond,**
  - Smaller coverage range,
  - More number and higher density of small cells,
  - Higher data rate & throughput
  - Higher speed with tight latency
  - Higher interference

- **Smart & Small Cell Business**
  - Explosive growth
  - Mobile users:
    - 500 M in 2011
    - 800 M in 2015 (Statista)
  - Monthly Data Usage (Global);
    - 270 M bytes in 2013
    - 600 M bytes in 2014 (Statista)

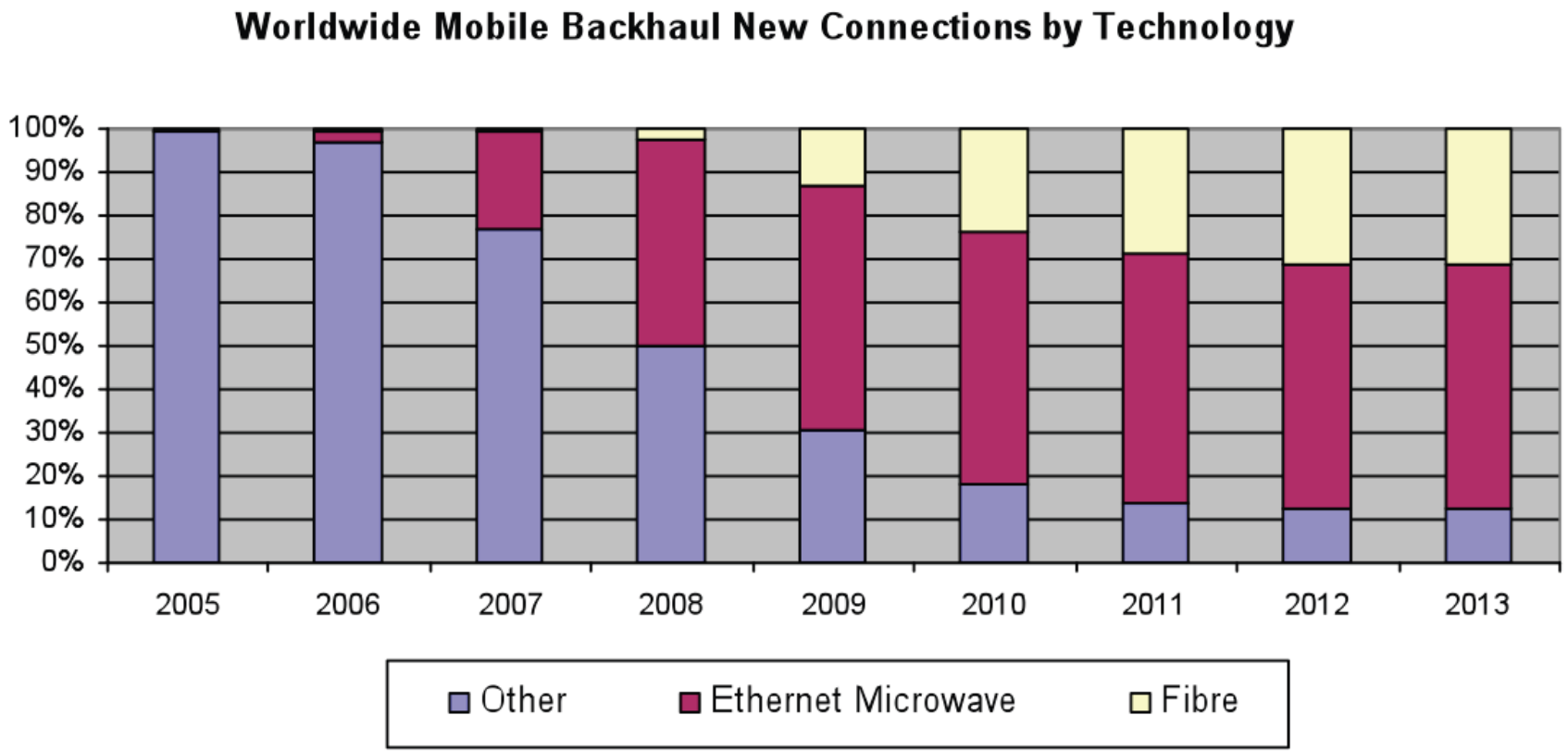
Communication System Overview

- **Wireless Communication System**
  - Mobile station (MS)
  - Access media
  - Base station (BS) (or cell)
  - Communication network (including BSC or MSC)

- **Types of Cell (depends on coverage range)**
  - Femto cell
  - Pico cell
  - Micro cell
  - Macro cell
  - **Small cell** includes Femto cell, Pico cell, and Micro cell now days.

- **Types of Communication Link**
  - **Fronthaul**
    - Communication link between handset (MS) and base station (BS)
  - **Backhaul**
    - Communication link between BS, MSC, and BS

Access Media & Technologies used in Backhaul Network



Backhaul Business with Small Cell

- **Application area of Small Cell Backhaul Modem**
  - Capacity & Coverage (hotspot, airport, shopping mall, any place)
  - Explosive increase of SOHO, PAN & LAN (Wi-Fi, AdHoc)
  - Centralized control & safety network (Point to Multi-point: PMP)
    - Traffic light tower, Security, Logistics
    - Hospital, Medical center, doctor office, remote diagnosis
    - Emergency (911), disaster report center
  - Aggregation (Point to Multi-point: PMP) network

Backhaul Business Opportunity

- **New drivers**
  - Small Cells (PAN, WLAN,)
  - LTE architectures (All IP, Point to Multipoint: PMP)
  - Network Evolution (Access & Core)
  - High-capacity & High coverage
  - Centralized control & safety network (Point to Multi-point: PMP)

- **Application Area**
  - Capacity & Coverage (hotspot, airport, shopping mall, any place)
  - Explosive increase of SOHO, PAN & LAN (Wi-Fi, AdHoc)
  - Femto cell, Picocell, Microcell, Macrocell
  - Centralized control & safety network (Point to Multi-point: PMP)
  - Traffic, Security, Logistics
  - Hospital, Medical center, doctor office, remote diagnosis
  - Wireless access network, Emergency (911), disaster report center
  - Last mile & Aggregation network

Backhaul Business Opportunity

- **Smart & Small Cell Business**
  - Explosive growth
  - Mobile users:
    - 500 M in 2011
    - 8000 M in 2015 (Statista)
  - Number of Backhaul modem used:
    - 800 M units in 2015 (8000M/10 users/sector)
  - Monthly Data Usage (Global); (Statista report)
    - 0.6 G bytes in 2014
    - 4.3 G bytes in 2019 (Statista)

Hybrid cell modem development overview

	Knowledge Needed	Players	Notes
Fronthaul Modem	Physical layer of GSM, CDMA, WCDMA, HSPA, LTE, WiFi, and WiMax Multimedia, applications Medium access control protocol & SW Radio link control protocol & SW	Qualcomm, Broadcom, Intel, Samsung, Marvel, etc	Extremely difficult business to survive
Backhaul Modem	Radio access control Mobile internet protocol SW Netwok control protocol & SW Network management protocol & SW	Wireless Modem: MaxLinear, Altera, Escape, Analog Devices, Xilinx,	Relatively easy for development due to; 1.Need classical communication technology 2.Simple data format and contents

GScom's Broadband 4096-QAM Modem

- **System Features**
  - Adaptive modulation: from QPSK up to 4096-QAM
  - Adaptive channel BW: 14/28/56/112 MHz
  - Variable roll-off factor in PSF: 10% - 18%
  - Parallel pipelined structured Reed-Solomon codec (super fast)
  - AA parallel TDMP architecture LDPC codec (super fast)
  - Joint estimation & correction of phase noise between CR and DFE
  - ACM, ATPC, HARQ, FS-DFE, XPIC etc.

- **Performance Simulation Result**
  - **World-Best receiver sensitivity** in AWGN & fading environments
  - Excellent coding gain (8-10 dB) from LDPC codec
  - Additional 2-4 dB coding gain above the achieved LDPC coding gain by using Reed-Solomon (R-S) code with RS(255,235,20) format (when used in a cascaded form of the R-S and LDPC codes)

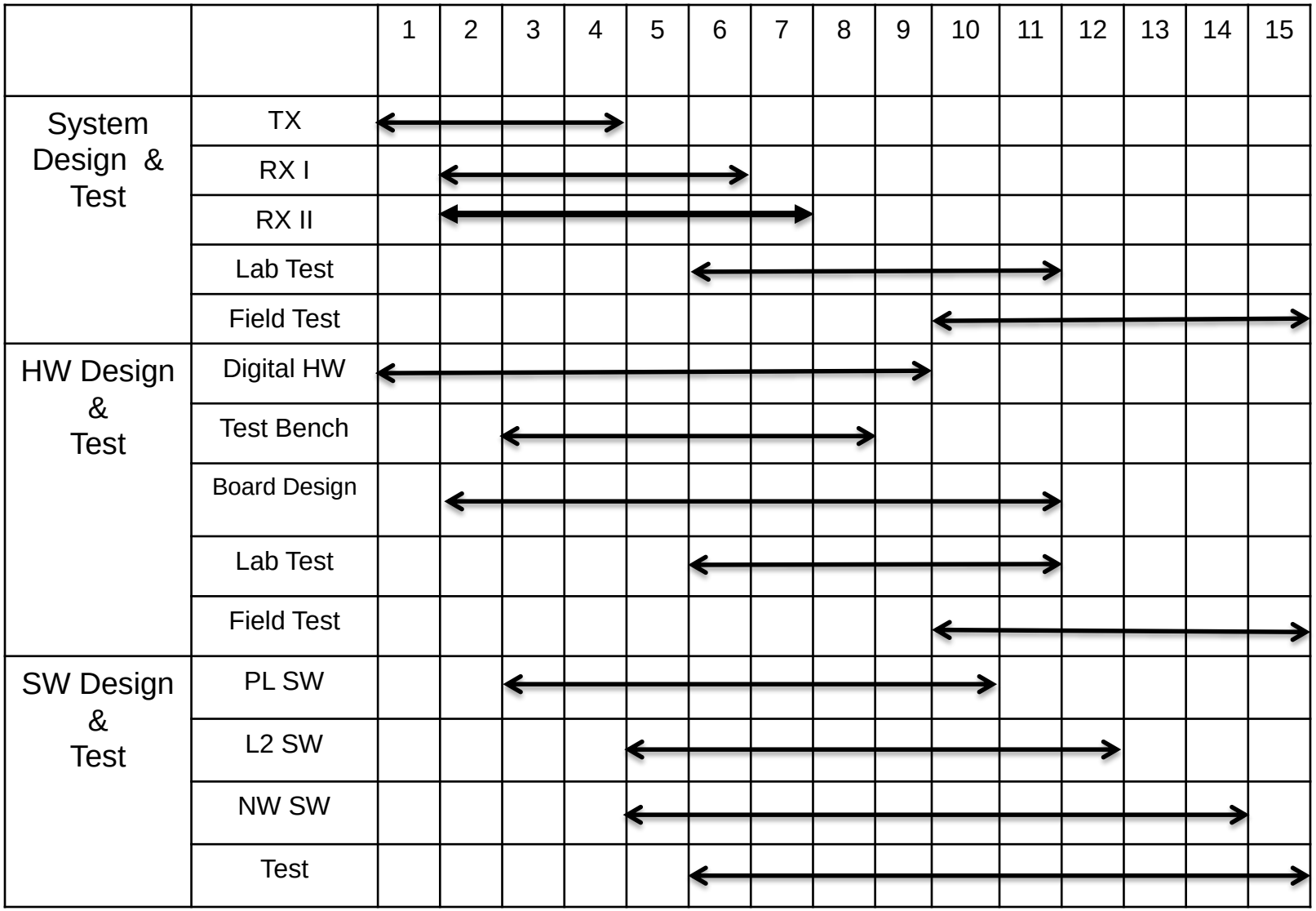
GScom's Broadband 4096-QAM Modem Product Development Plan

- **Project Milestone**
  - System design & Test: 11 months
  - FPGA Board design & test: 11 months
  - SW design & Test: 12 months
  - Field Test: 6 months
  - Commercial product available: 15 months

- **Project Resources Plan**
  - 3 Systems engineers
  - 3 HW engineers
  - 1 RF Analog engineer
  - 3 SW engineers

Product Development Plan

- **Project Milestone**



Project Budget

- **Employee Salary**
  - Systems engineer I, II & III (15, 14, & 14 months); 43 man-months
  - HW engineer I, II & III (15, 13, & 13 months); 41 man-months
  - RF Analog Engineer (13 months); 13 man-months
  - SW engineer I, II, & III (13, 12, & 12 months); 37 man-months

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  - Total no of man-months: 134 man-months
  - Sub Total; (no. of man-month)/12 X 120K = **1340K USD**
  - Employee benefit (Health & 401K) = **402K USD**
- **Office rent (18 months); 180K USD**
- **Engineering design tool & test equipment rent: 310K USD**
- **Product Sample Development: 60K USD**

- **Total: 2292K USD ≈ 2.3 M USD**