Introduction of HINOC: a solution to the TDD mode

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面向NGB的同轴电缆接入技术
HINOC
High performance Network Over Coax

Contents

- About HINOC
- HINOC 1.0 and HINOC 2.0
- PHY Techniques
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HINOC (High performance Network over Coax)

- HINOC targets on the last 100 meters high speed data transmission via coax
- FTTB scenario, based on existing cable in the buildings
- The HINOC Bridge (HB) connects the optical fiber unit ONU and existing cable
- The HINOC Modem (HM) connects the HB through cable, and connect with the user devices.
- Central controlled structure

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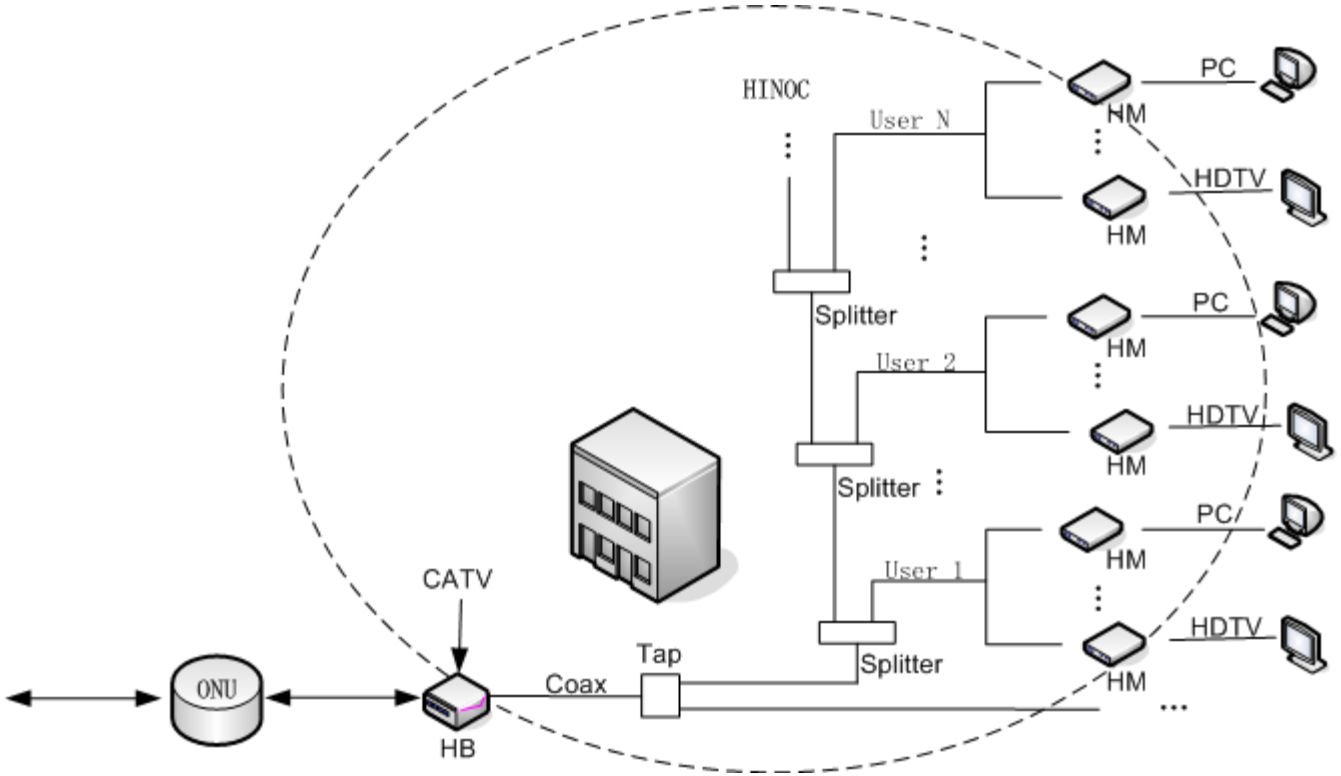
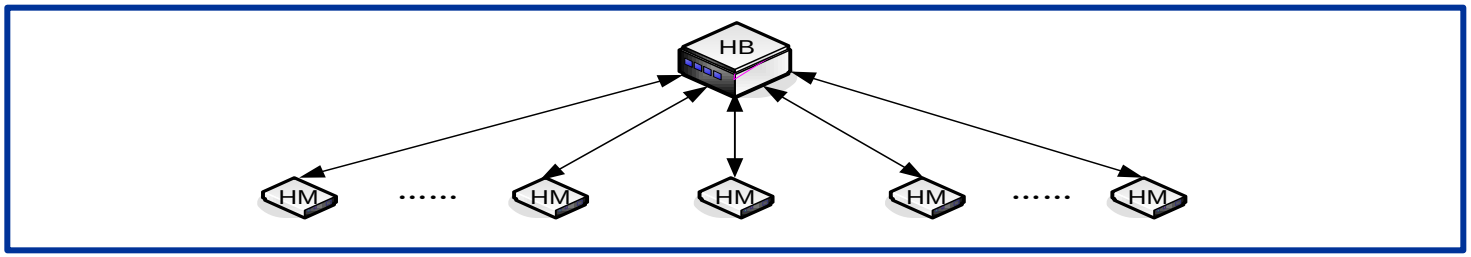
HINOC (High performance Network over Coax)

- Started in 2008 by Peking University (PHY techniques), Xidian University (MAC techniques), Academy of Broadcasting Science
- Obtained lot of funding from Chinese government
- HINOC standardization group includes companies and operators

HINOC Network Structure





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HINOC1.0 Features

- Bandwidth: **8MHz /16MHz**
- Multiplexing: **TDD**
- Multiple Access: **TDMA**
- Data rate: **100Mbps**
- Number of users: 1-32
- PHY：
  - OFDM
  - Adaptive modulation: QPSK – 1024QAM
  - BCH coding
- MAC：
  - DBA
  - Priority control

Current Situation of HINOC1.0

- HINOC1.0 chips and equipment are manufactured by big companies (i.e. Haier)
- Chinese Standard of HINOC1.0 has been approved
- International standard is in progress (ITU G9)
- The frequency band, 750MHz – 1006MHz is allocated to HINOC
- National HINOC LAB is established

HINOC1.0 Prototypes

- Public exhibitions

CCBN2011

BIRTV2012

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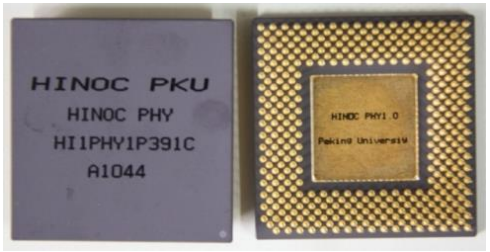
HINOC1.0 Chips



PHY Baseband
2010.10
130nm SMIC

PHY + MAC
2012.06
130nm SMIC

PHY + MAC + AD/DA
2012.09
65nm TSMC

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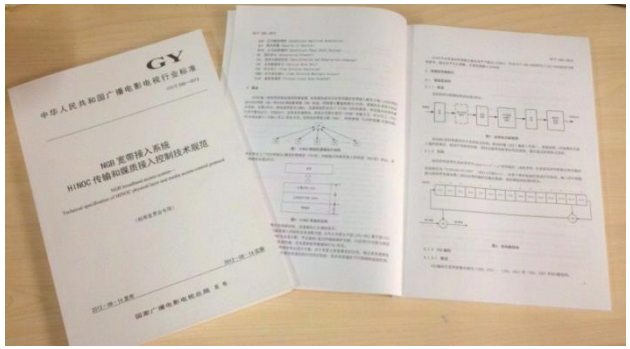
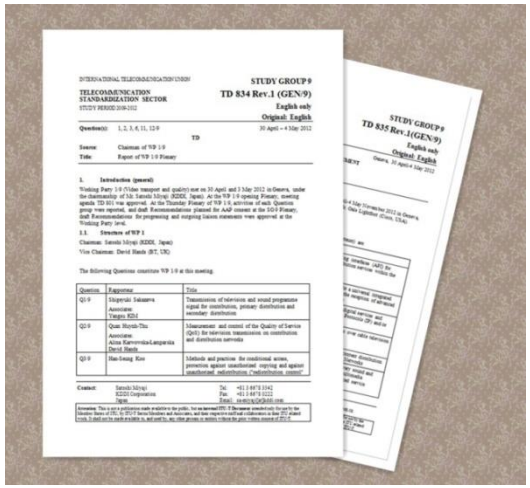
HINOC1.0 Standardization

- Chinese standard
  - Approved on Aug. 16 2012 (GY/T265-2012)
- International standard
  - HINOC standardization item is started in May 2012 in ITU-T SG9 (HINOC J.HiNoC)





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HINOC2.0 Features

- Backward compatible with HINOC1.0
- Wider bandwidth and higher data rate
- Simplified MAC procedure

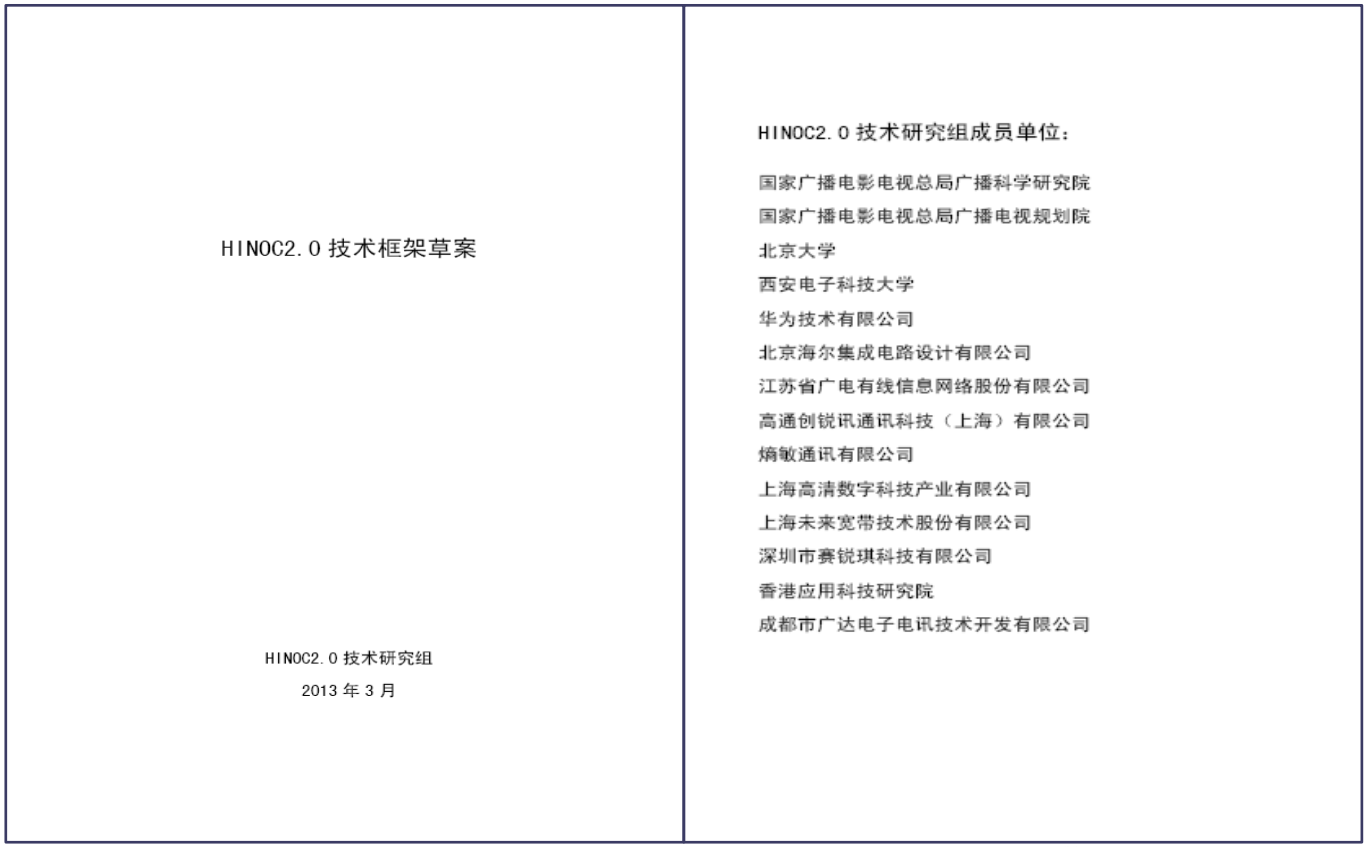
- Standard is not finalized, proposals are welcome

HINOC2.0 Features

	HINOC1.0	HINOC2.0
Max data rate	100Mbps	1Gbps
Bandwidth	16MHz	128MHz
Max modulation	1024QAM	4096QAM
Subcarriers	1024	2048
Subcarrier interval	62.5KHz	62.5KHz
FEC coding	BCH	BCH/LDPC
Multiplexing Multiple access	TDD/TDMA	TDD/TDMA+OFDMA

HINOC2.0 Technical Draft

- The first version of technical draft was given in Mar. 2013



HINOC2.0 技术框架草案

HINOC2.0 技术研究组

2013 年 3 月

HINOC2.0 技术研究组成员单位：

国家广播电影电视总局广播科学研究院
国家广播电影电视总局广播电视规划院
北京大学
西安电子科技大学
华为技术有限公司
北京海尔集成电路设计有限公司
江苏省广电有线信息网络股份有限公司
高通创锐讯通讯科技（上海）有限公司
熵敏通讯有限公司
上海高清数字科技产业有限公司
上海未来宽带技术股份有限公司
深圳市赛锐琪科技有限公司
香港应用科技研究院
成都市广达电子电讯技术开发有限公司

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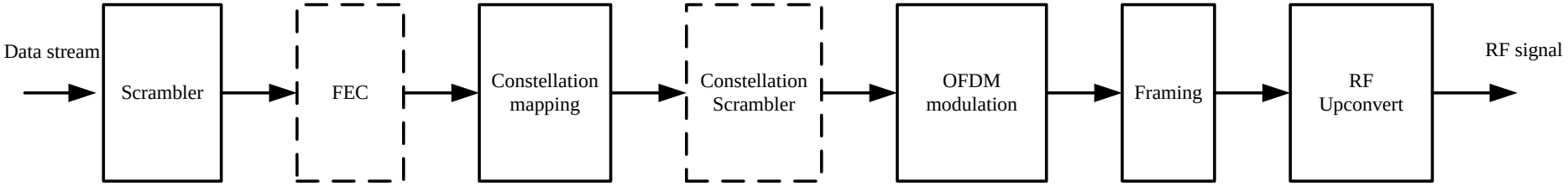
PHY Layer Transmitter Block Diagram

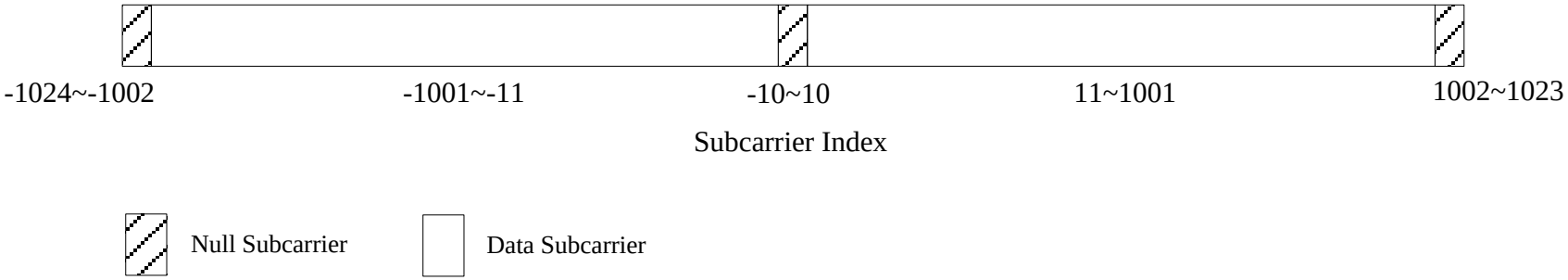


FEC Coding and Modulation

- FEC coding
  - BCH
    - (392,248), (1920,1040), (1920,1744)
  - LDPC
    - Under discussions
- Modulation
  - DQPSK, QPSK,8QAM~4096QAM
- Adaptive modulation and coding
  - Adjacent subcarriers are grouped and use the same AMC

OFDM

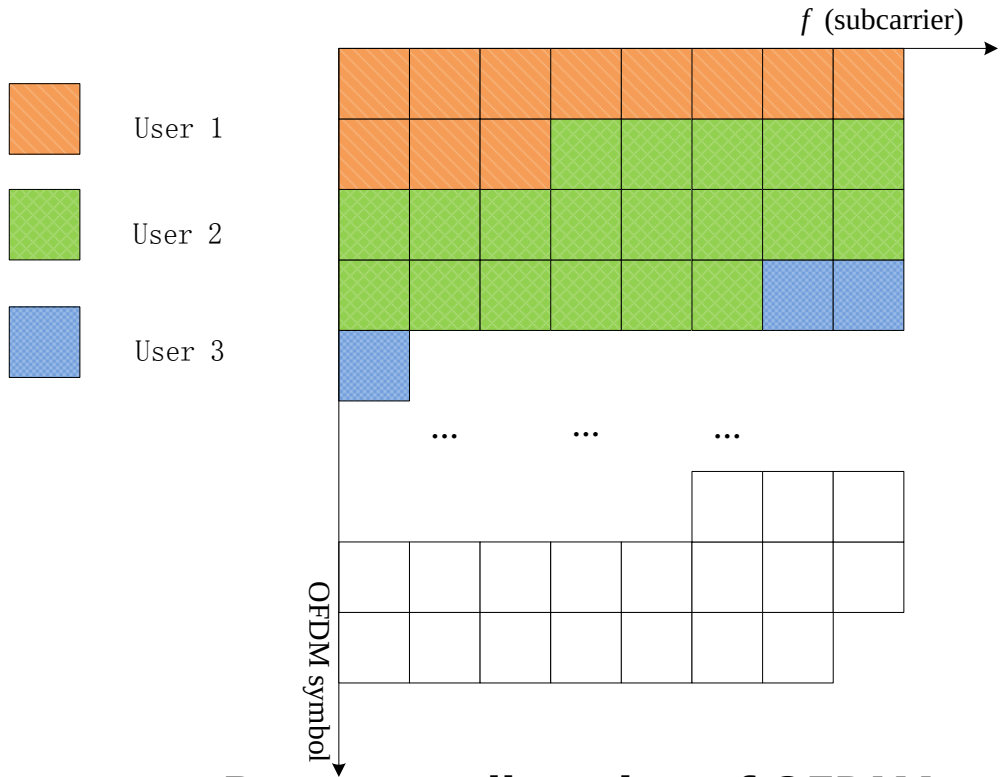
- Number of subcarriers: 2048
- Subcarriers interval: 62.5KHz
  - Backward compatible with HINOC1.0



- Cyclic prefix length: 0.5/1/2 us

Multiple Access

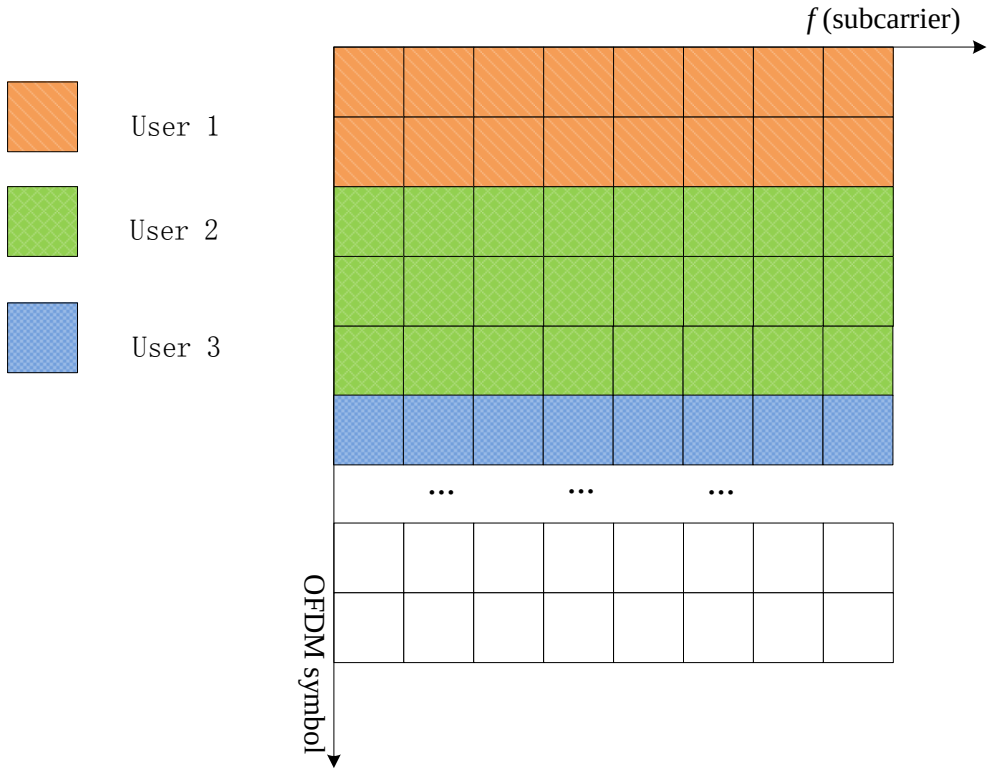
- OFDMA
  - Each user occupies numbers of subcarriers of a OFDM symbol
  - Highly suitable for frequency selective channel
  - High efficiency in the case of short packets.



Resource allocation of OFDMA

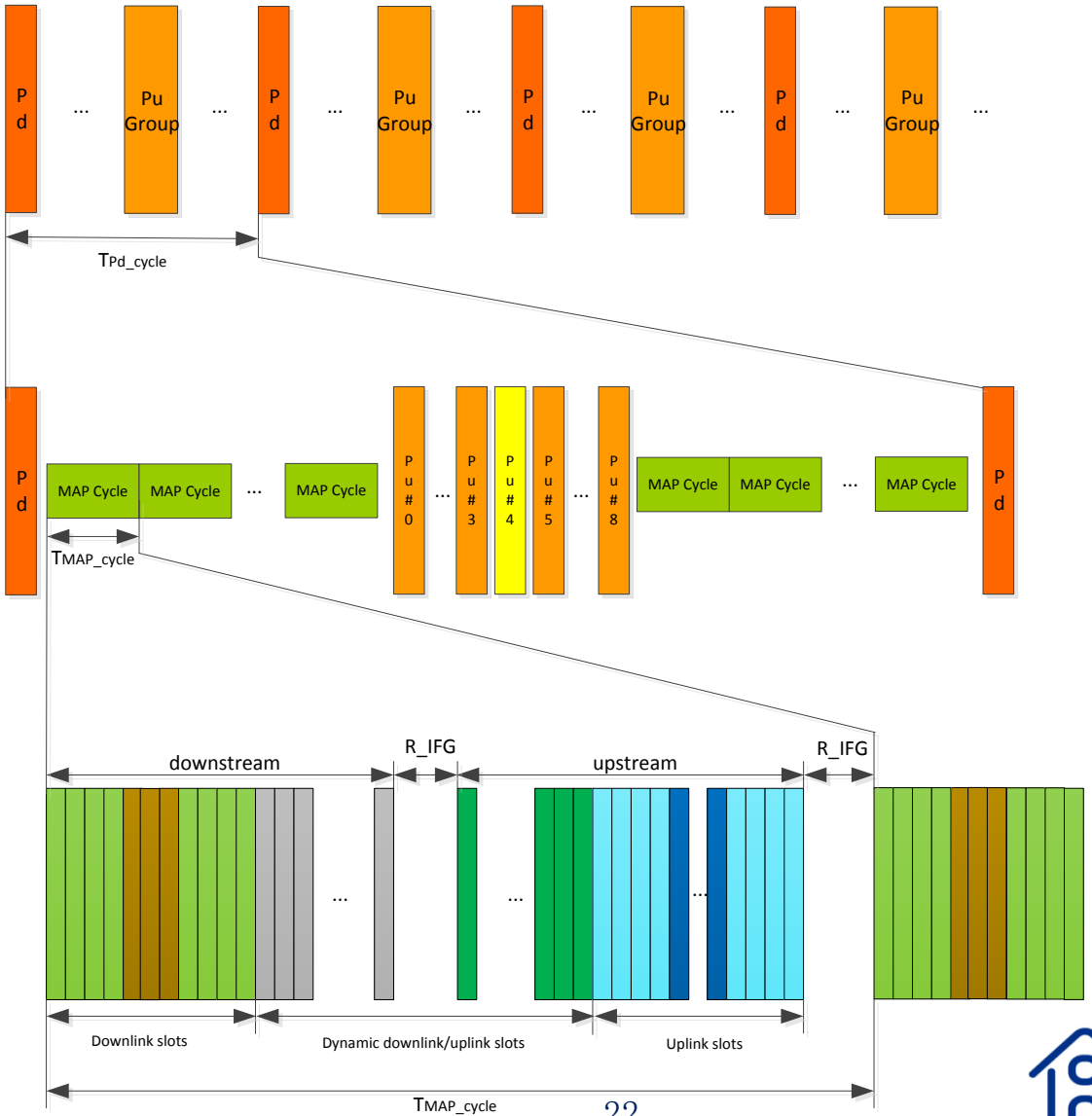
Multiple Access

- TDMA
  - Each user occupies all subcarriers of a OFDM symbol
  - Lower implementation complexity than OFDMA in the uplink
  - A particular case of OFDMA.



Resource allocation of TDMA

PHY Layer Frames



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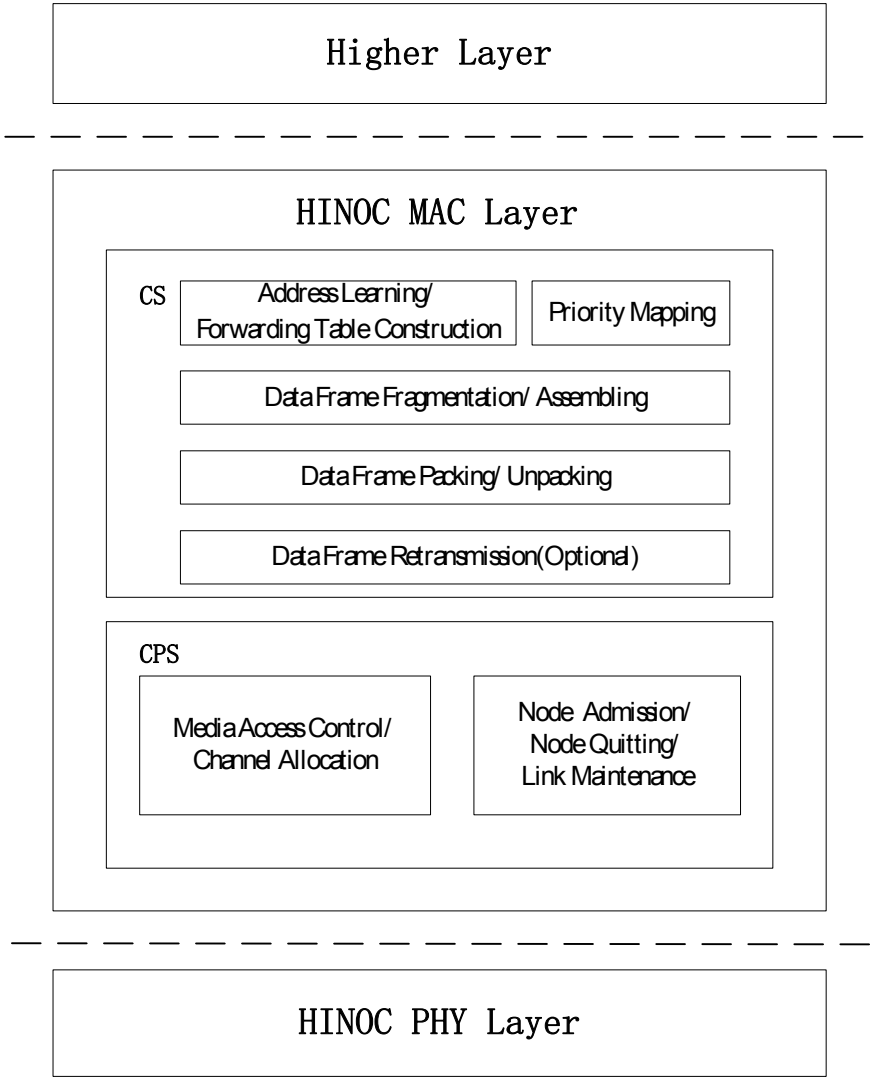
MAC Layer Structure



MAC Functions and Mechanisms

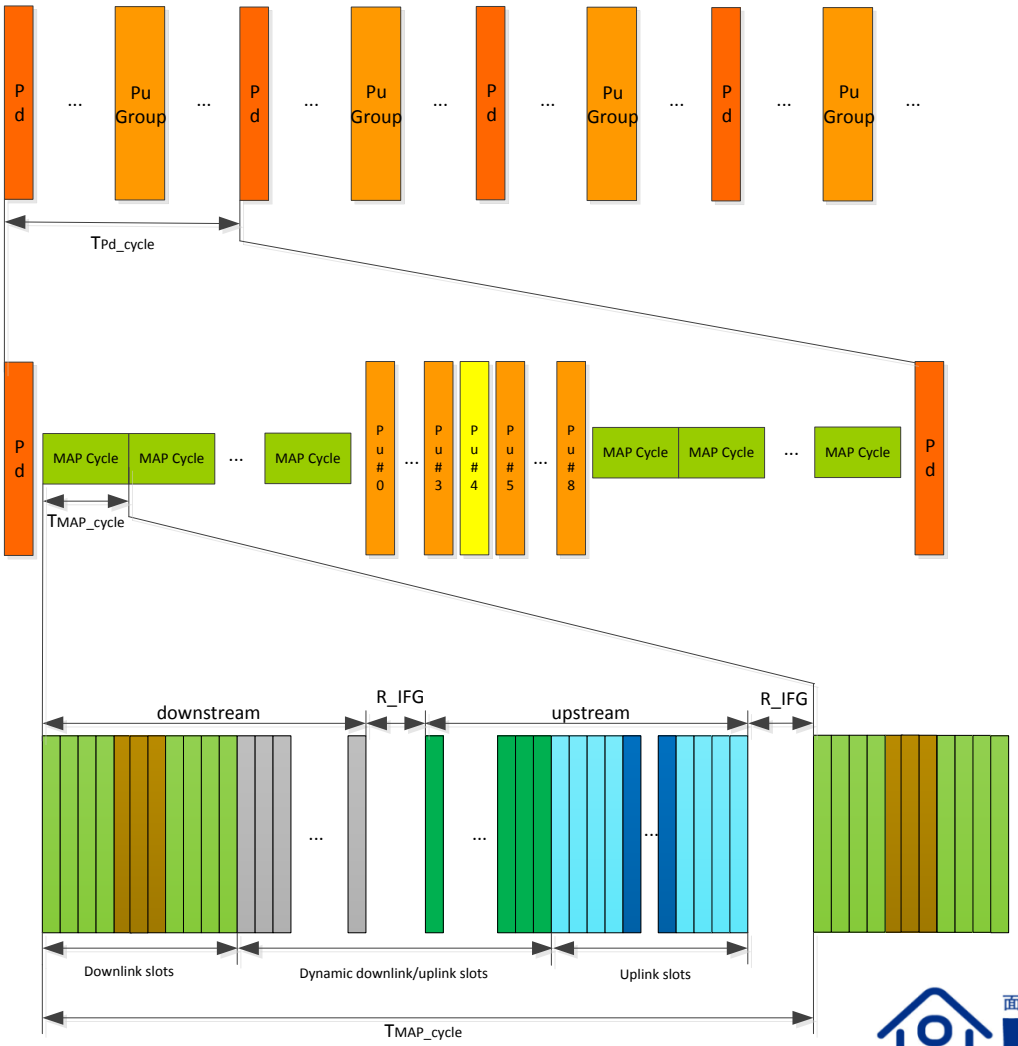
- Data Frame Packing/Unpacking
  - Packing and fragmentation mechanisms used to increase throughput and transmission efficiency
- Data Frame Retransmission
  - ARQ optionally supported to improve reliability of transmission
- Media Access Control
  - Both TDMA and OFDMA is supported.
  - Sub-Channel is introduced to support multiple terminals with different bandwidth

MAC Functions and Mechanisms

- **Channel Allocation**
  - Report-Grant mechanism used to realize various dynamic bandwidth allocation
- **Node Admission/Quitting**
  - A multi-channel mechanism is proposed to realize multiple terminals admission/maintenance in parallel which can accelerate node admission/maintenance procedure

Channel Allocation

- Pd Cycle
- MAP Cycle



Channel Allocation

- **Channel Allocation of a MAP Cycle**

  Report/Grant mechanism is used.

  - Current queue information is reported to HB by each HM using OFDMA.
  - According to HMs' reports and local queue information, HB gives a channel plan in MAP frame which is transmitted to each HM.
  - HB and HMs transmit data according to MAP frame.

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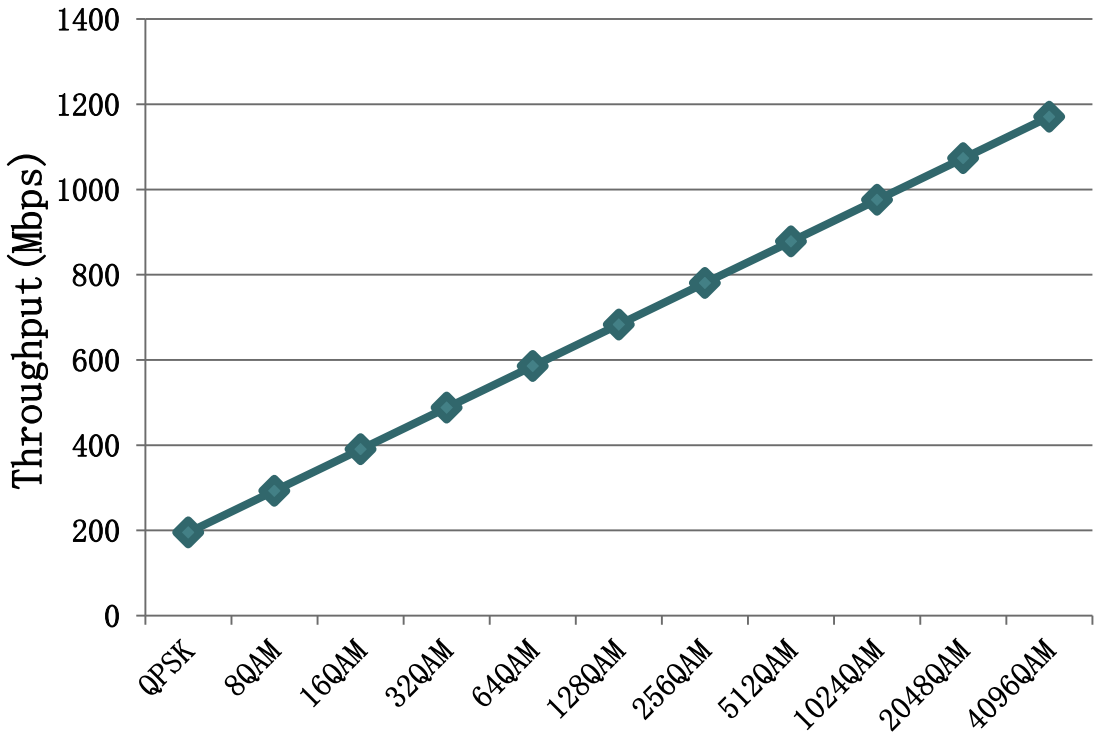
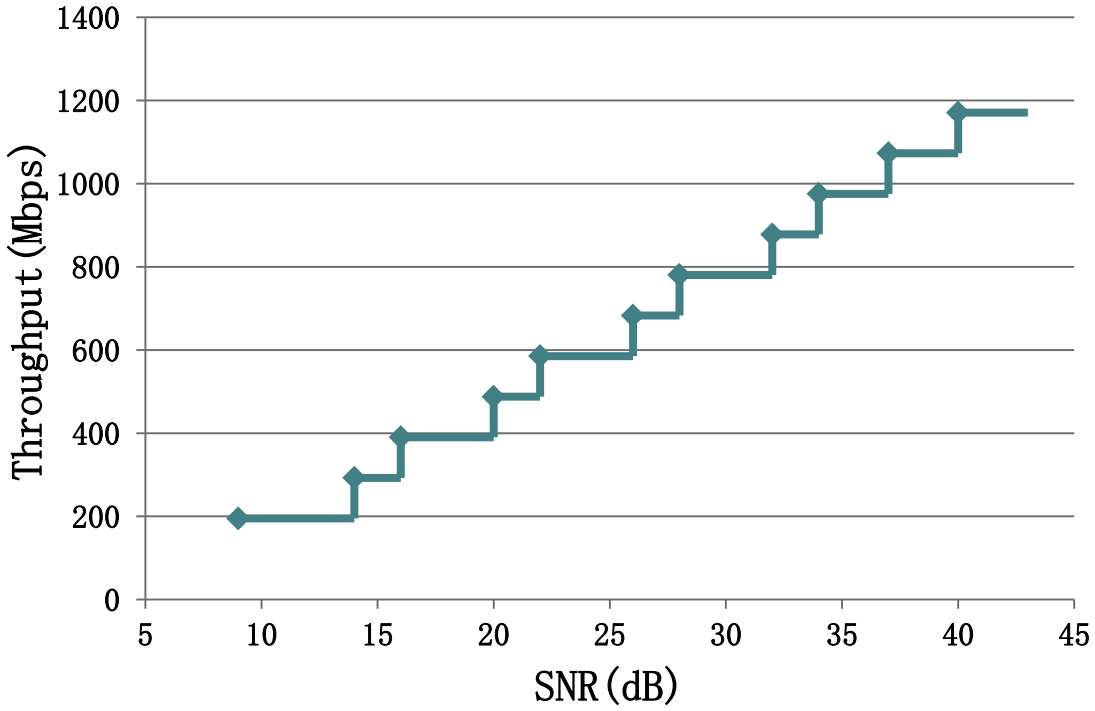
Throughput

- **Maximum Throughput with different QAMs**
  - Cyclic Prefix: 1us
  - FEC type: BCH(1920,1744)



Throughput

- **Maximum Throughput with different SNRs**
  - Cyclic Prefix: 1us
  - FEC type: BCH(1920,1744)
  - BER<1e-12



Latency and Jitter

- Maximum Latency: 2 MAP Cycle(~5ms)
- Minimum Latency: <2.5ms
- Maximum Jitter: ~5ms

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Summary

- HINOC2.0 is an effective TDD mode solution
  - High data rate and spectrum efficiency
  - Small latency and jitter

- The draft of HINOC2.0 has been released
  - Some aspects in PHY and MAC need to be further defined

- Welcome to give suggestions and proposals to HINOC2.0

Thank you!