# P2MP Burst Mode Transceiver and guard band

Ajay Gummalla, Broadcom

JC Kuo , Alloptic

Supporters:

Lior Khermosh, Passave

Larry Rennie, National Semiconductor

# Contents

- Burst mode transmitter (ONU)
- Burst mode receiver (OLT)
- System guard band margin analysis
- Bandwidth efficiency considerations
- Summary

# Burst mode transmitter (ONU)

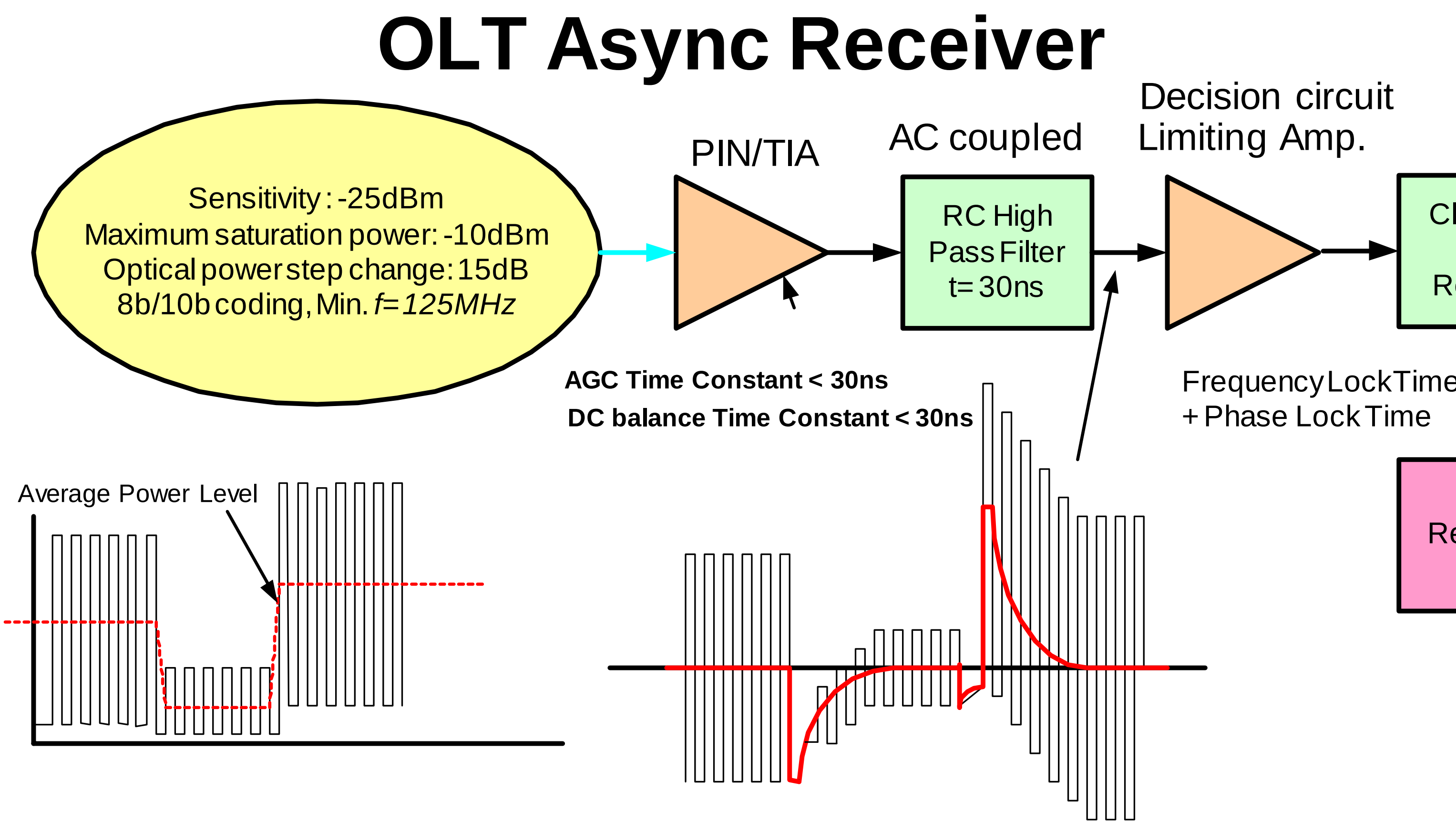
- Transmitter activation delay
  - Electric delay
  - APC close loop stabilized delay
- Transmitter deactivation delay
- Leakage power at deactivated mode

# Burst mode receiver (OLT)

- Receiver capture time considerations
  - ±15dB optical step change between two transmissions
  - 8b/10b line coding result 125MHz minimum frequency
  - DC canceling loop time constant in TIA
  - AGC loop time constant in TIA

- Clock and data recovery time (1.25Gb/s)
  - 8b/10b line coding
  - FEC is used, assume 4dB gain (-4dB optical signal at PIN/TIA input, results higher jitter and pulse width distortion to clock and data recovery input)

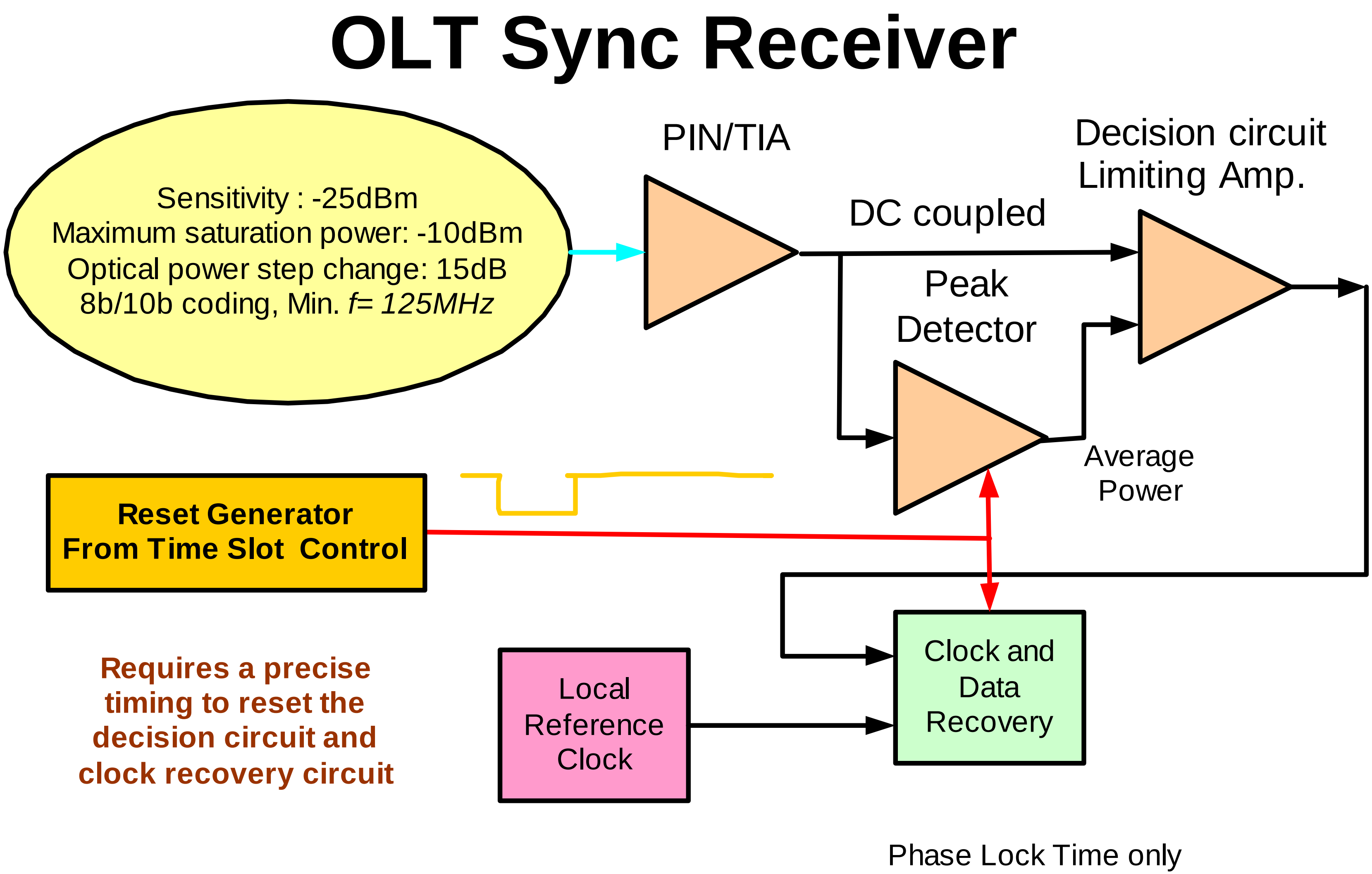
# Asynchronous burst mode receiver



# Asynchronous BMR

- Advantage
  - No synchronization is required, self tracking
  - Technical feasible
  - Low cost
- Disadvantage
  - Slow acquisition time
  - AC coupled, acquisition time is line coding dependent
- Performance improvement
  - Frequency lock ONU transmission clock to OLT will eliminate frequency lock time
  - The cutoff of the high pass filter effects the spectrum of the signal coming in. Its effect on receiver sensitivity needs to be carefully studied

# Synchronous burst mode receiver



# Synchronous BMR

- Advantage
  - Fast acquisition time, not line coding dependent
  - More efficient system
- Disadvantage
  - Questionable technical feasibility at 1.25Gb/s
  - Need precise reset signal (must used PHY with high solution system clock to control timing)
  - Synchronization complexity
  - Need special coded delimiter for restoring the receiver decision level

# System Guard Band margin

- System guard band – The dead zone between two ONU transmissions
- Three margins
  - Electric control margin
  - Optical delay margin
  - Time sharing protocol margin

# Electric control margin

- ONU transmitter activated/deactivated delay time
- OLT receiver capture time
- OLT receiver clock recovery time
- Resolution of system clock (phase variation of OLT and ONU system clocks)
  - High resolution system clock cost more on silicon
  - Example of 125MHz system clock has margin of ±8 bit or ±8ns

# Optical delay variation margin

- Optical round trip considerations
  - 20km optical round trip delay is about 200uS
  - At 1.25Gb/s, one bit length is about 15cm (6”)
  - Fiber cable length change cause by environmental – Wind, ice, temperature and animal
  - ±0.1% of 20km fiber = 400ns optical delay variation
  - Optical Path length change = 8ppm/C
  - Max diurnal delay = 50C x 1E5ns x 8E-6 = 40ns
- Margin for optical delay is protocol dependent
  - Optical delay change within fine ranging loop time
  - Optical delay change between two worst case transmission opportunities if flexible bandwidth assignment is used

# Time sharing protocol margin

- Unpredictable transmission stop/start position
  - Delay variation cause by random transmission with variable packet size in MAC control layer based time sharing control

# Bandwidth efficiency consideration

- Guard band
  - Electric control delay margin is a fixed constant
  - Need analysis on clock and data recovery performance of FEC
  - Optical delay variation margin can be improved by high fine ranging frequency but it take more downstream bandwidth
  - Time sharing protocol margin can be eliminated by guaranteed start/stop transmission position

- No packet fragmentation
  - Maximum Ethernet frame is 12us
  - Average unused gap is 1.5us (assumed 400 byte average packet length)

# Summary

- Careful study of the cost vs performance tradeoff is necessary in the choice of burst transceiver
  - Frequency synchronization takes the longest time
  - Study effect of AC coupling on receiver sensitivity
  - Fully synchronous receiver requires accurate state of arrival of upstream bursts
- Have to account for three uncertainties in guard band allocation
  - Electrical
  - Optical
  - Protocol