# A Brief Introduction to Interference Cancellation in Wireless Networks

Hongxing Li

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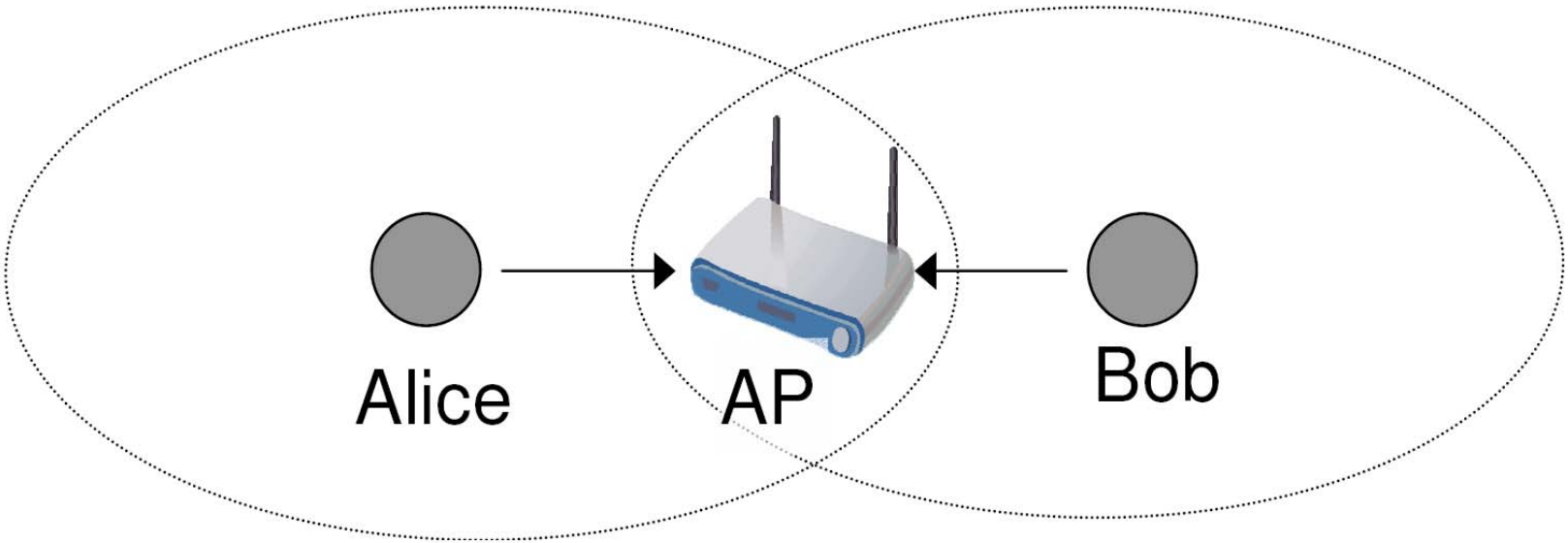
# Multiple Transmitters Single Receiver




Hidden Terminal

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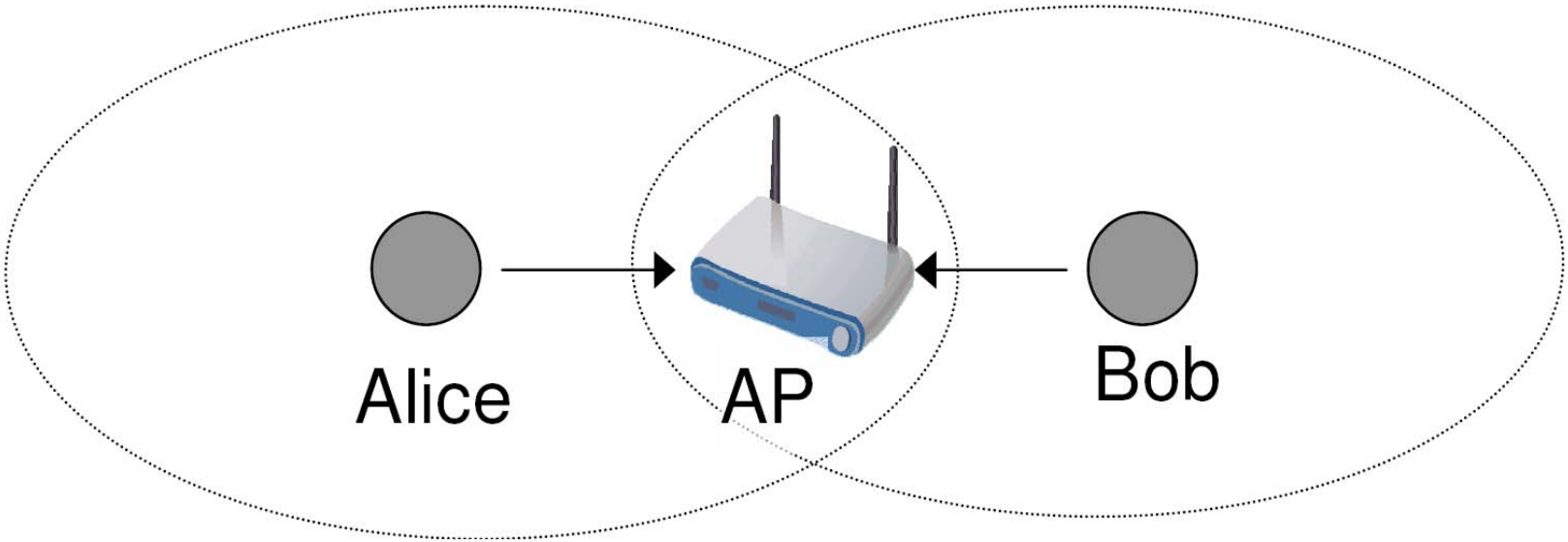


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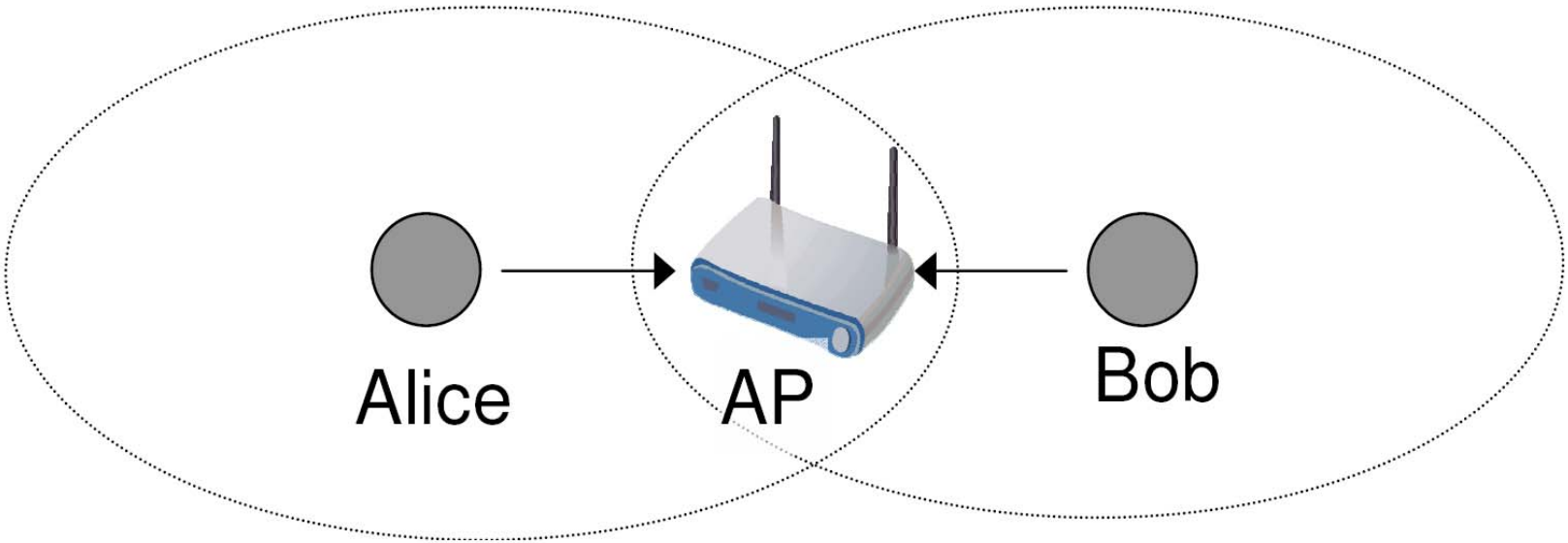


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- **Theory Perspective**: In graph interference model, Alice and Bob cannot transmit to the AP simultaneously.
- **Engineering Perspective**: With CSMA/CD, if Alice and Bob conduct transmission to the AP concurrently, they will suffer from packet loss and long delay.

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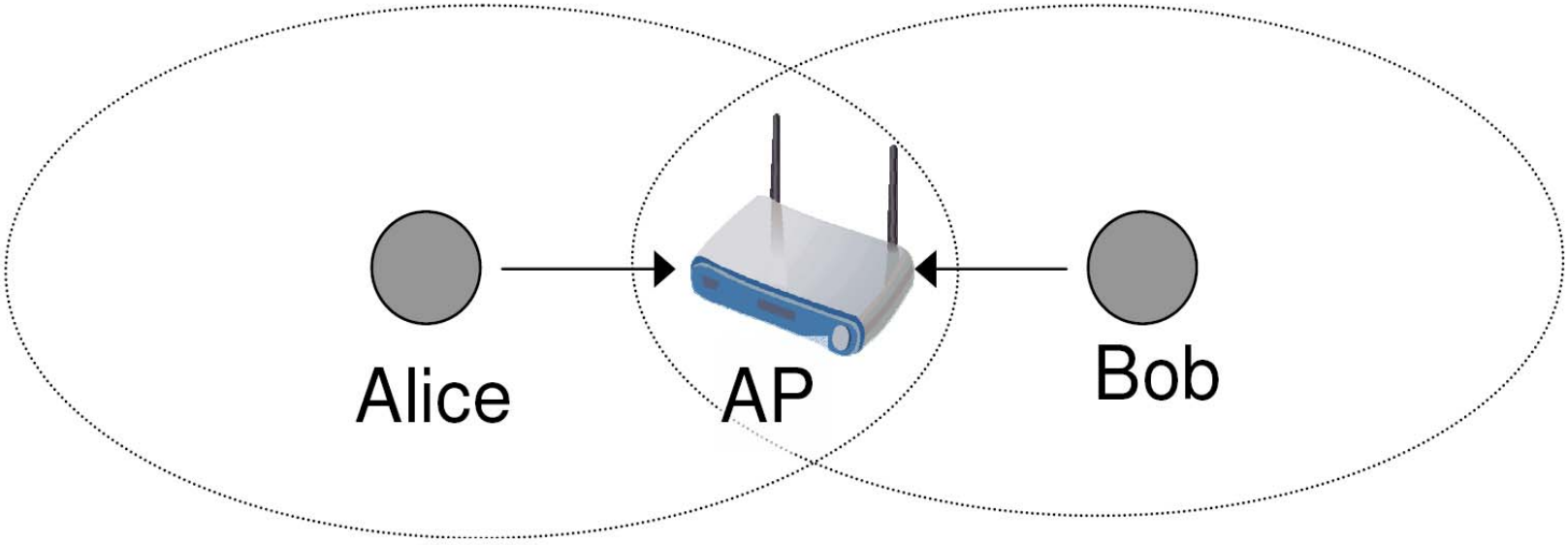


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- **Theory Perspective**: Graph interference model is unrealistic. Is it possible to schedule Alice and Bob simultaneously in the SINR model?
- **Engineering Perspective**: Is it possible to reduce the packet loss rate?

# What is Interference Cancellation?

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Interference Cancellation techniques are any technique or combination of techniques that allow an existing receiver to operate with co-channel interference and recover the data.

# Successive Interference Cancellation (SIC)

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$$SINR_i = \frac{P_i / d_{ii}^{\alpha}}{N_0 + \sum_{e_k \in \Lambda} P_k / d_{ki}^{\alpha}} \geq \beta$$

Here, $\Lambda$ denotes the set of links that transmit simultaneously with $e_i$. $P_i$ and $P_k$ denote the transmission power at the transmitters of link $e_i$ and $e_k$, respectively. $d_{ii}$ ($d_{ki}$) is the distance between transmitters of link $e_i$ ($e_k$) and the receiver of link $e_i$. $N_0$ is ambient background noise, $\alpha$ is path loss ratio, $\beta$ is SINR threshold.

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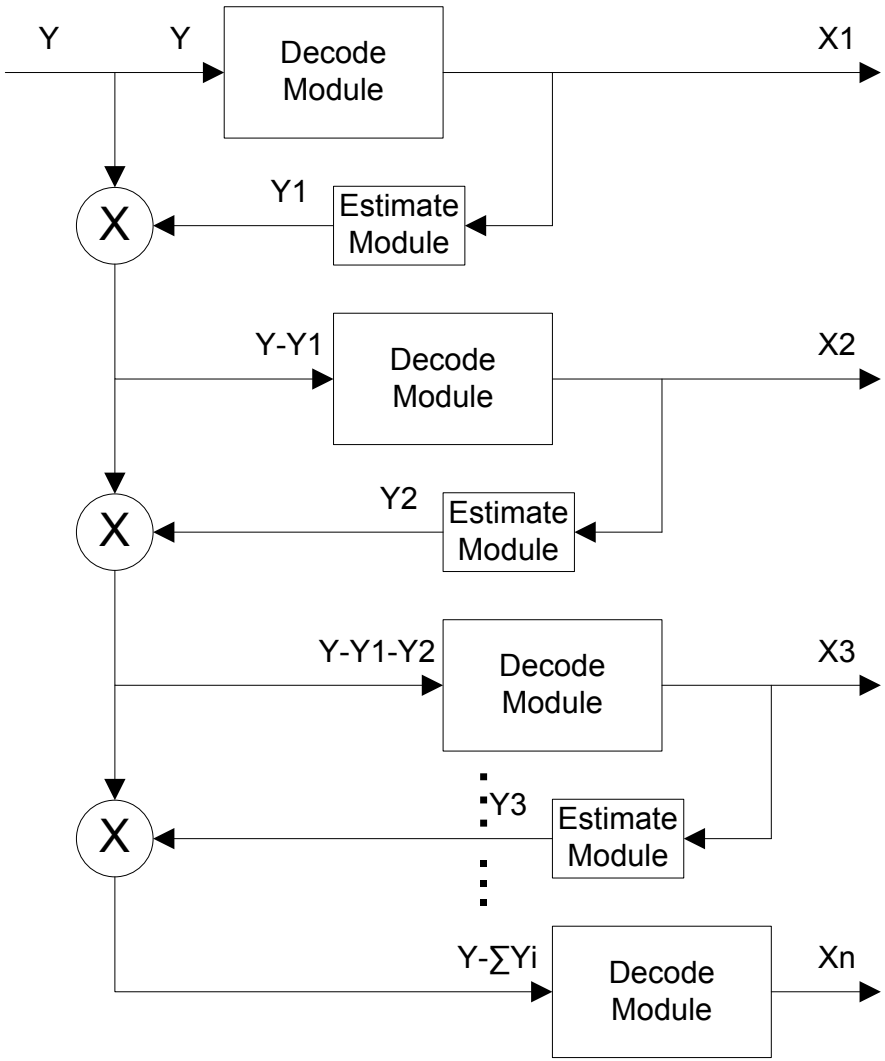
With Successive Interference Cancellation

- Time slot 1: Alice to AP and Bob to AP

# Execution details of SIC



# Condition for a successful SIC

$$SINR_i = \frac{P_i/d_{ii}^{\alpha}}{N_0 + \sum_{e_j \in \Lambda_i} P_j/d_{ji}^{\alpha} + \sum_{e_k \in \Lambda - \Lambda_i} P_k/d_{ki}^{\alpha}} \geq \beta$$

Here, $\Lambda_i$ denotes the set of links that share the same receiver with $e_i$ but canceled after $e_i$.

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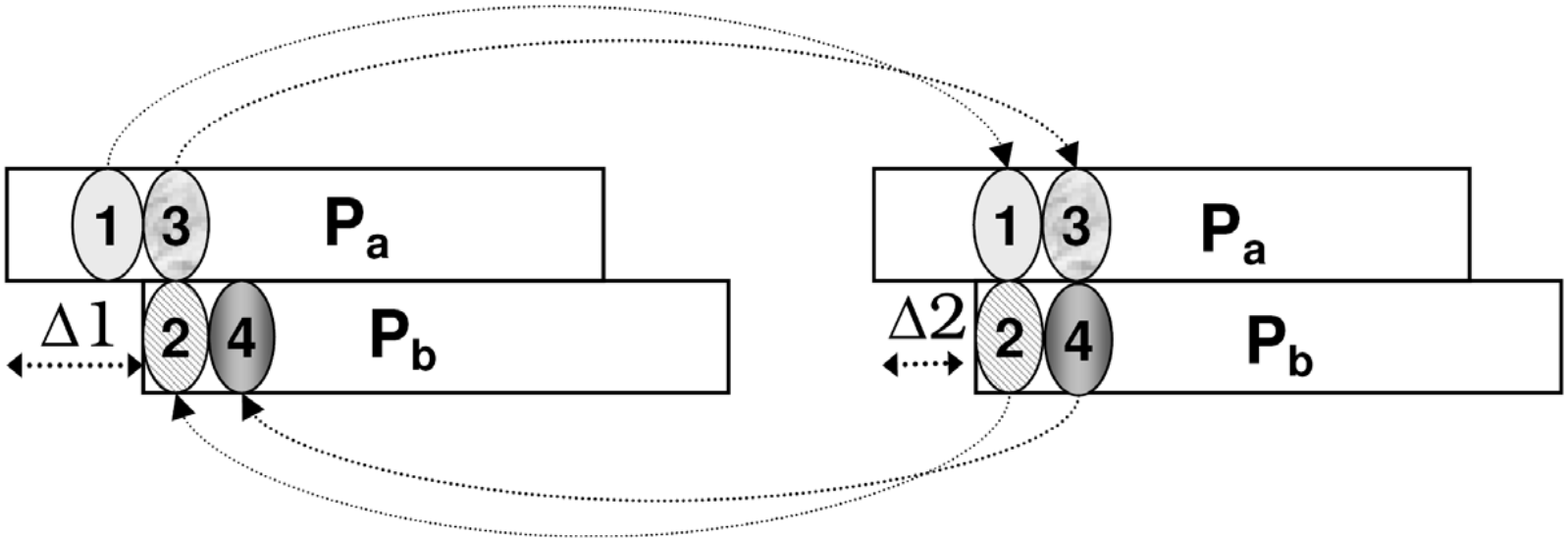
**Feature**: Chunk-level decoding instead of packet-level decoding
**Performance**: In a testbed of 14 USRP nodes, ZigZag reduces the average packet loss rate at hidden terminals from 72.6% to about 0.7%.

# Execution details of ZigZag



# Examples

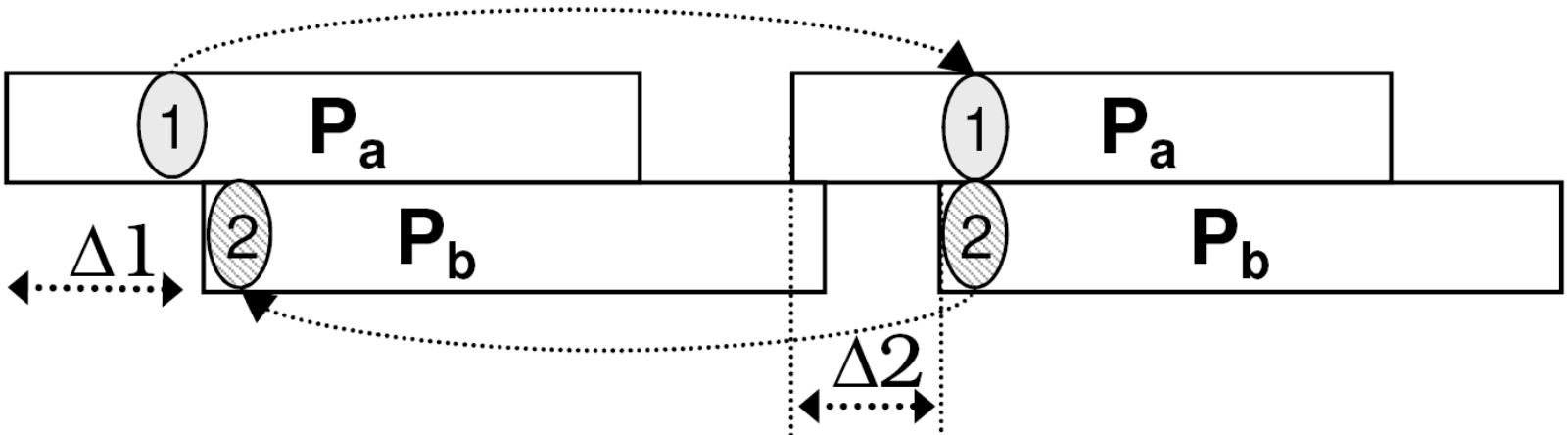



Figure: Overlapped collisions.

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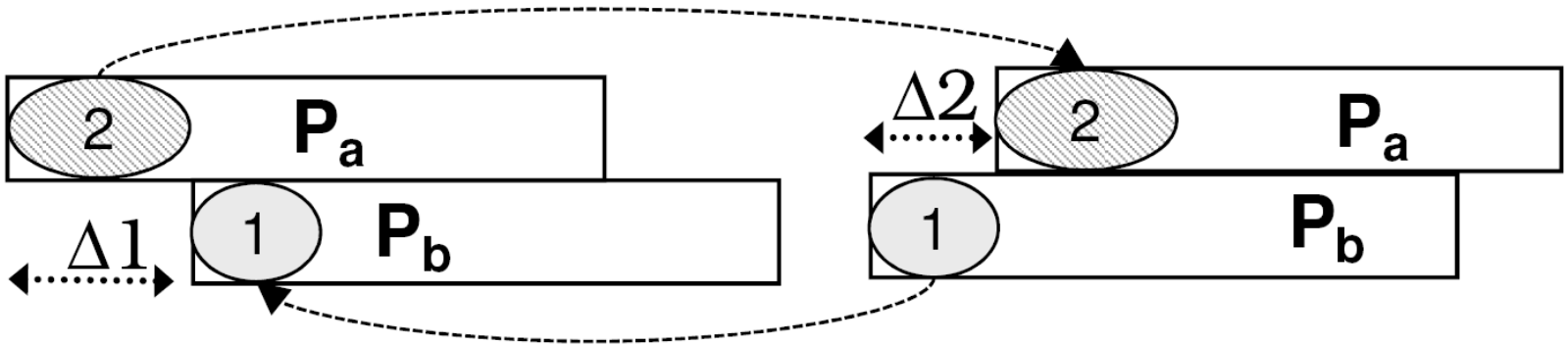


Figure: Flipped Order.

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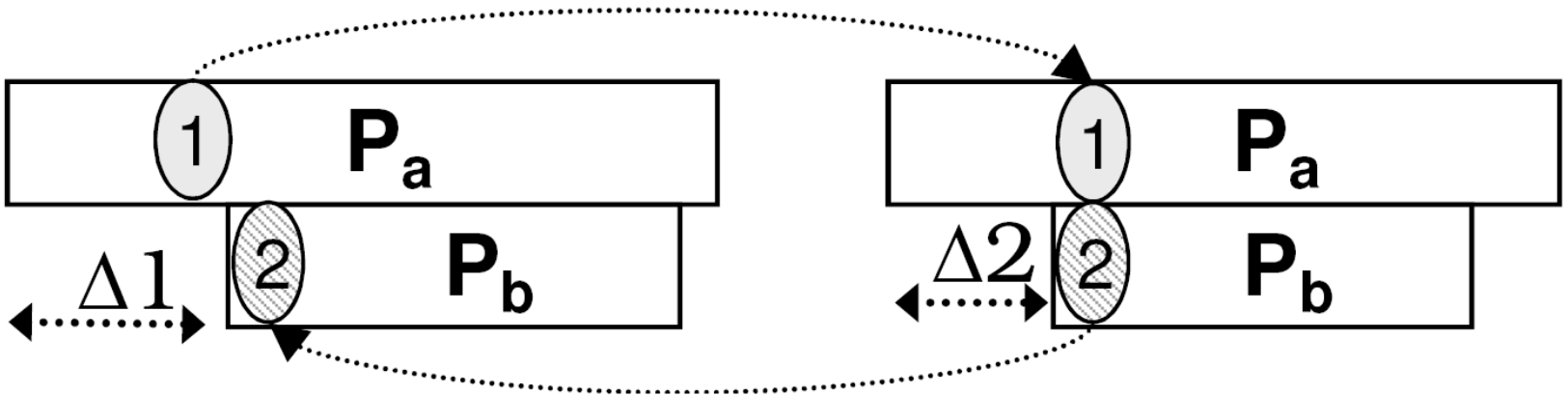


Figure: Different Packet Sizes.

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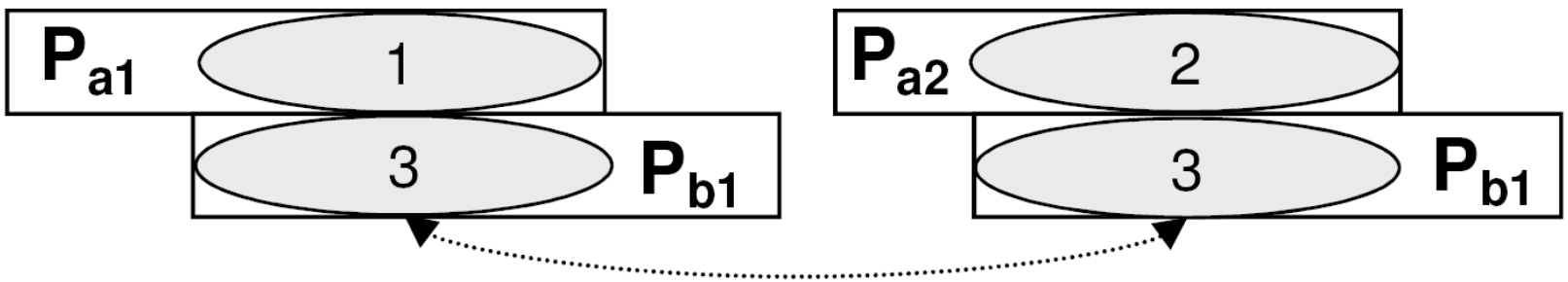


Figure: Alice's Packets Enjoy the Capture Effect.

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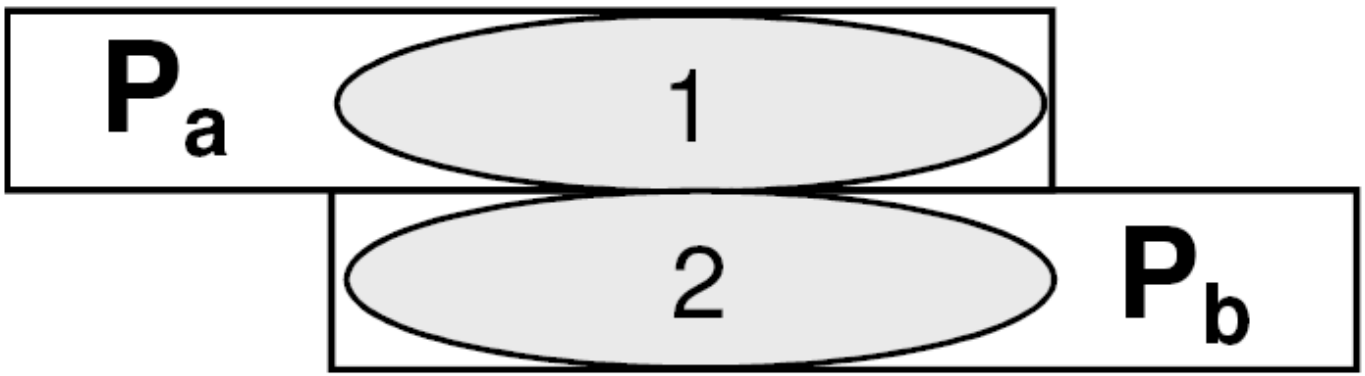


Figure: Single Decodable Collision; Inefficient Choice of Bit Rates.

# Examples

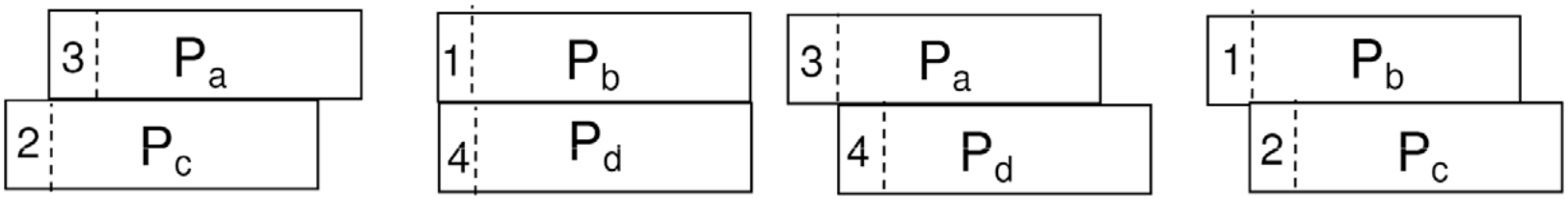


Figure: Nodes A and B are hidden from C and D.

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  - Power control and Exponential power increase: for the $i^{th}$ canceled signal, we should have $P_i \geq (1+\beta)^{n-i}\beta N_0 d_{ii}^{\alpha}$ (proved by induction).

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  - *Drawbacks*:
    - Cannot reduce the scheduling latency.

# Thank You!