Energy Consumption - TCP

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Energy Consumption - TCP

- **Possible Strategies.**

- **Low Power/Energy Hardware Design.**
- **Link Layer Optimization.**

Switch to sleep mode whenever idle, to probe mode whenever error-prone or congestive.

- **Transport protocol Optimization.**

Minimize unnecessary retransmissions.

- **Transmission power control.**

Use minimum transmission power required. Mainly used in Ad hoc networks(Distance based Power control).

- **Application selectivity of smoothness or responsiveness**

Applications select the kind of transport protocol they prefer.

- **Transport protocol management policies**

Probing and selective sleep lead by TCP signals to lower layers

Energy Consumption - TCP

- **Transport Level Wireless Simulation.**

1. Using NS Wireless model.

2. Using NS Energy Model.

3. Using Uniform and MultiState Error Models.

4. Using Shadowing propagation Models.

Goal: To see how energy cost changes as a result of transport protocol changes for wireless and ad-hoc networks.

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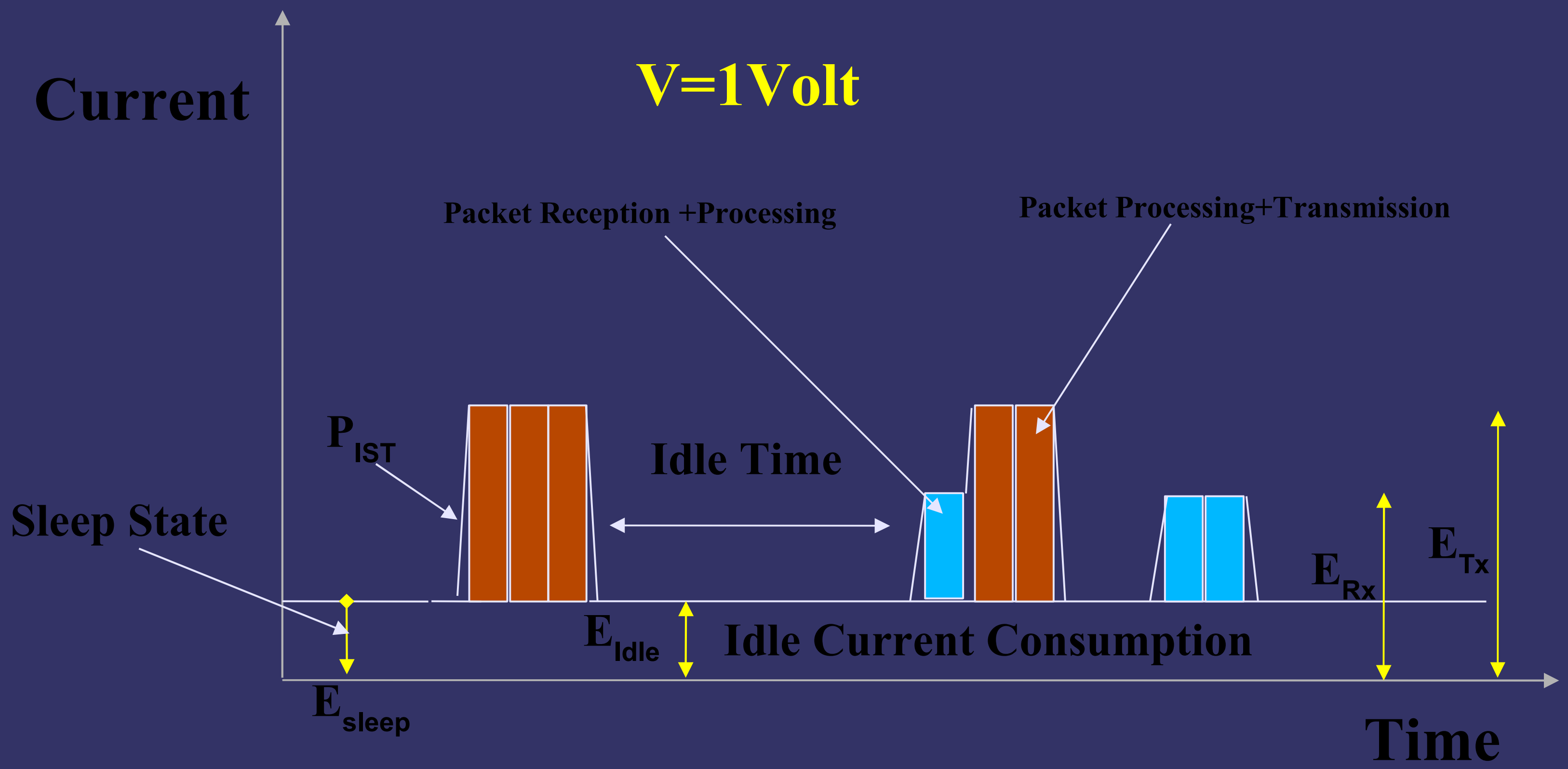
- **Device Energy Consumption**



$$E = P_{IDLE}t_{idle} + P_{Tx}t_{Tx} + P_{Rx}t_{Rx} + P_{IST}t_{IST} + P_{SLEEP}t_{sleep}$$

B bytes $\longrightarrow$ t_{total}

$$t_{total} = t_{Tx} + t_{Rx} + t_{Idle} + t_{IST} + t_{Sleep}$$

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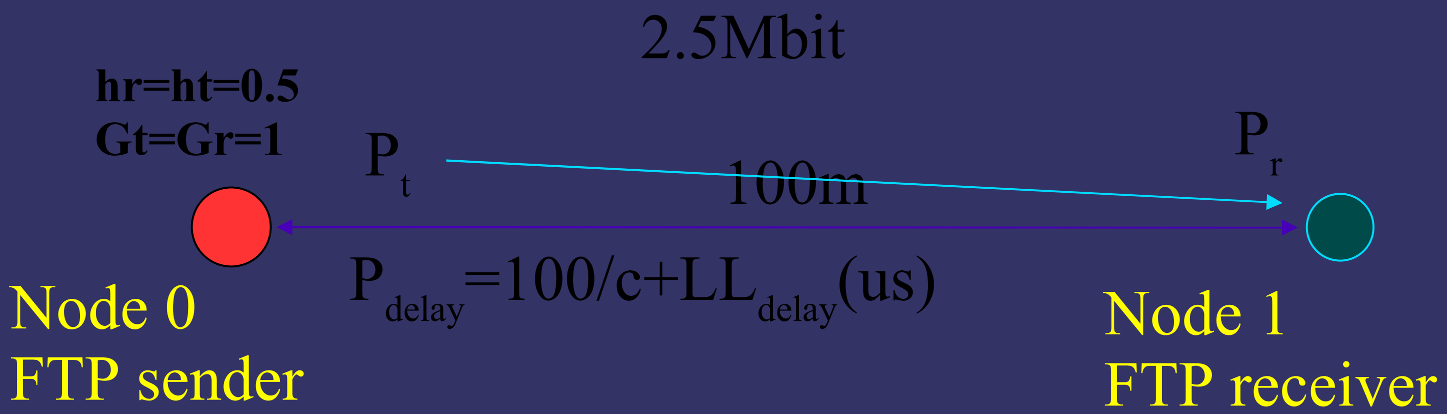
- **Device Power Consumption.**

Typical Matrix of Power Consumption.

Device:	Tx Power(mW):	Rx Power(mW):	Idle Power(mW):
OriNOCO:	١٤٢٥mW	٩٢٥mW	٤٥mW
Aironet ٣٤٠:	١٧٥٠mW	١٢٥٠mW	٥٠mW
Aironet ٤٨٠٠:	٢٤٥٠mW	١٤٠٠mW	٢٥mW
Aironet ٣٥٠:	٢٢٥٠mW	١٣٥٠mW	٨٥mW
Intel W٢٠١١:	١٧٥٠mW	٨٥٠mW	٥٠mW
Dlink DWL٦٥٠:	١٤٢٥mW	٩٢٥mW	٤٥mW
Compaq WL١١٠:	١٤٢٥mW	٩٢٥mW	٤٥mW

Wireless Simulation Scenario



Calculate Pr: → Friss free space equation
d_{cross} → Two ray Ground approximation

RXThresh: Under that P_r we detect signal, but cannot decode packet without errors.

CSThresh: Under that P_r we drop packet, no signal detection

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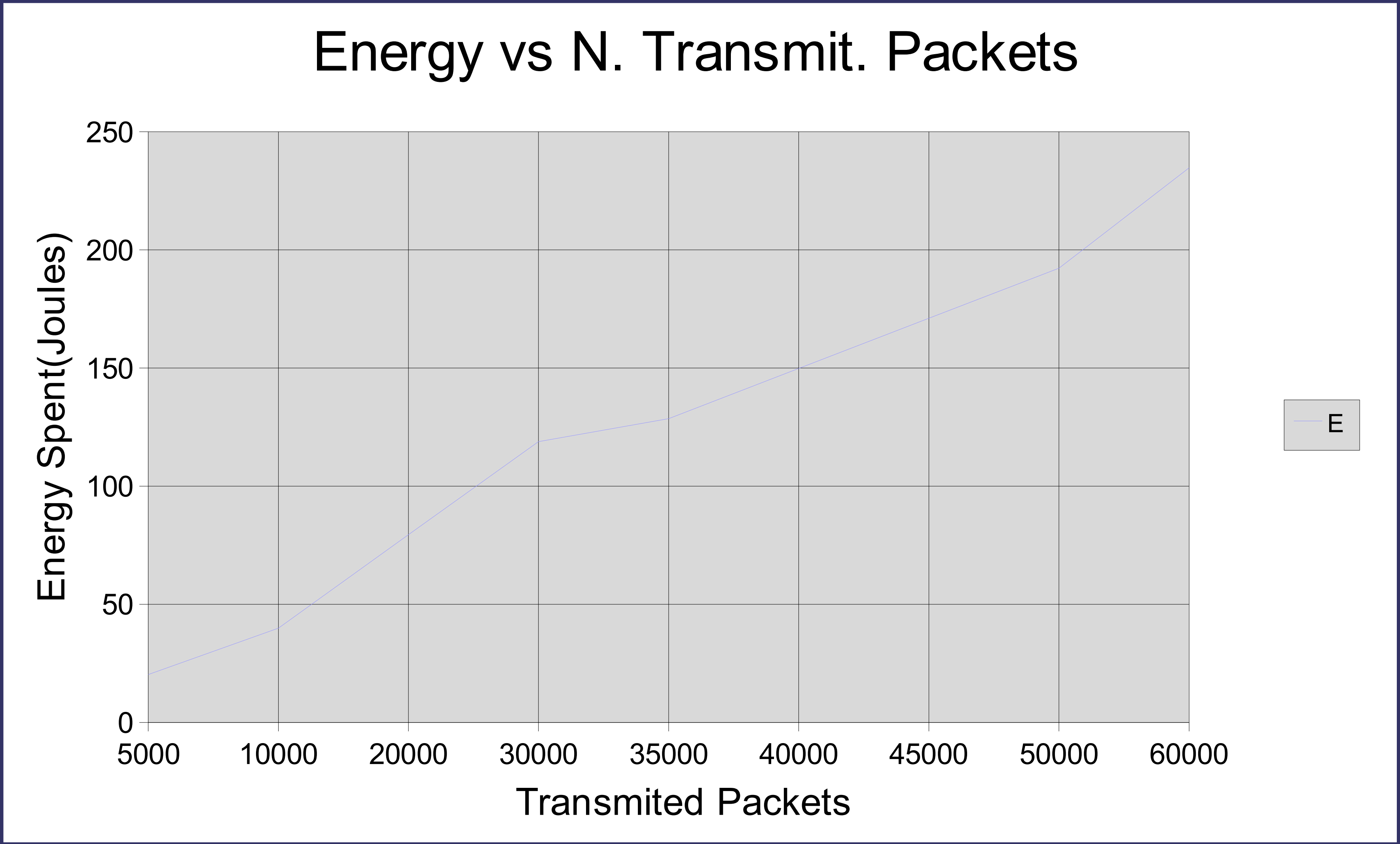
- **Energy Measurement Results.**



Energy Consumption for different packet sizes for 2.472 Mhz DWL 650.

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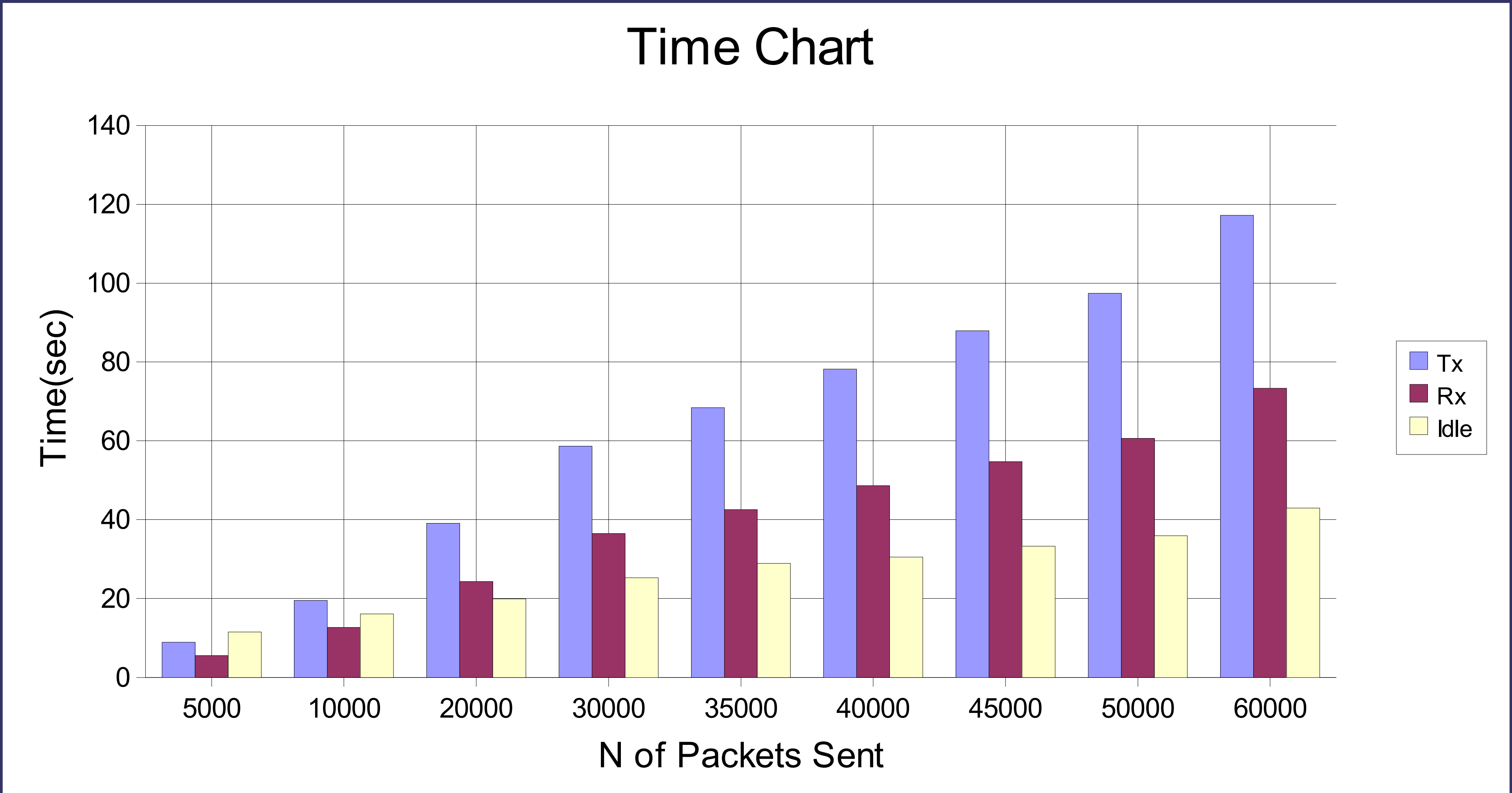
- **Time Measurement Results.**



Proto:tahoe, F.I.=1, RTR=0

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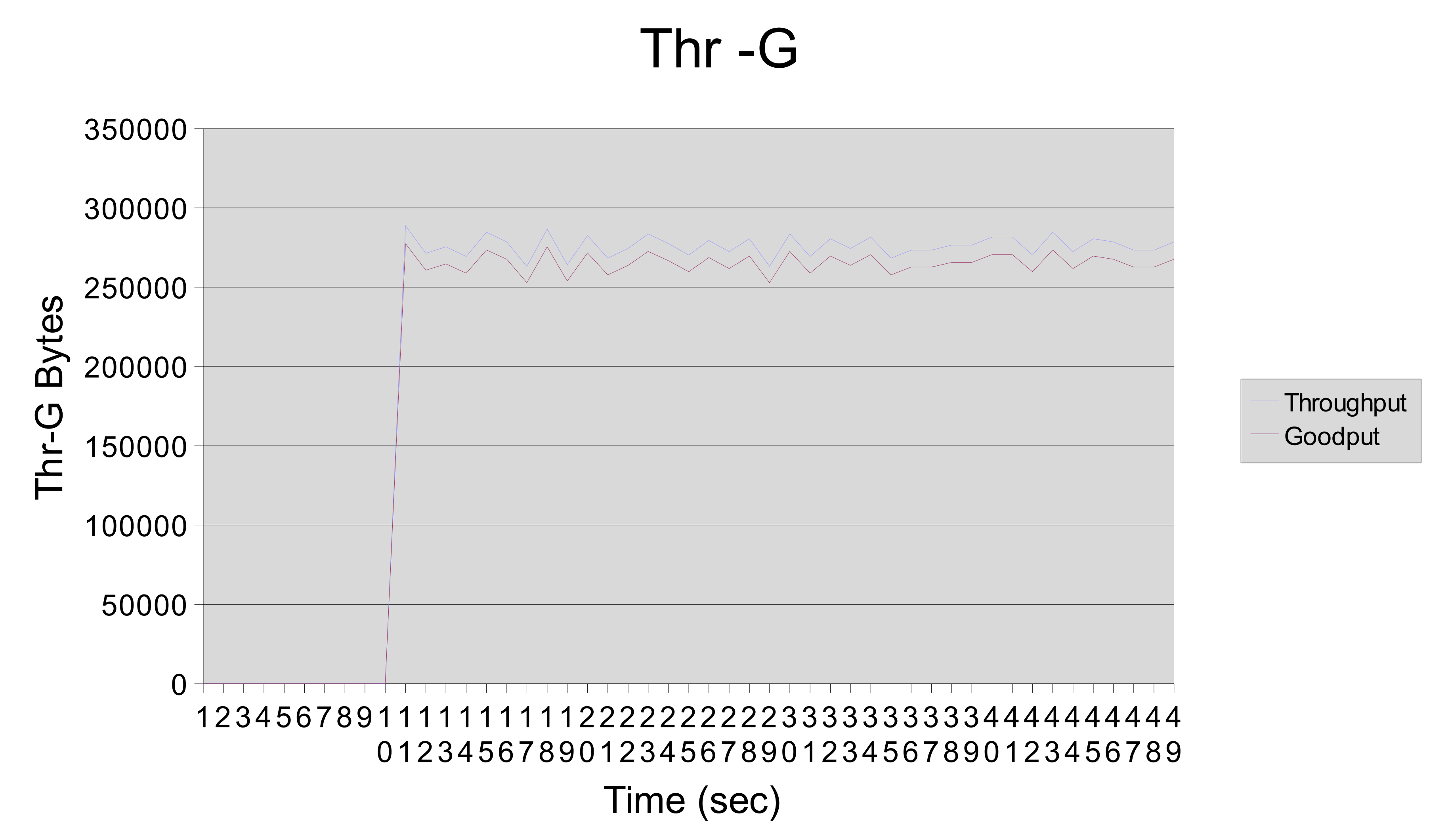

MSS=1024 Bytes

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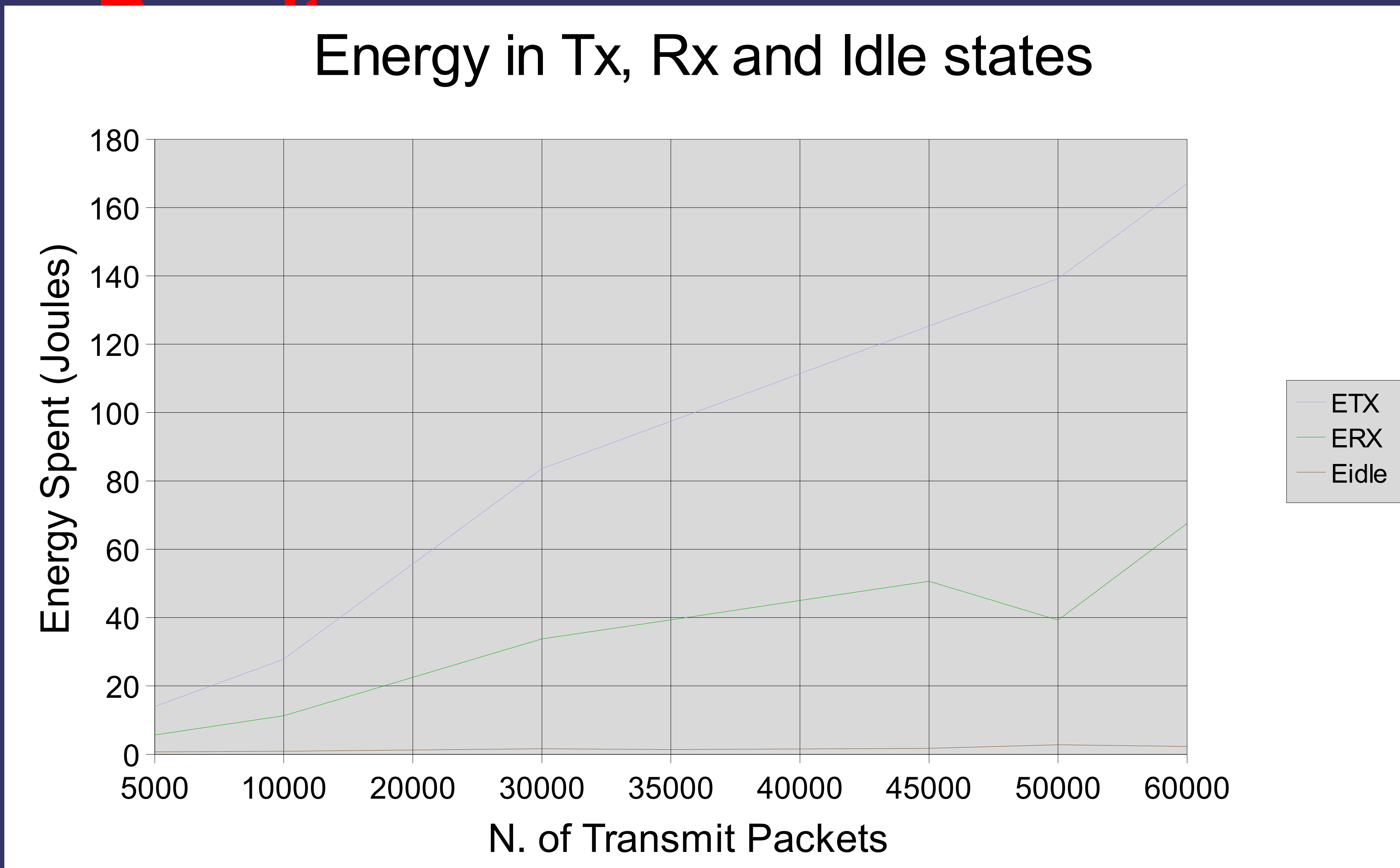
- **Energy Measurement**



Energy Consumption for different states Tx, Rx, Idle, DWL 650

3E Energy Index

$EEE = \alpha \cdot (Thr-G)/Tmax + b \cdot (Tmax-Thr)/Tmax$

1. G=Thr=Tmax, **(All energy is consumed into succesfull transmissions)**

   $EEE = 0$

2. Thr=Tmax (G<Thr), **(Energy lost due to RTR(congestion) and overhead)**

   $EEE = \alpha \cdot (Thr-G)/Tmax$, $\alpha_{RTR+Overhead}$

3. G=Thr → 0, **(Energy lost due to RTO and time waiting)**

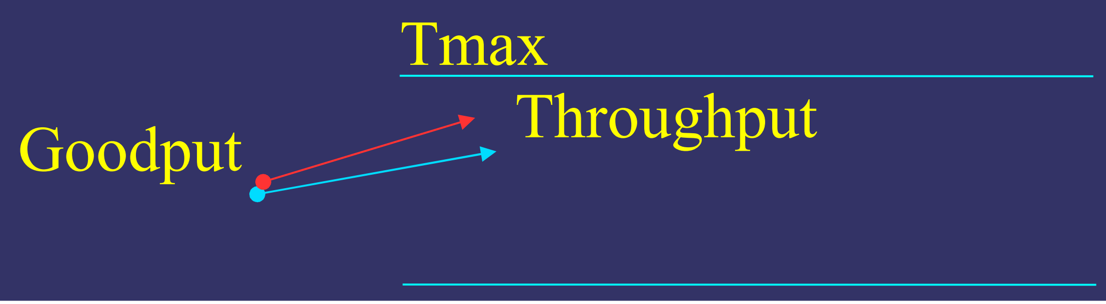
   $EEE = b \cdot (Tmax-Thr)/Tmax$, b_{IDLE}

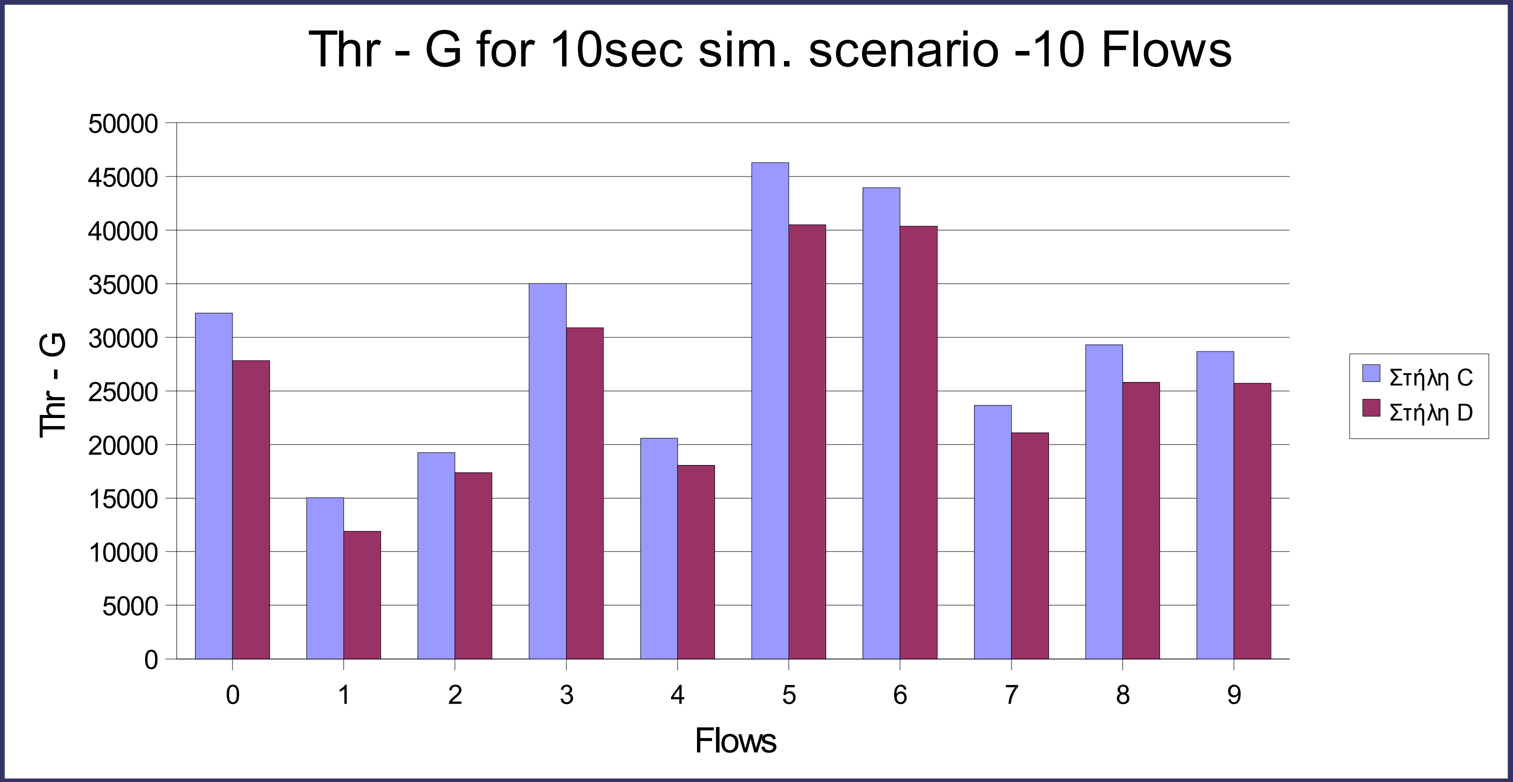
4. G=0 ⟶ $EEE = b + (\alpha - b) \cdot Thr/Tmax$

5. G=0 & Thr=Tmax ⟶ $EEE = \alpha$

EEE<0 → Wrong Estimation of Tmax

3E Energy Index





Fairness Index Proposal

Proposal

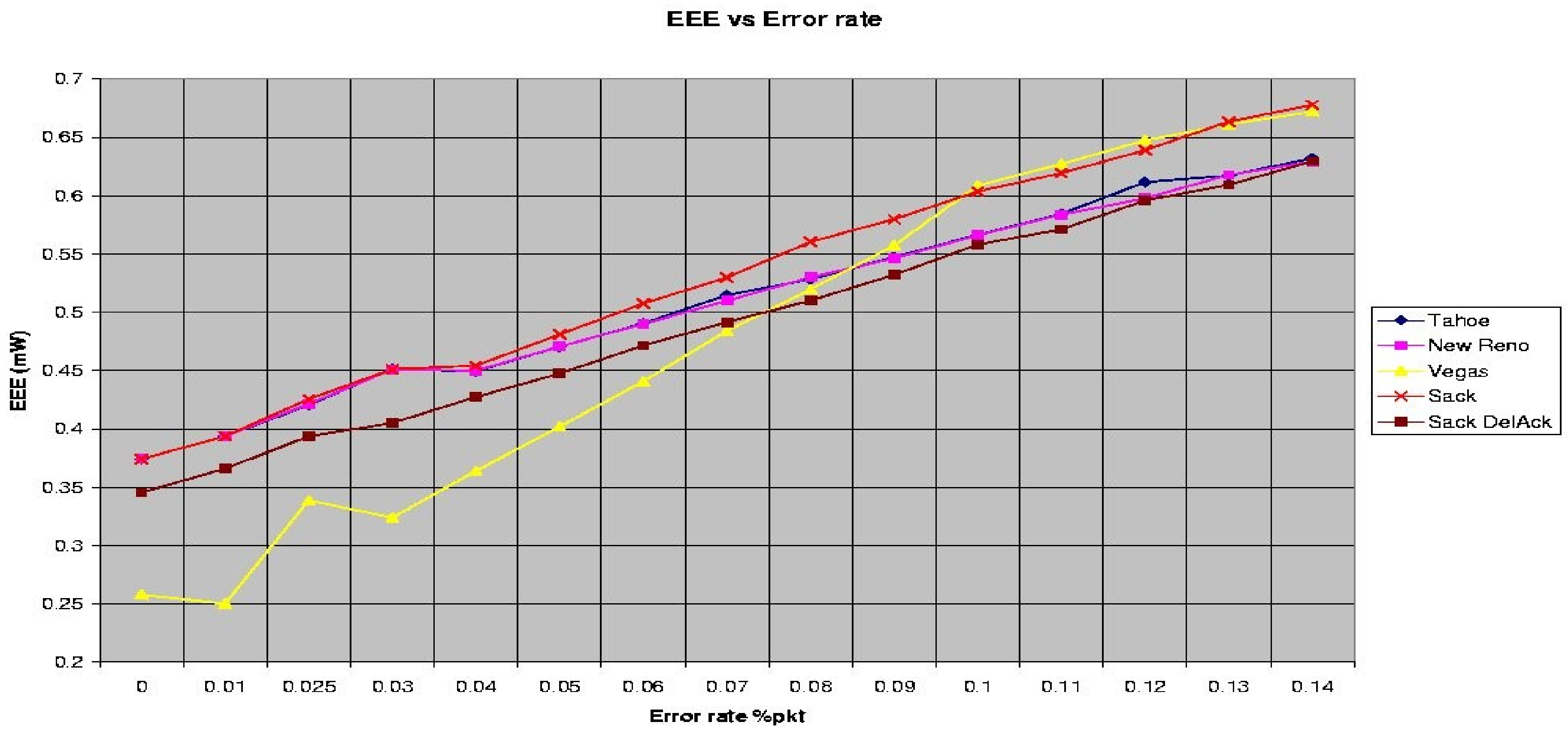
- Measured Throughput: $(T_1, T_2, \ldots, T_n)$
- Use any criterion (e.g., max-min optimality) to find the Fair Throughput $(O_1, O_2, \ldots, O_n)$
- Normalized Throughput: $x_i = T_i/O_i$

$$\text{Fairness Index} = \frac{(\Sigma x_i)^2}{n \Sigma x_i^2}$$

Example: 50/50, 30/10, 50/10 $\Rightarrow$ 1, 3, 5

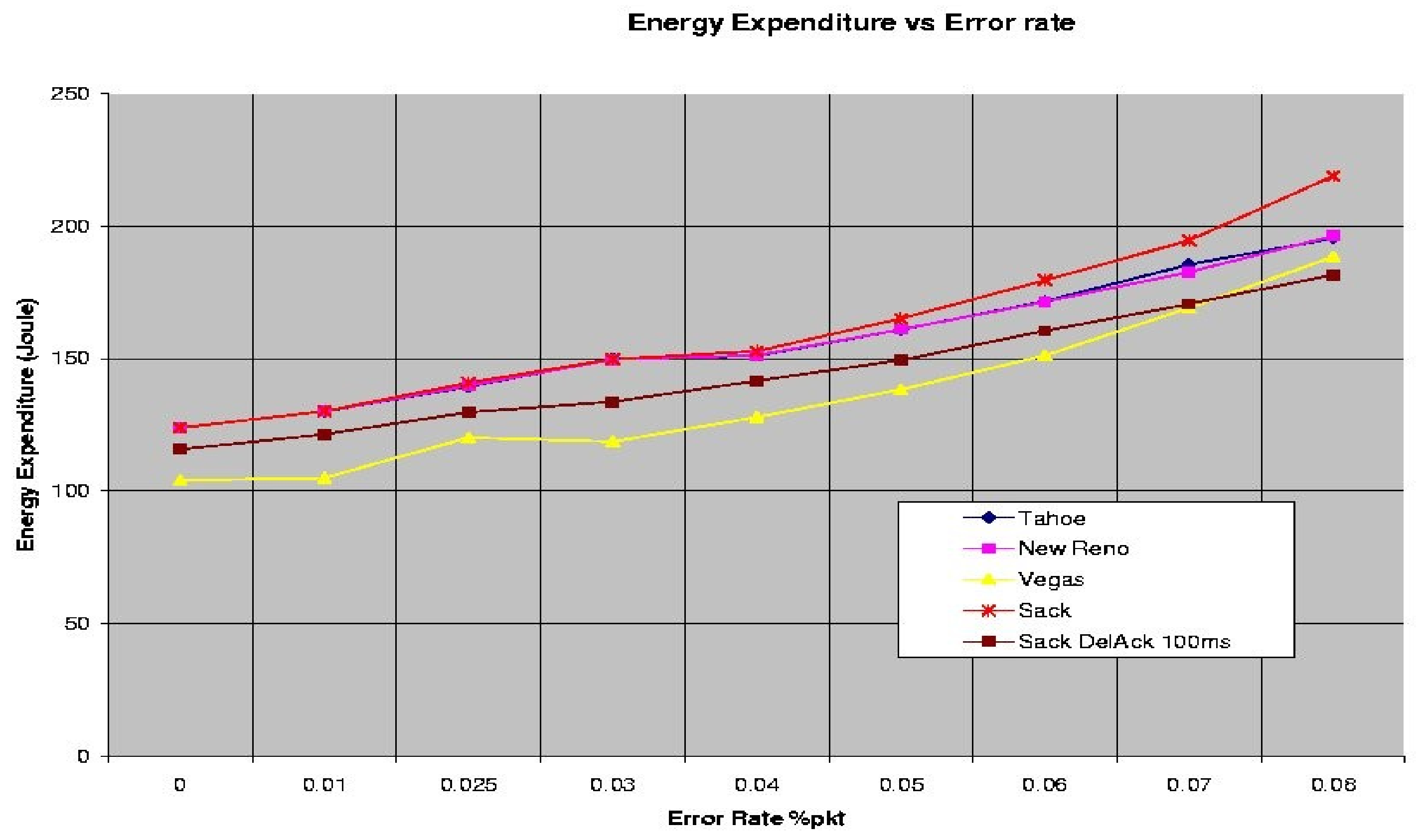
$$\text{Fairness Index} = \frac{(1+3+5)^2}{3(1^2+3^2+5^2)} = \frac{9^2}{3(1+9+25)} = 0.81$$

3E vs error rate



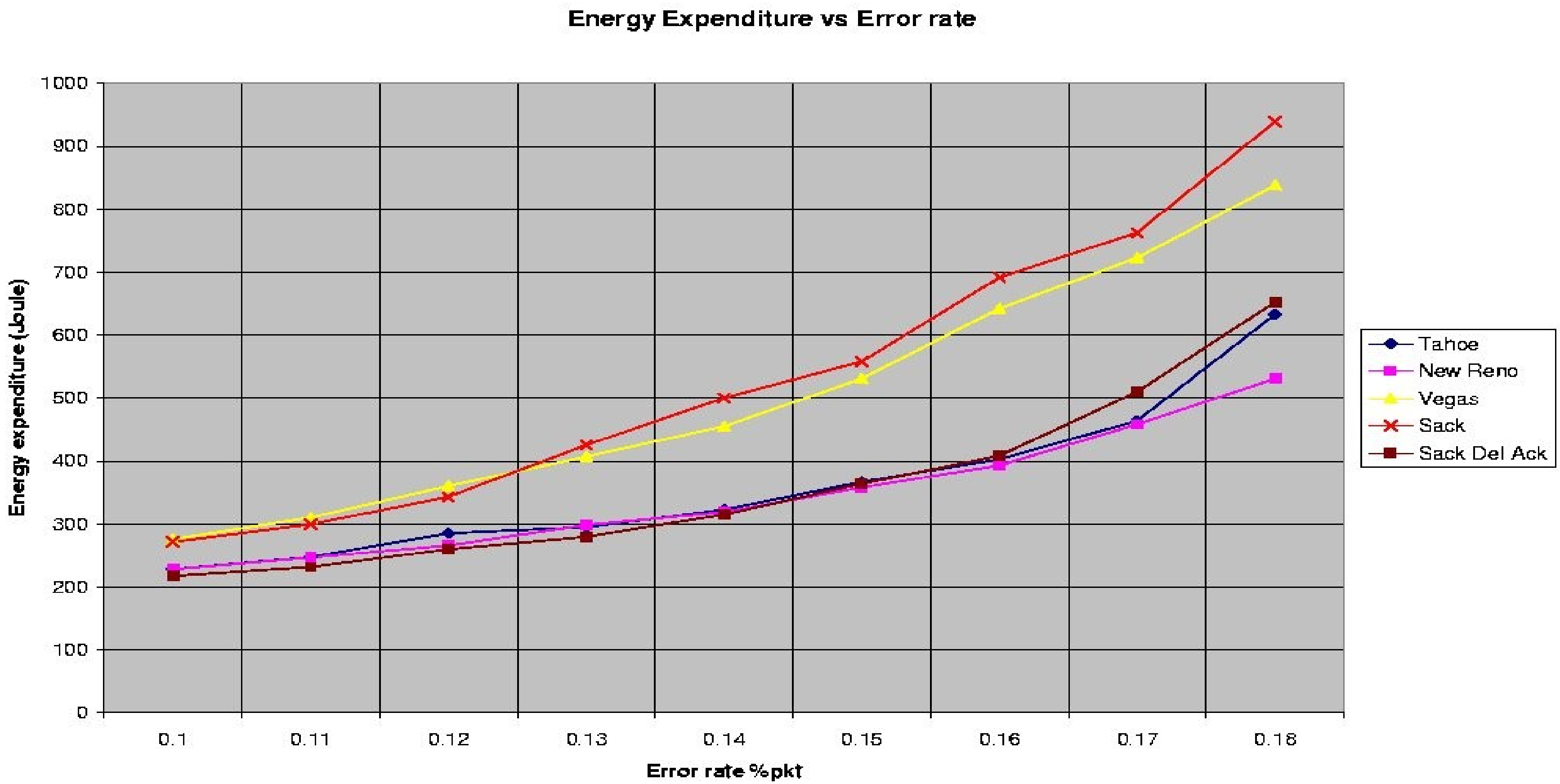
Scenario: Random-Burst Errors 0%-15% PER
1 flow, 2Mbit channel, 10MBytes Transfer.

E.E. Low pkt error rate



Scenario: Random Errors 0%-8% PER
1 flow, 2Mbit channel, 10MBytes Transfer.

E.E. burst pkt error rate



Scenario: Burst Errors 10%-20% PER
1 flow, 2Mbit channel, 10MBytes Transfer.

THE END.