

# REAL-TIME SCHEDULES ARE PREDICTABLE

HYPERPERIODS	1	1	2	2	3	3	1	2	2		1	2	2	1	3	3	2	2	1		2	1	2
2	1	2	2	3	3	1	2	2		1	2	2	1	3	3	2	2	1		2	1	2	
3	1	2	2	3	3	1	2	2		1	2	2	1	3	3	2	2	1		2	1	2	
4	1	2	2	3	3	1	2	2		1	2	2	1	3	3	2	2	1		2	1	2	
5	1	2	2	3	3	1	2	2		1	2	2	1	3	3	2	2	1		2	1	2	

## ADVERSARIES CAN

- LAUNCH TARGETED ATTACKS
- STEAL INFORMATION VIA SIDE CHANNELS

## SCHEDULE INDISTINGUISHABILITY!

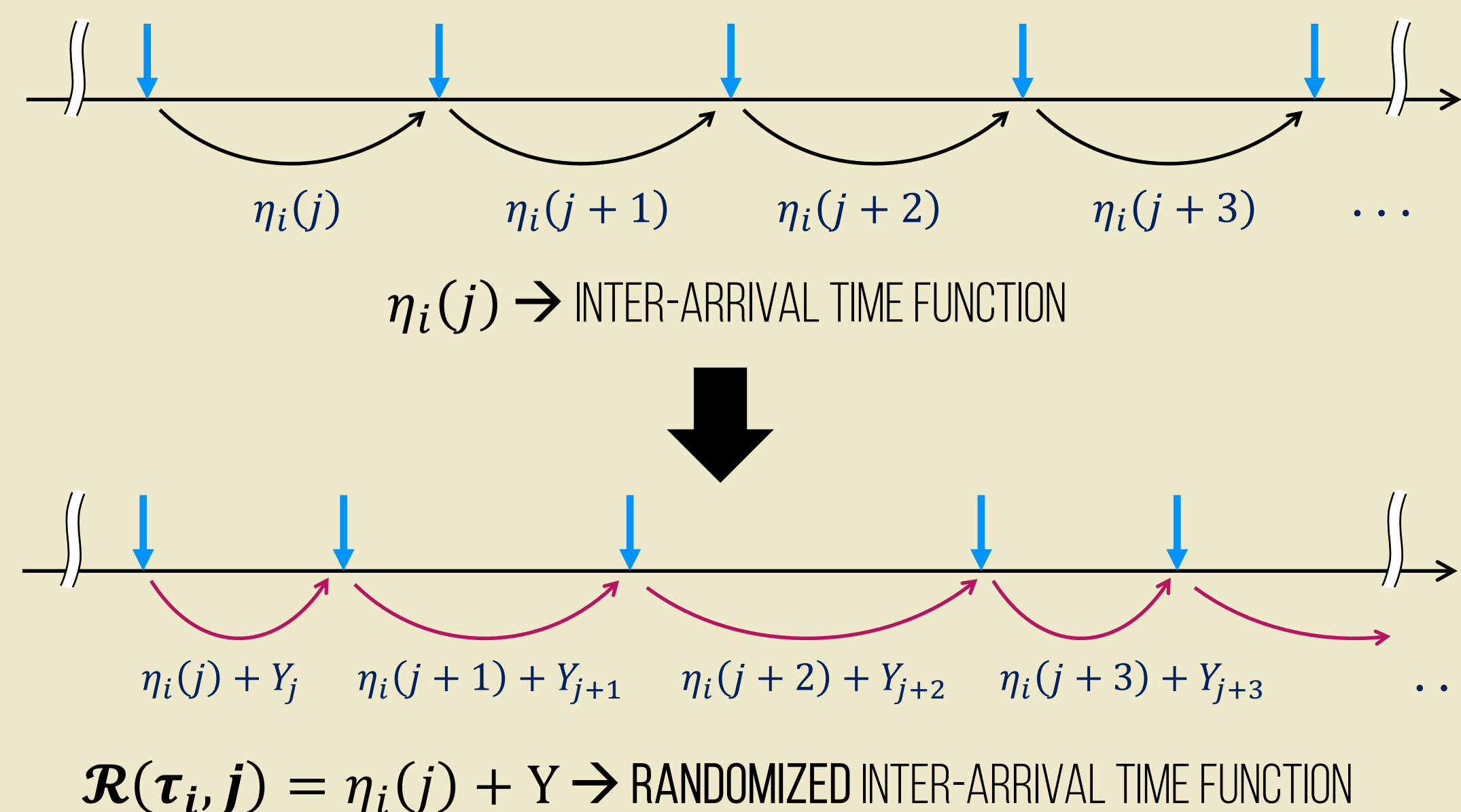
- INTRODUCE DIVERSITY INTO SCHEDULES
- OFFERING ANALYZABLE SECURITY GUARANTEES
- INSPIRED BY DIFFERENTIAL PRIVACY CONCEPTS

### DEFINITION:

THE DIFFICULTY OF DISTINGUISHING ONE JOB'S ARRIVAL FROM ANOTHER

## METHODOLOGY

- ADD (SUFFICIENTLY LARGE) NOISE INTO SYSTEM
- BREAK DETERMINISM!
- ADD LAPLACIAN NOISE TO INTER-ARRIVAL TIMES



# PREVENT INFORMATION LEAKAGE IN REAL-TIME SYSTEMS

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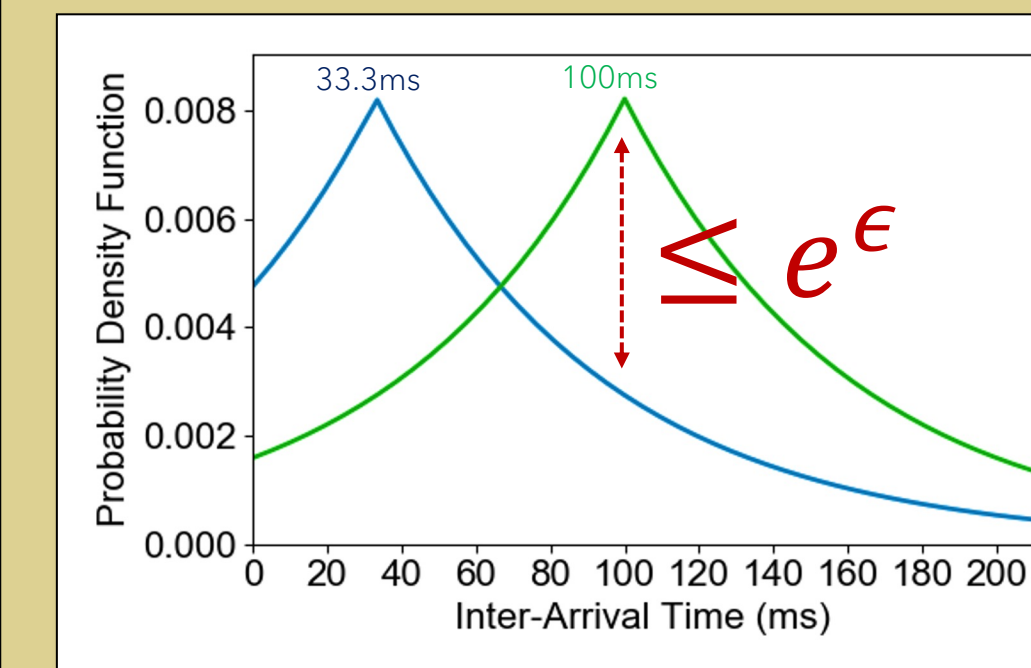


## ε-SCHEDULER

REAL-TIME SCHEDULER THAT DIVERSIFIES TASK SCHEDULE BY ENABLING SCHEDULE INDISTINGUISHABILITY

HIGH LEVEL GOALS

- DIVERSIFY TASK SCHEDULE
- OFFER ANALYZABLE PROTECTION



$$\frac{\Pr[\mathcal{R}(\tau, j) \in S]}{\Pr[\mathcal{R}(\tau', j') \in S]} \leq e^\epsilon$$

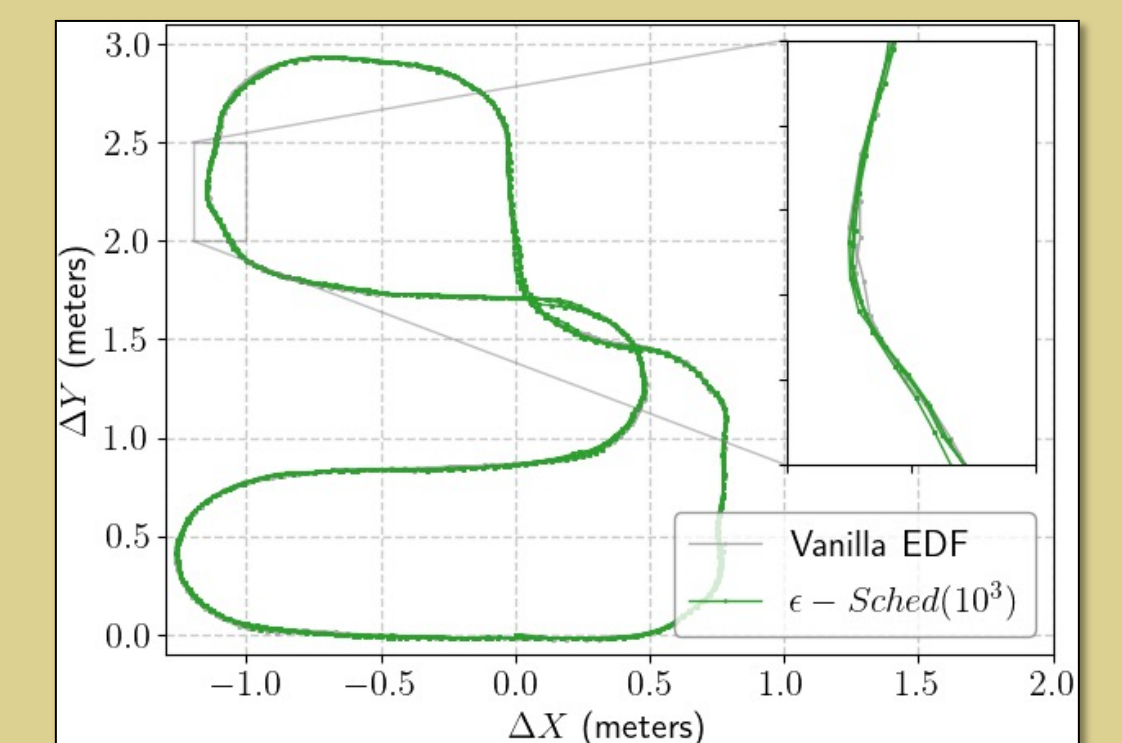
RATIO OF ANY TWO INTER-ARRIVAL TIME DISTRIBUTIONS

## IMPLEMENTATION & EVALUATION

- SCHEDULING MODE UNDER SCHED\_DEADLINE



+ ROVERBOT  
+ RASPBERRY PI



ε-SCHEDULER (ε = 10<sup>3</sup>)

## SUMMARY

