MagneComm: Magnetometer-based Near-Field Communication

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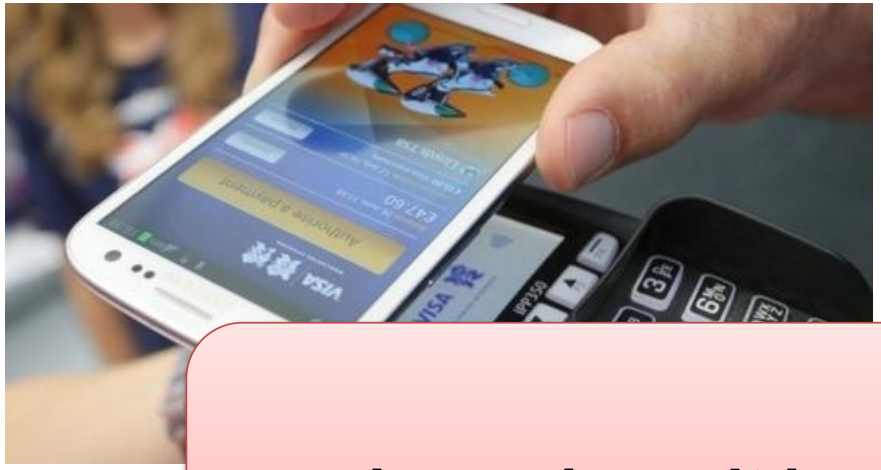
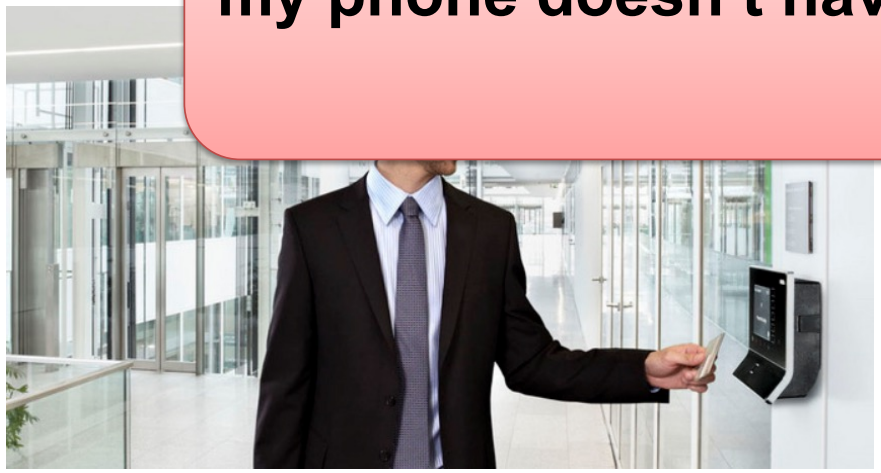
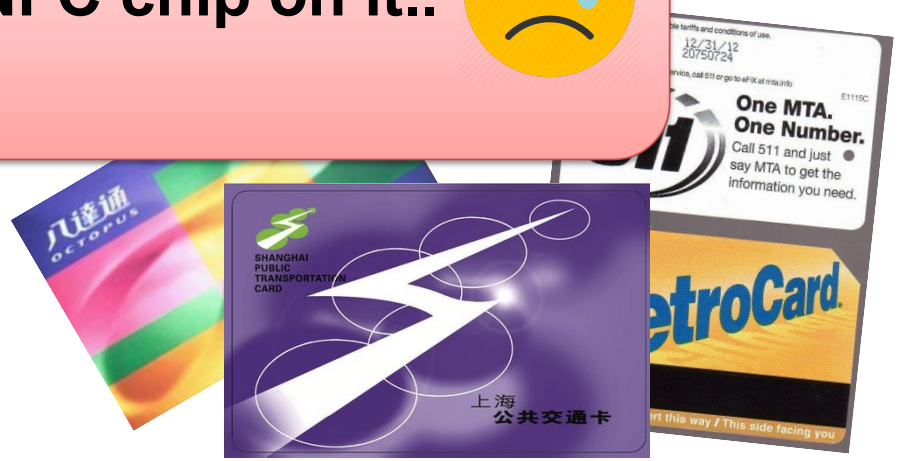
1 Near-Field Communication Applications



my phone doesn't have NFC chip on it..





1 NFC Availability

NFC will be included in 64% of the mobile phones in 2018.
Still 675 million phones have no NFC.

OUTLINE

1. Motivation
2. Key Idea and Applications
3. Challenges and Design
4. Prototypes
5. Evaluation
6. Conclusion

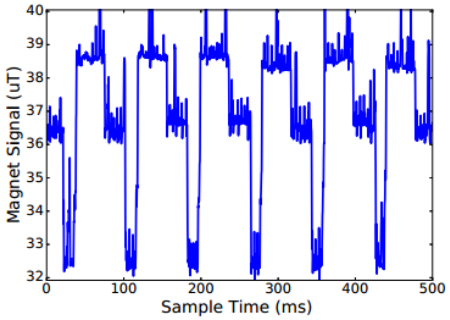
2

PART

Key Idea and Applications

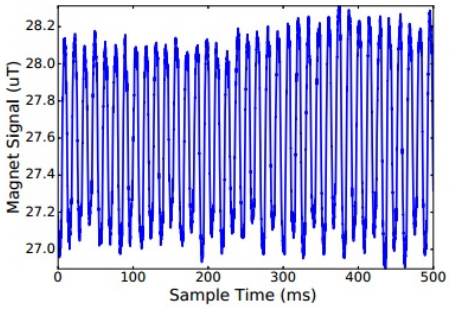
Magnetic Induction (MI) Signals 2

CPU



(a) CPU.

fans



(b) Fan.

Use MI signals to Transmit Data? 2

1 0 0 1 1

3 PART

Challenges and Design

3 Challenges

How to modulate CPU MI signals?

1

2

How to handle the user's interference?

How to enhance the transmission speed?

3

4

How to implement the full-duplex communication?

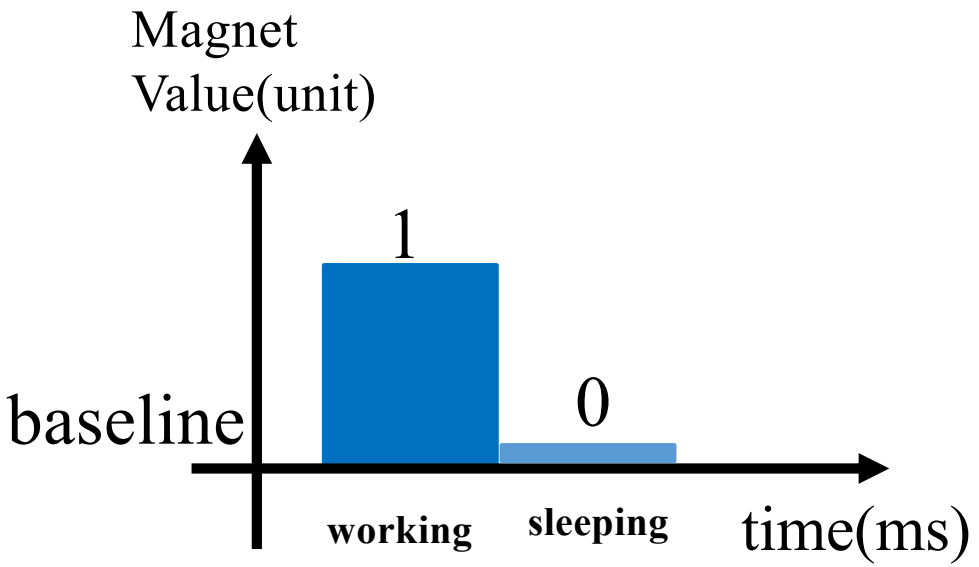
3-1 Generating Desired MI Signals

```
/* ---working----*/

def working(interval):
{
        while true
        {
                if((time.time() - starttime)
                        > interval ):
                          break
        }
}
```

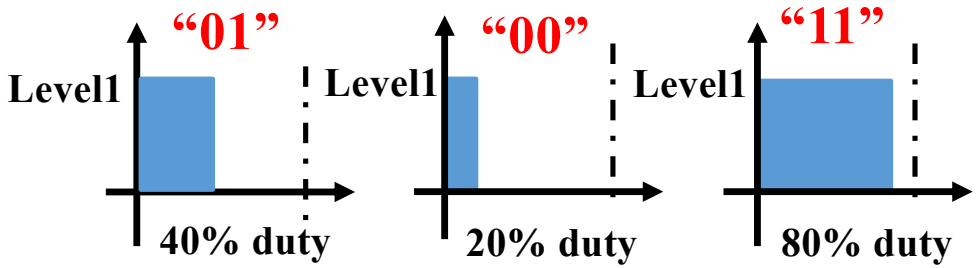
```
/* ---sleeping----*/

def sleeping(interval):
{
         time.sleep(interval)
}
```

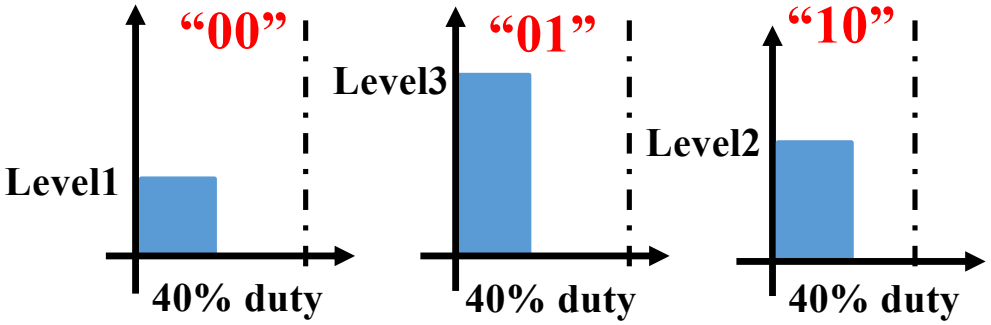


3-1 Modulation

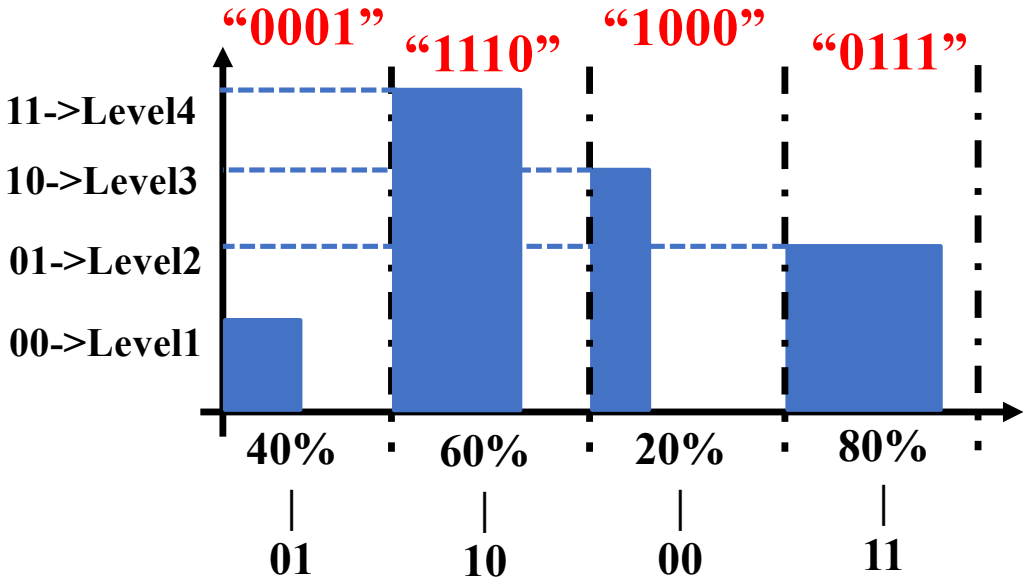
PWM: Changing Width, M = 2



PAM: Changing Amplitude, N = 2

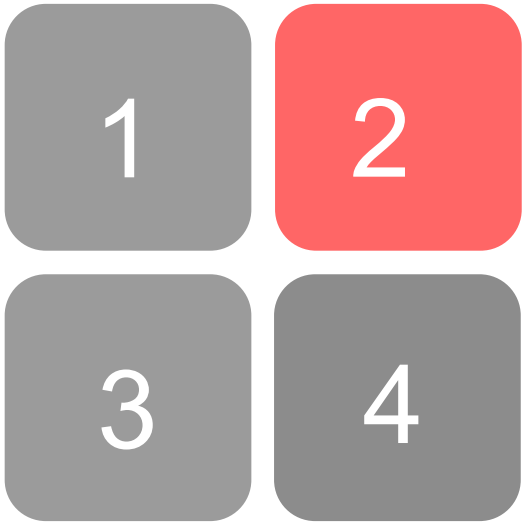


PWAM: Changing Width & Amplitude



3 Challenges

How to modulate CPU MI signals?

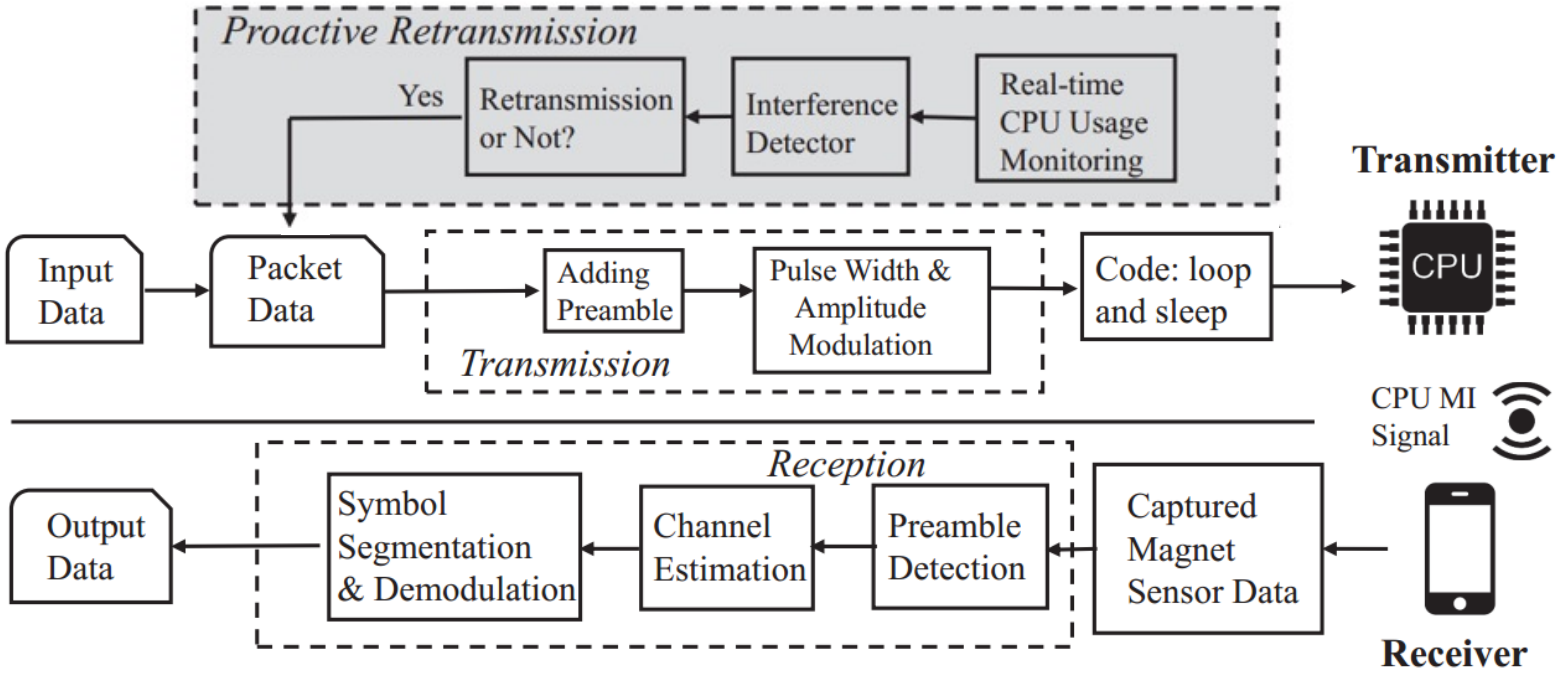


How to handle the user's interference?

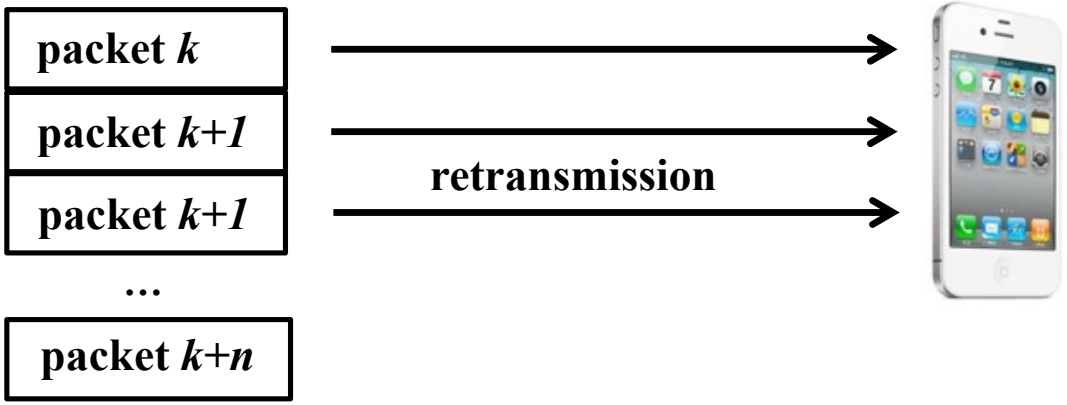
How to enhance the transmission speed?

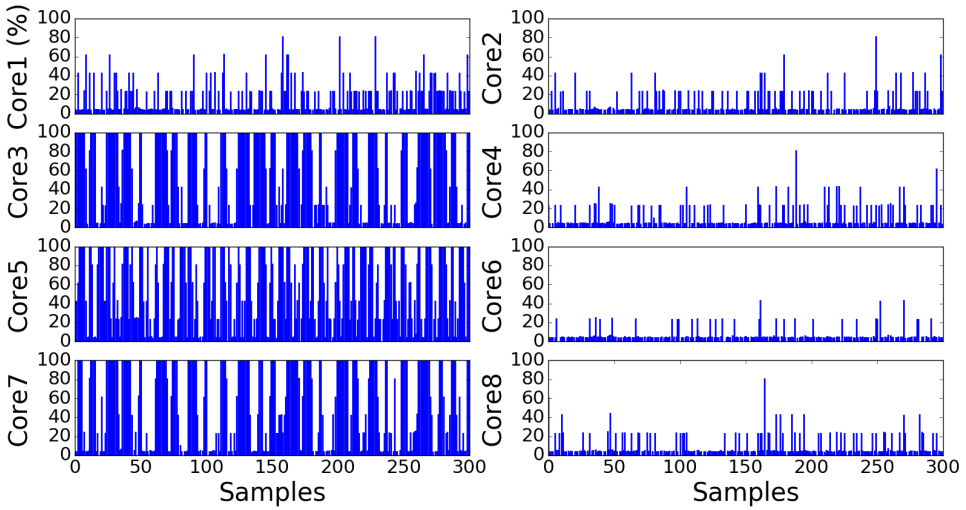
How to implement the full-duplex communication?

3-2 Work Flow


Proactive Retransmission
Yes
Retransmission or Not?
Interference Detector
Real-time CPU Usage Monitoring
Transmitter
Input Data
Packet Data
Adding Preamble
Pulse Width & Amplitude Modulation
Transmission
Code: loop and sleep
CPU
CPU MI Signal
Reception
Output Data
Symbol Segmentation & Demodulation
Channel Estimation
Preamble Detection
Captured Magnet Sensor Data
Receiver

3-2 Retransmission Mechanism





3 Challenges

How to modulate CPU MI signals?

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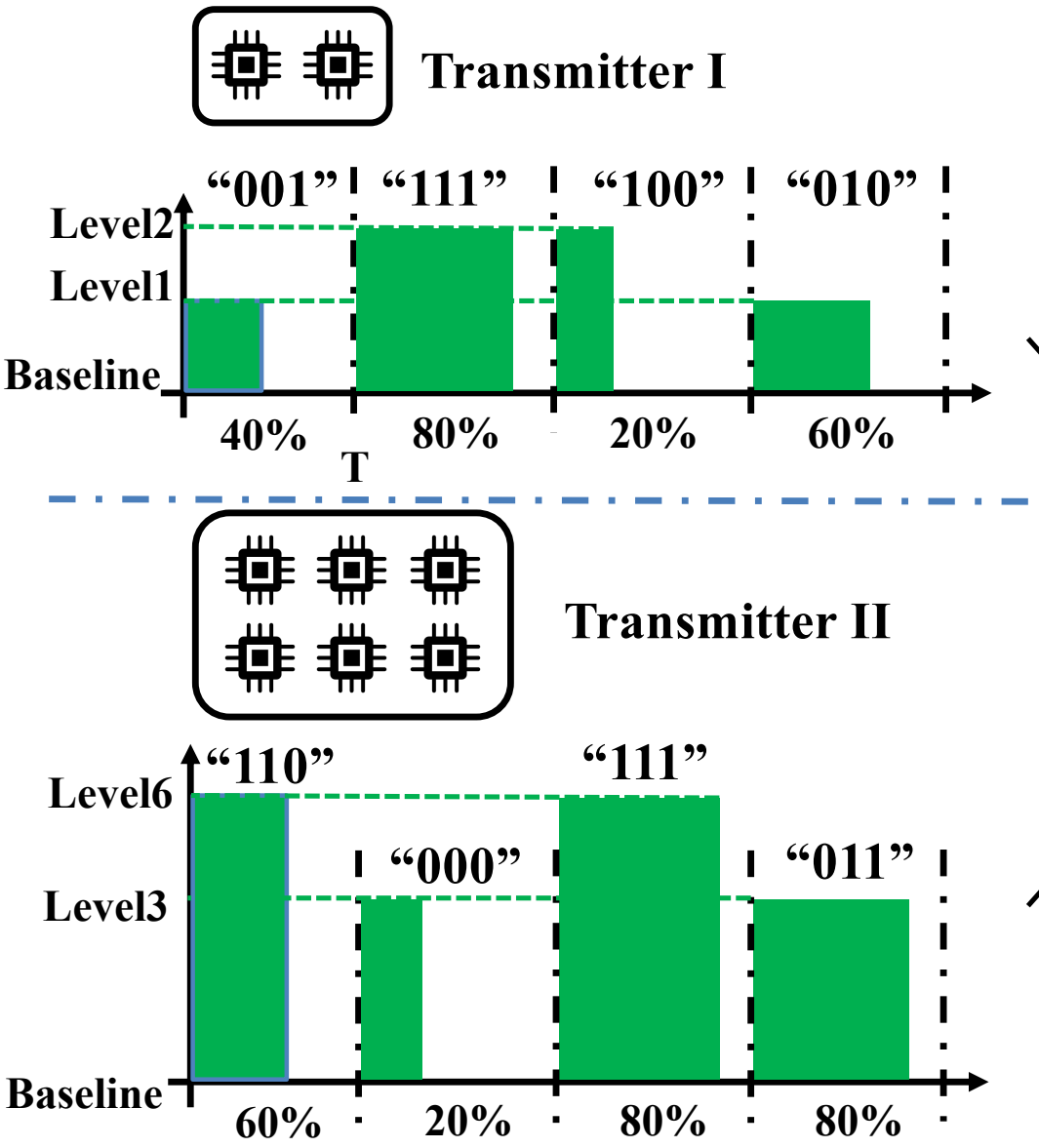
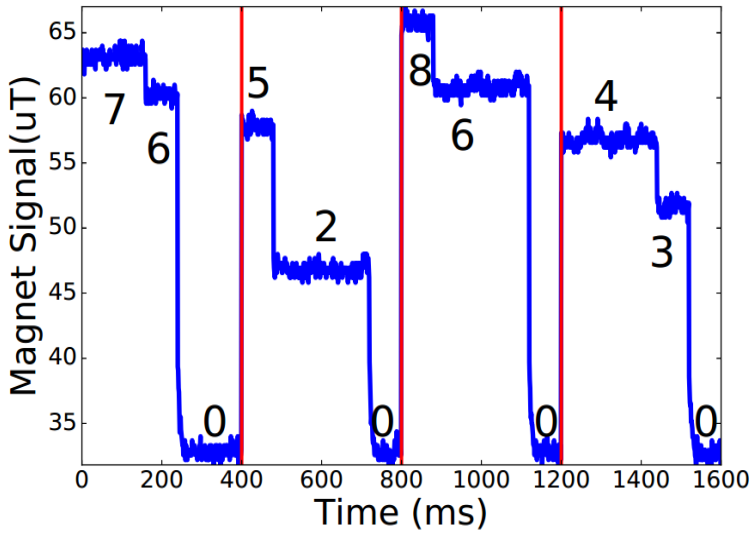
How to implement the full-duplex communication?

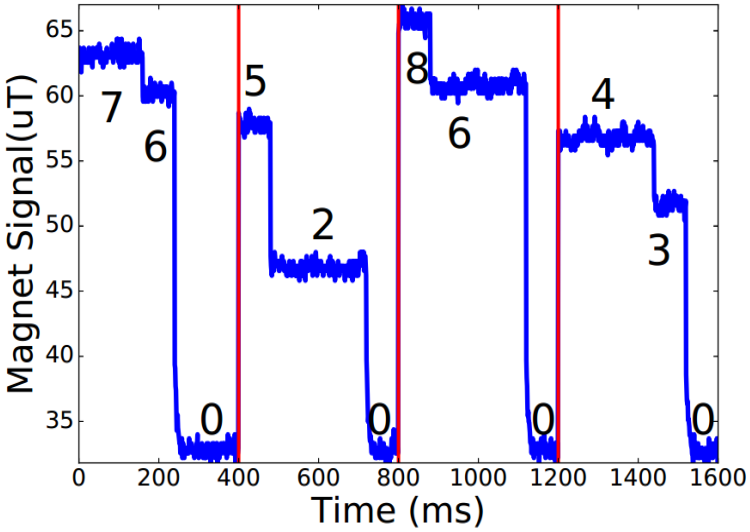
Multiple Transmitters 3-3



MI Signals with Multiple TXs

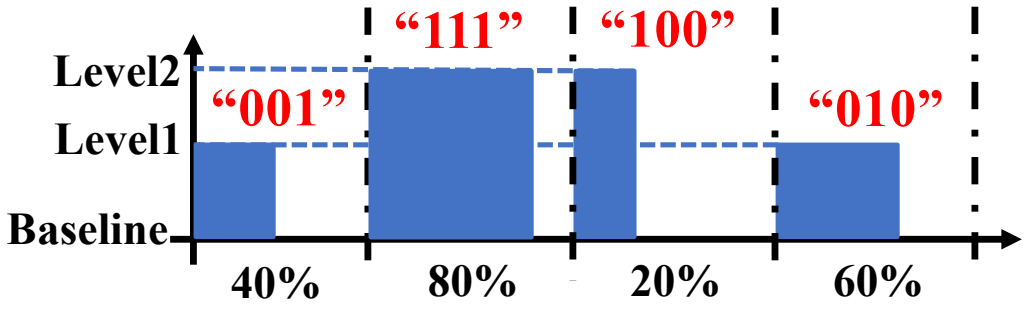


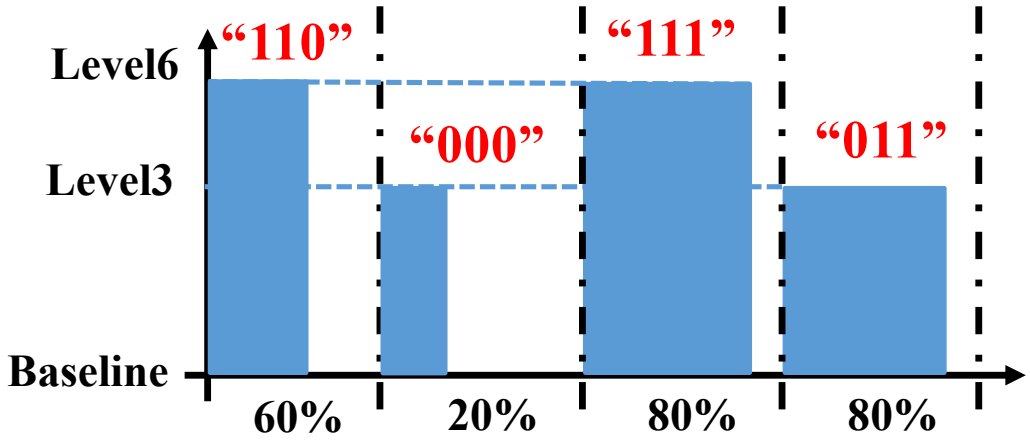
Separating Signals From Transmitters 3-3



Rules Table:

0 = 0+0	3 = 3+0	6 = 6+0
1 = 0+1	4 = 3+1	7 = 6+1
2 = 0+2	5 = 3+2	8 = 6+2





3 Challenges

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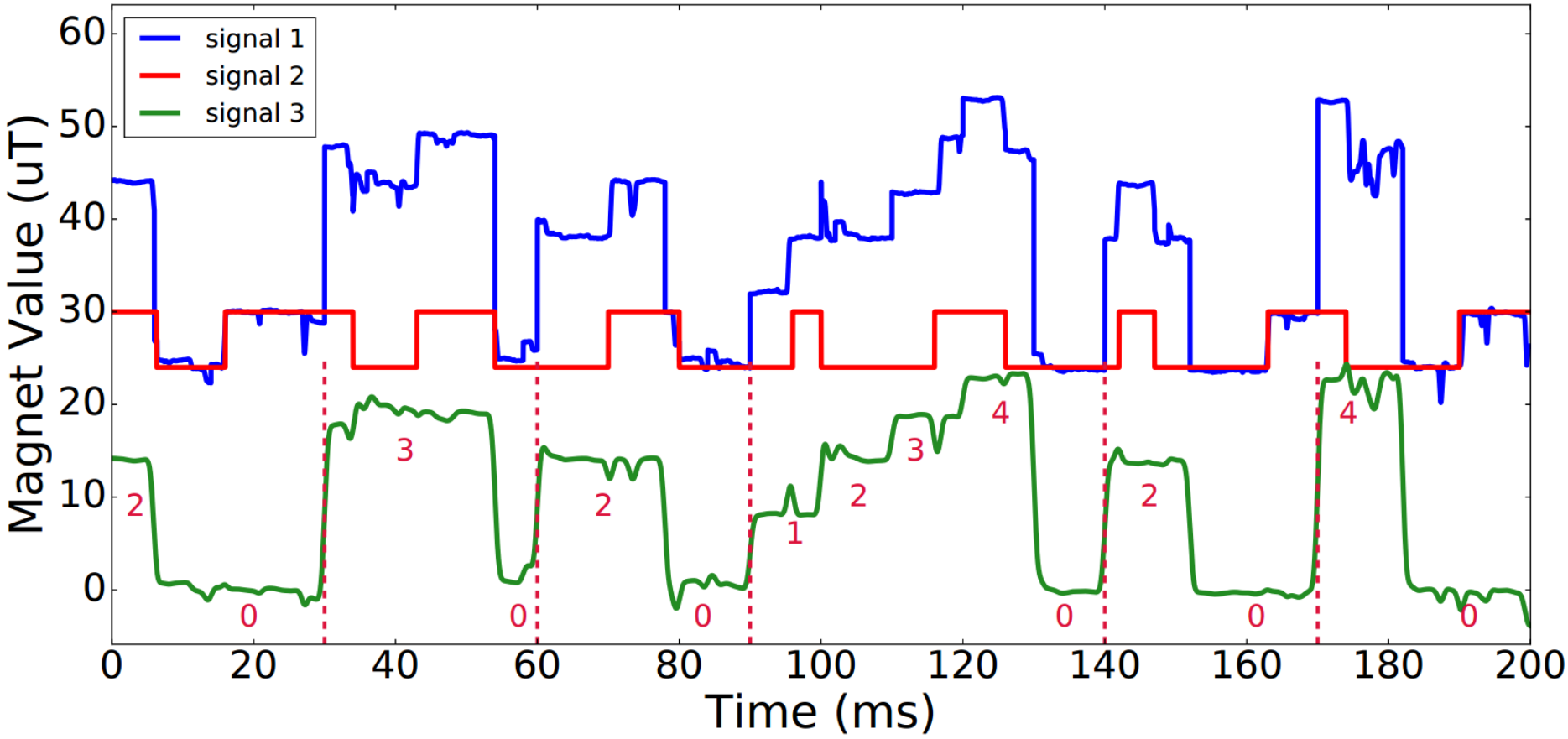
Full-Duplex Communication 3-4

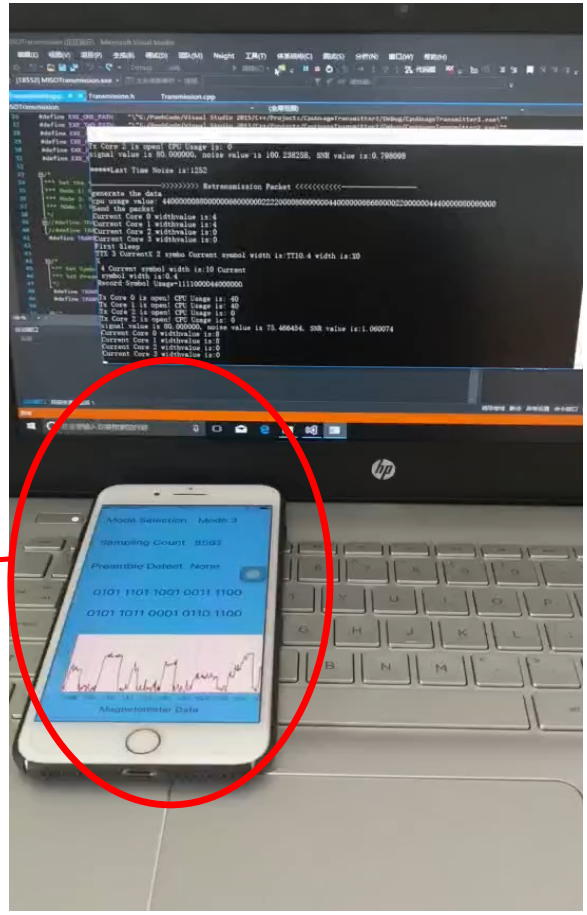


4

PART

MagneComm Prototypes

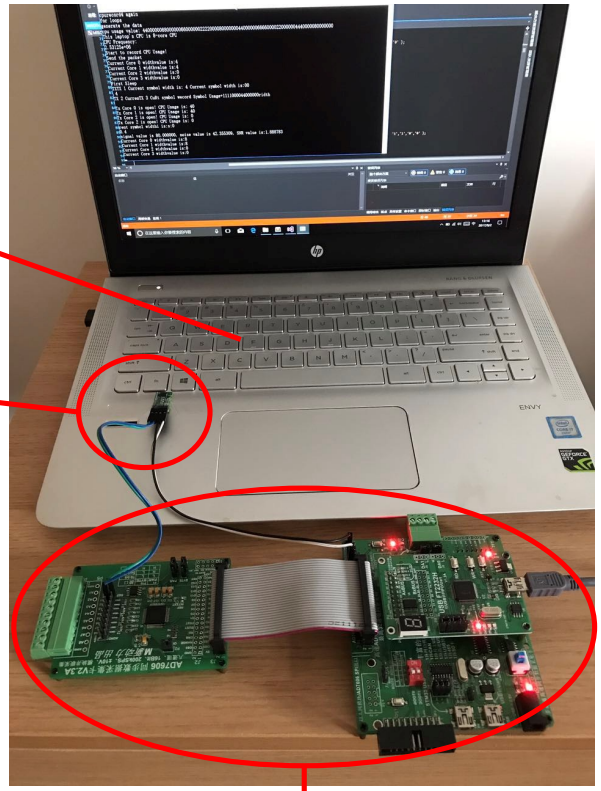
4 Two Prototypes



Receiver:
iPhone

Transmitter:
CPU cores

Receiver:
Magnet sensor

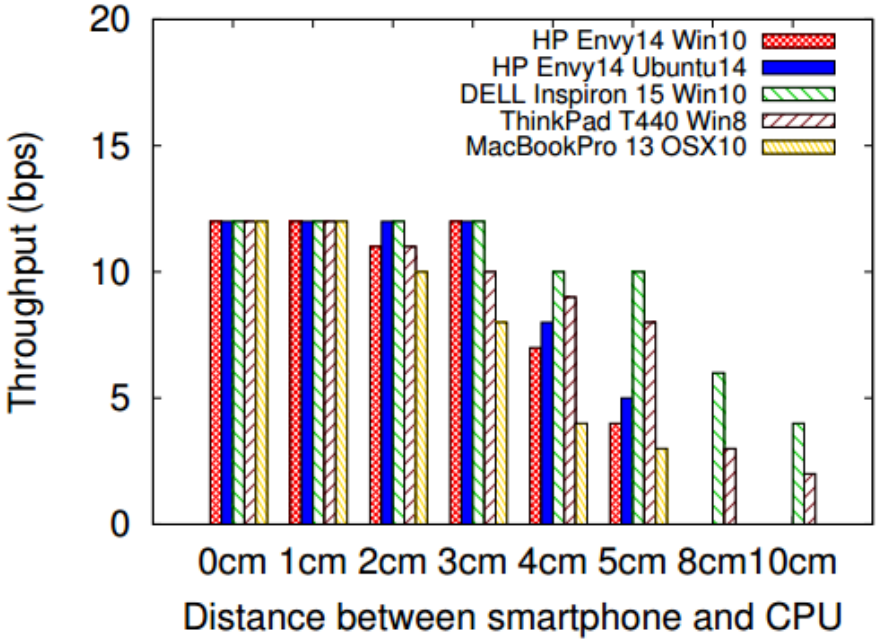


AD sampling board

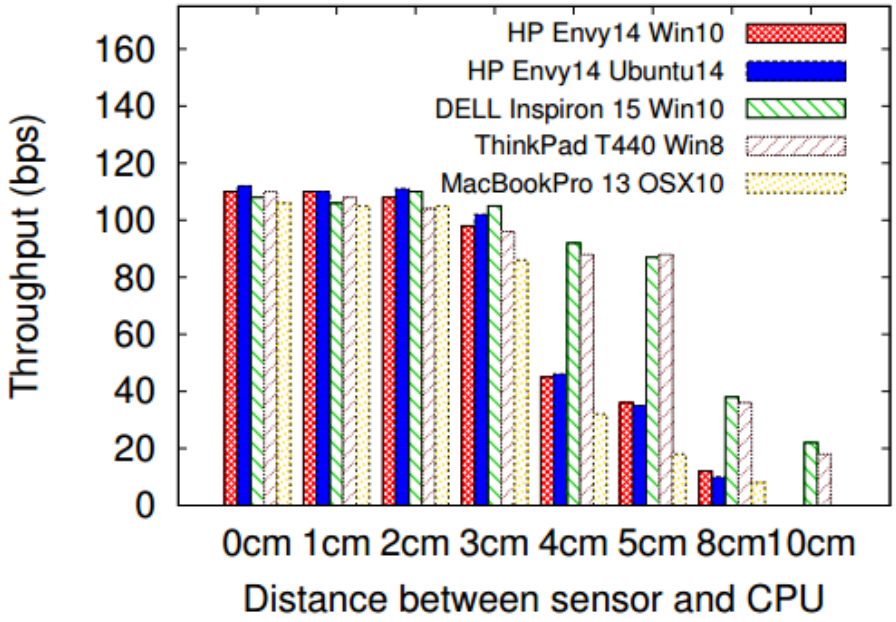
5 PART

Performance

One-Way Communication 5



(a) Prototype I: throughput vs. distances.

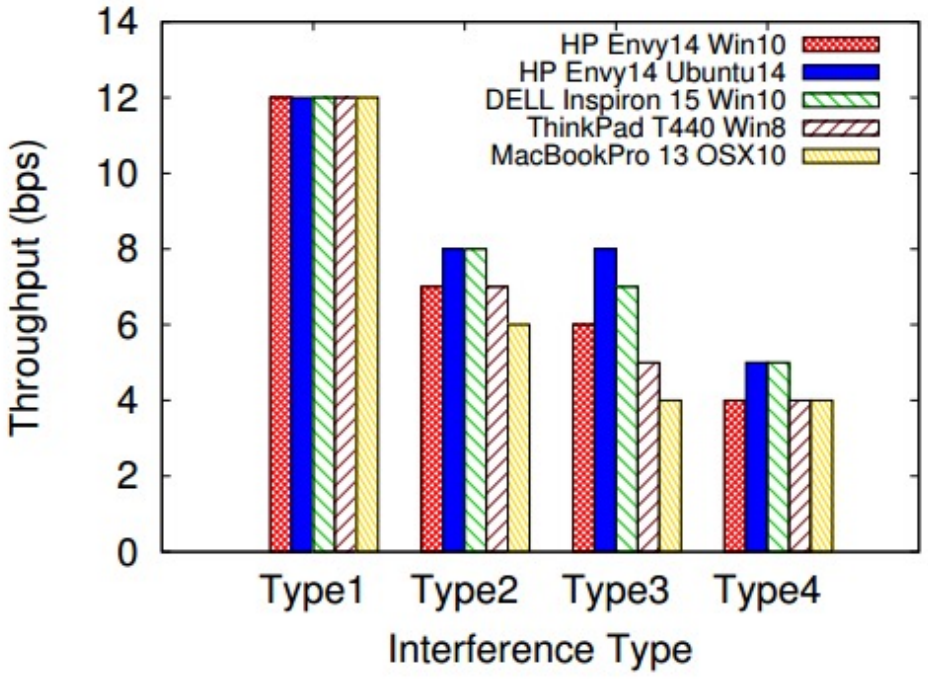


(b) Prototype II: throughput vs. distances.

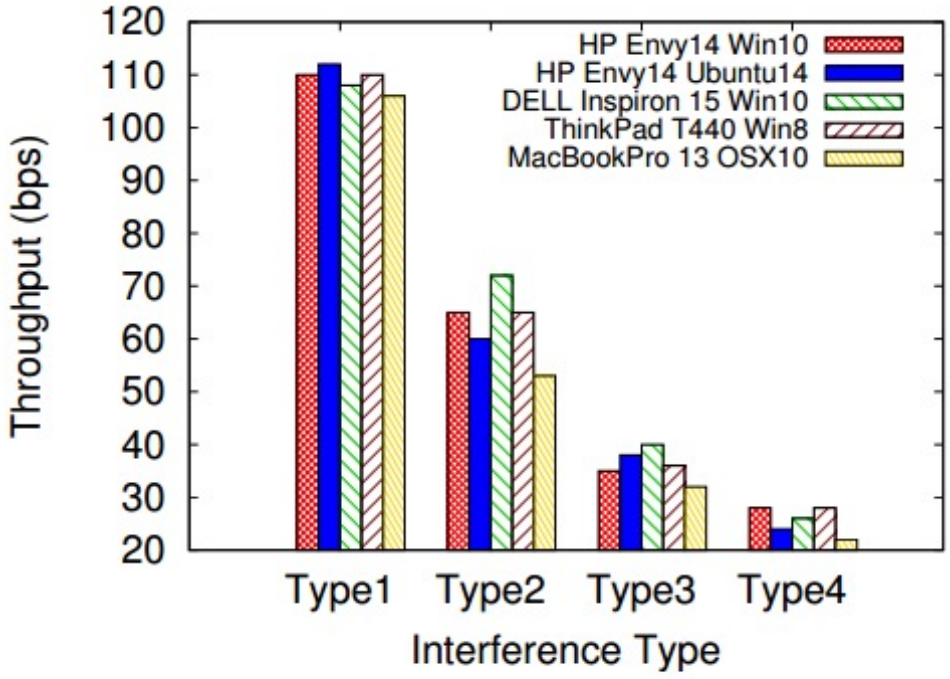
T = 300ms, M=2, N=2

T = 30ms, M=2, N=2

Impact of Interference 5



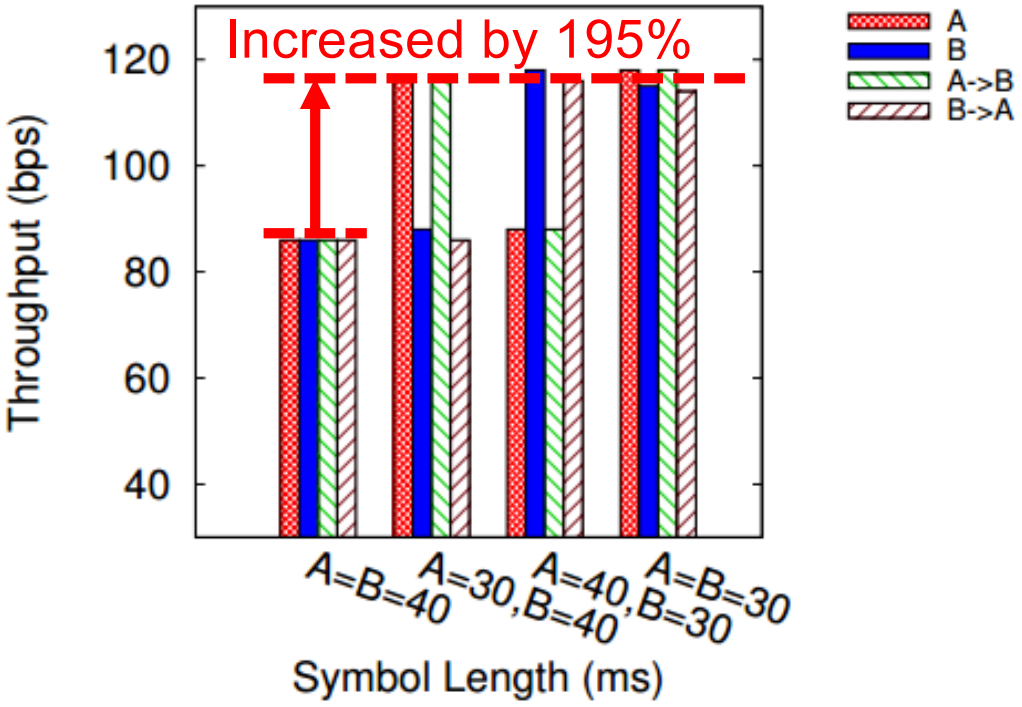
(a) Prototype I: throughput vs. scenarios.



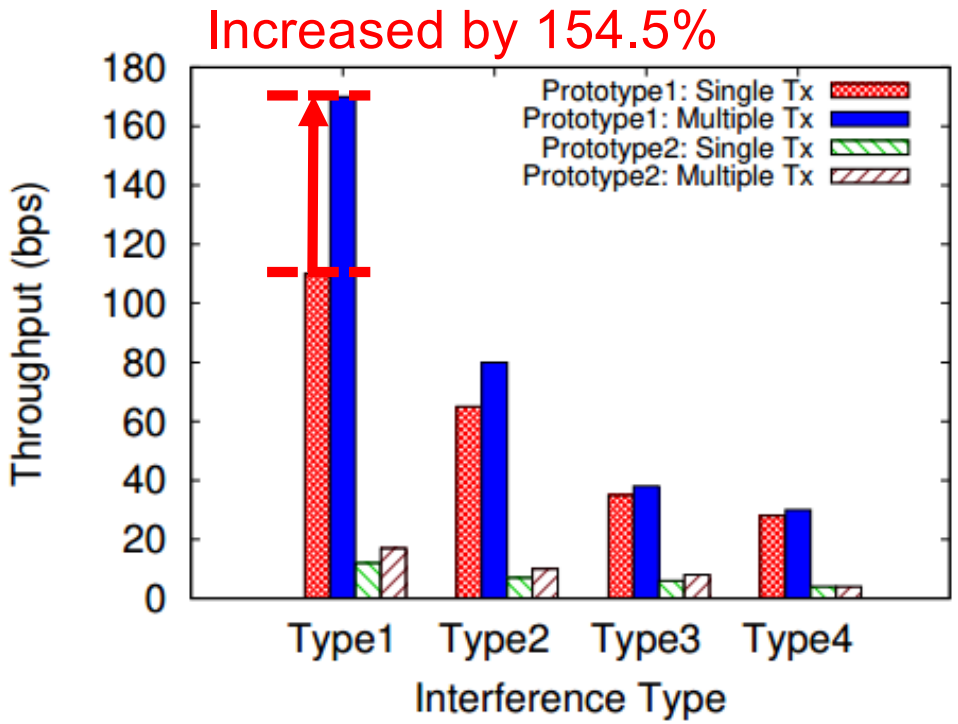
(b) Prototype II: throughput vs. scenarios.

Type1 = doing nothing, Type2 = watching live video,
Type3 = surfing websites, Type4 = playing games

Full Duplex & Multiple Transmitters 5



$M_A=M_B=2$, $N_A= N_B =2$



Type1 = doing nothing, Type2 = watching live video,
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6 PART

Conclusion

- ***MagneComm***
  - Explore the possibility of a novel near-field communication using Magnetic Induction signals.
  - Use CPU and magnetometer as sender and receiver
    - No additional hardware is required.
  - Compensate existing NFC technologies with additional bandwidth

THANKS

Any question, please contact me!

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