

# IEEE CQR Technical Papers Session 2 (May 12, 2015)

# PCI Reduction Method Suitable for Type-II HARQ with SR-ARQ

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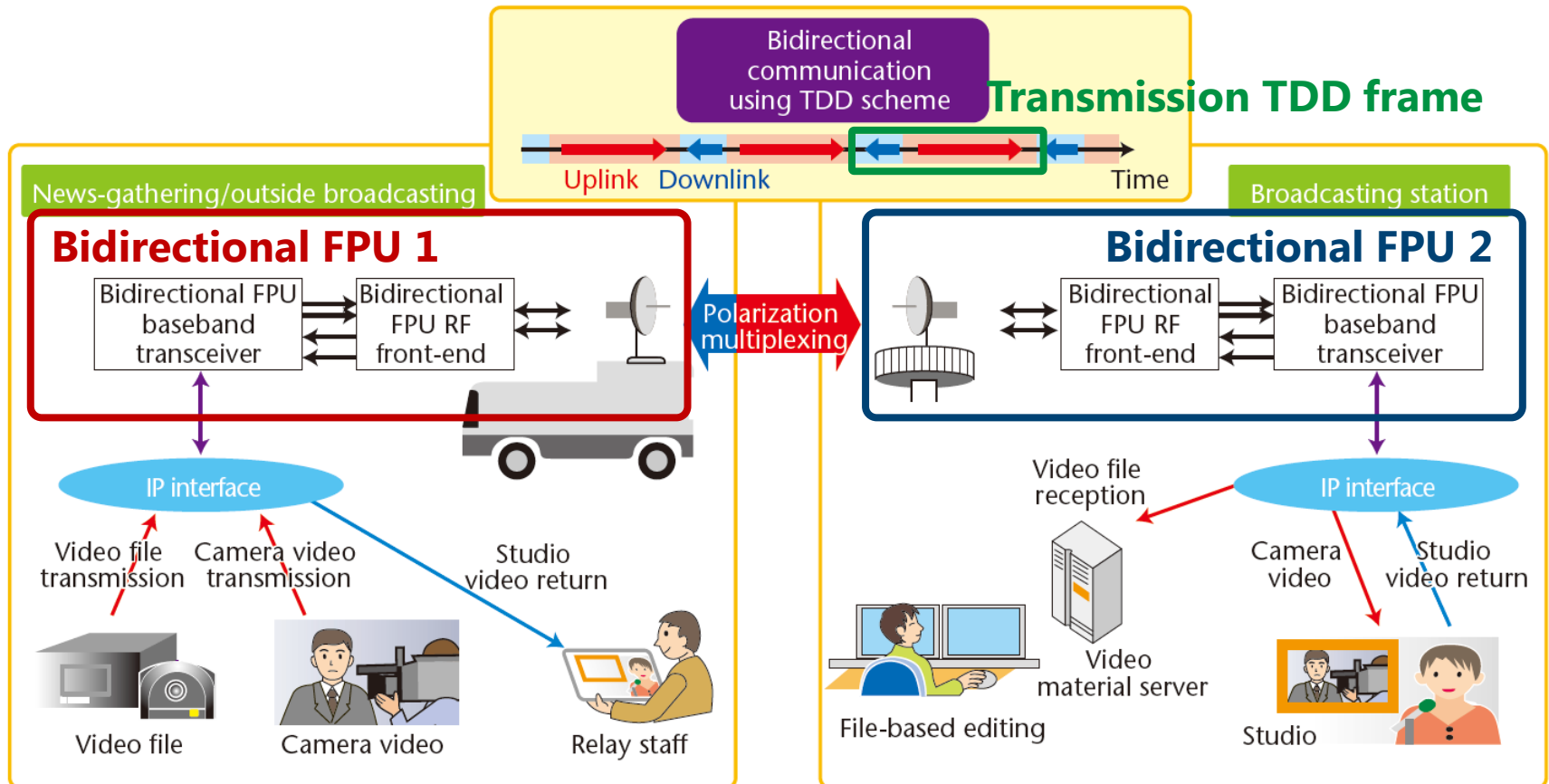
- > **About bidirectional FPU (field pick-up unit)**
  - > Packet communication with PCI (packet control information)
- > **ARQ protocols in bidirectional FPU**
  - > PCI reduction method for SR-ARQ
  - > Implementation of type-II HARQ (hybrid ARQ)
- > **Compressed PCI for SR and type-II HARQ**
  - > TDD frame format of bidirectional FPU
  - > Amount of PCI for bidirectional FPU
  - > Bidirectional FPU's data throughput
- > **Our prototype of bidirectional FPU**
- > **Conclusions**

**Calculations**  
**Computer simulations**

# About Bidirectional FPU\* (Field Pick-up Unit)

Current FPU system is **unidirectional**.

➡ Unable to transmit IP packets bidirectionally

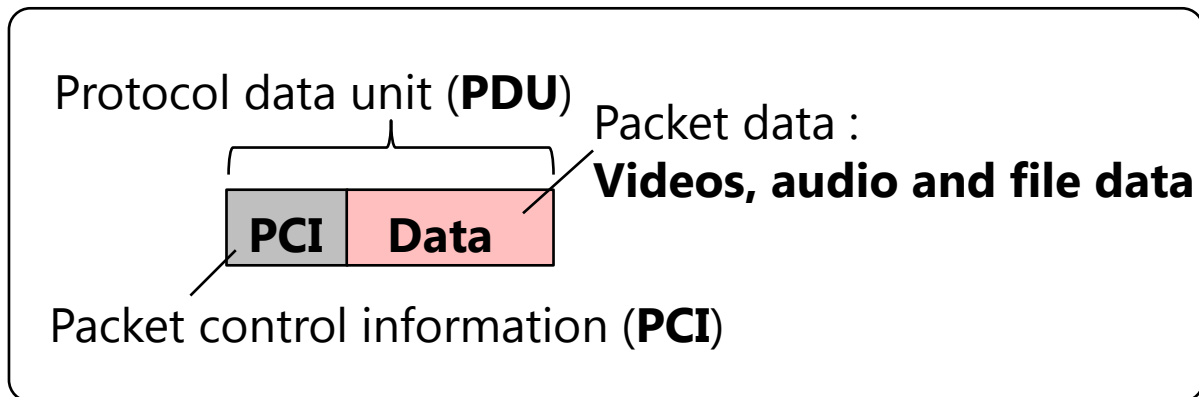


- > Using TDD (time division duplex)
- > Dual-polarized 2×2MIMO & 256-QAM
- > IP interface for file-based videos simultaneous transmission

\* FPU is one type of microwave links (for broadcasters)

# Packet Communication with PCI

## Packetized data



Contemporary wireless  
packet communications :  
**Using ARQ schemes**



PCI : Important and necessary,  
but causing **overheads** and  
file **throughput degradation**

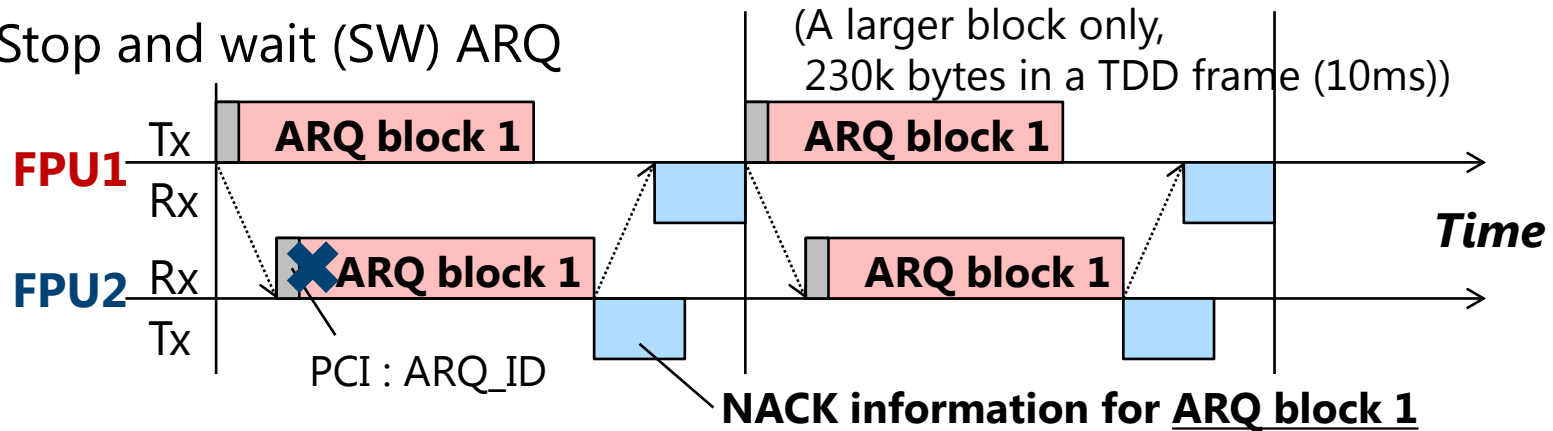
- Aims**
- > **To improve throughput in packet transmission**
  - > To reduce transmission data overhead depending on PCI



These are closely related to **ARQ schemes** which we use.

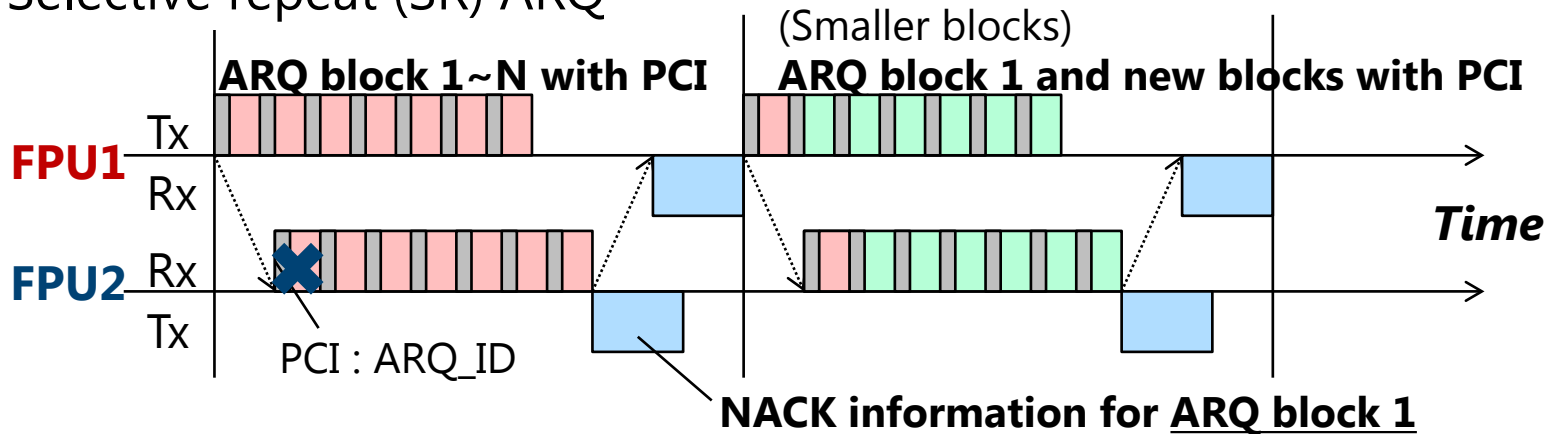
# ARQ Protocols in Bidirectional FPU

A : Stop and wait (SW) ARQ



Retransmission data overhead (containing unnecessary data) : **large**

B : Selective repeat (SR) ARQ



Retransmission data overhead : **small** → Required PCI size : **large**

**PCI reduction techniques are important in order to improve throughput.**

# PCI Reduction Method for SR-ARQ

- > PCIs for the  $n$  th transmission ARQ blocks shall be the same set of IDs belonging to the ARQ blocks which failed in the  $(n-1)$  th transmission in previous TDD frames.
- > If the ACK/NACK signals are **correctly transmitted and received**, the transmitter and the receiver **can generate PCIs without any data**.

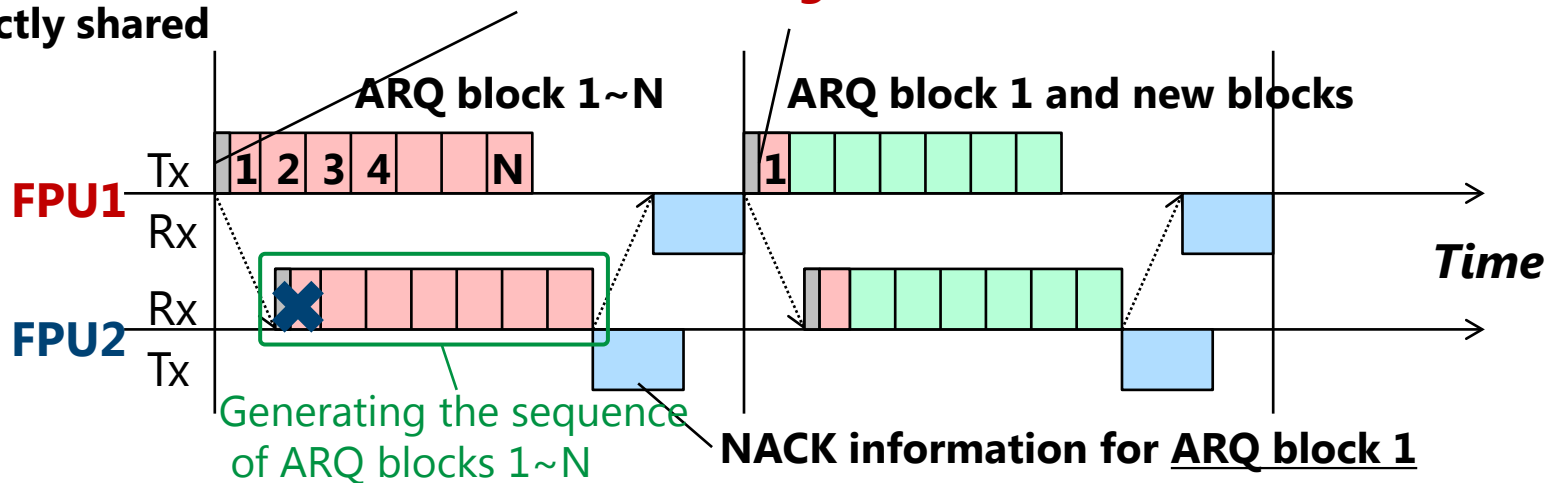


**An acknowledgement of ACK/NACK information is required.**

(Proposed method)

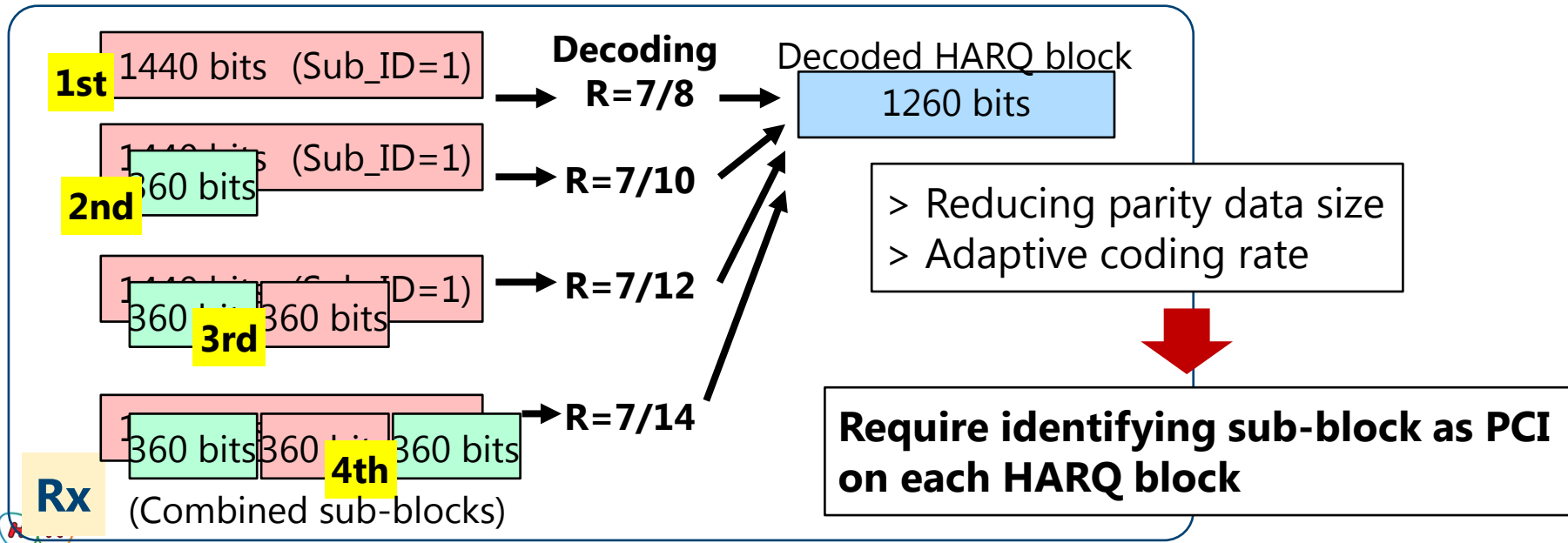
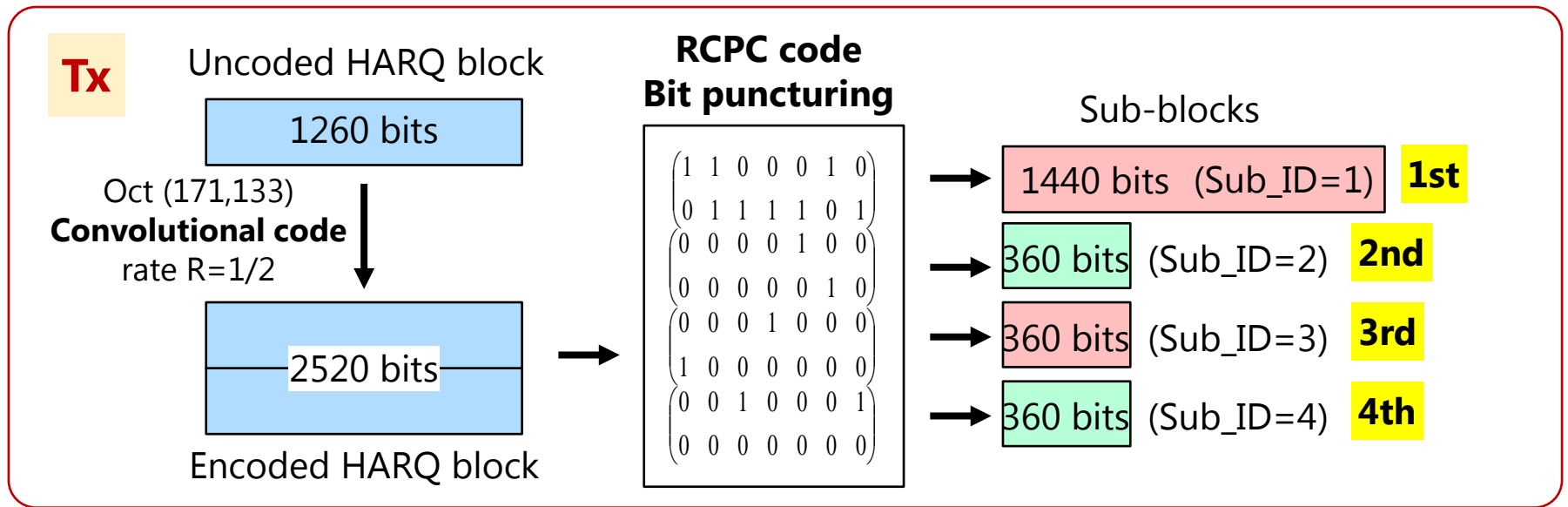
Should be  
correctly shared

**PCI : Number of ARQ blocks = "N" and  
Acknowledgement of ACK/NACK information**



# Implementation of Type-II HARQ (Hybrid ARQ)

e.g.) 1 HARQ block is divided into 4 sub-blocks for implementation.

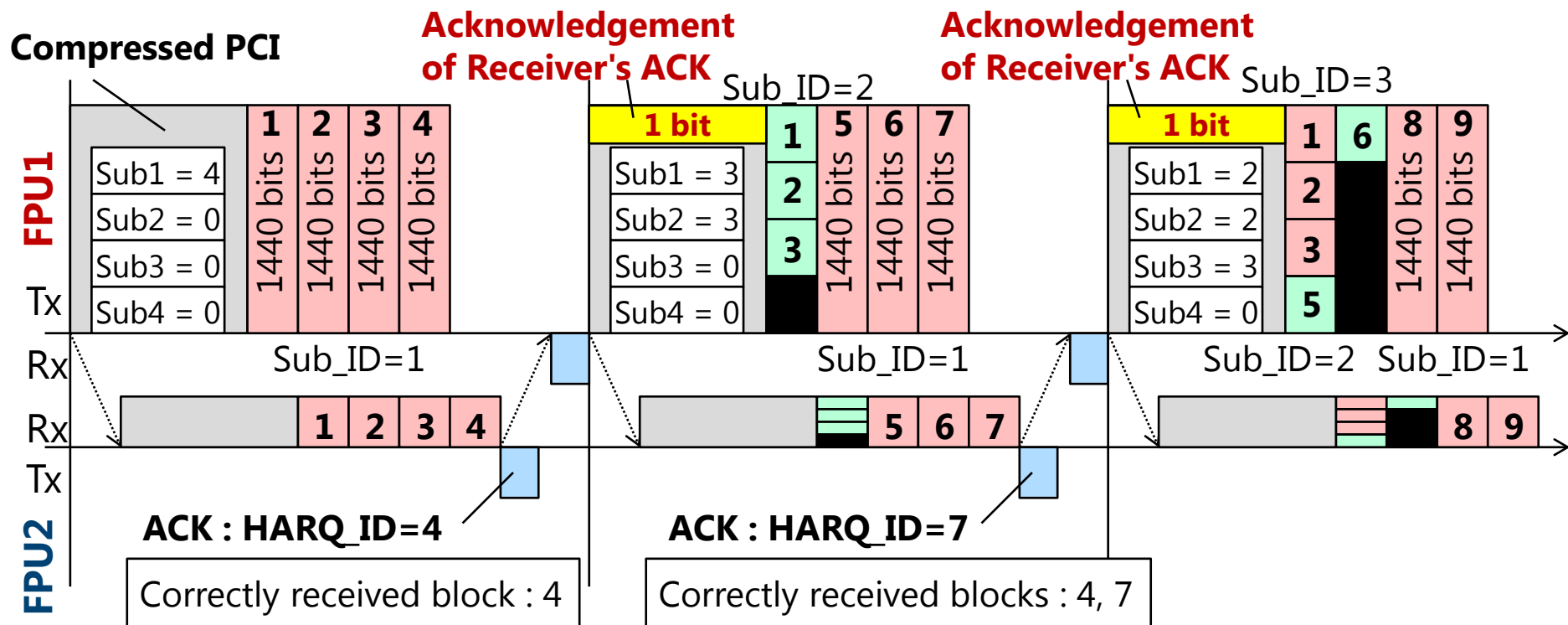


# Compressed PCI for SR and Type-II HARQ

Proposed method extended for type-II HARQ

Sub-blocks of a HARQ block which was transmitted less successfully will have a higher SUB\_ID and also reflect the number of attempted transmissions.

➔ The sequence is determined.

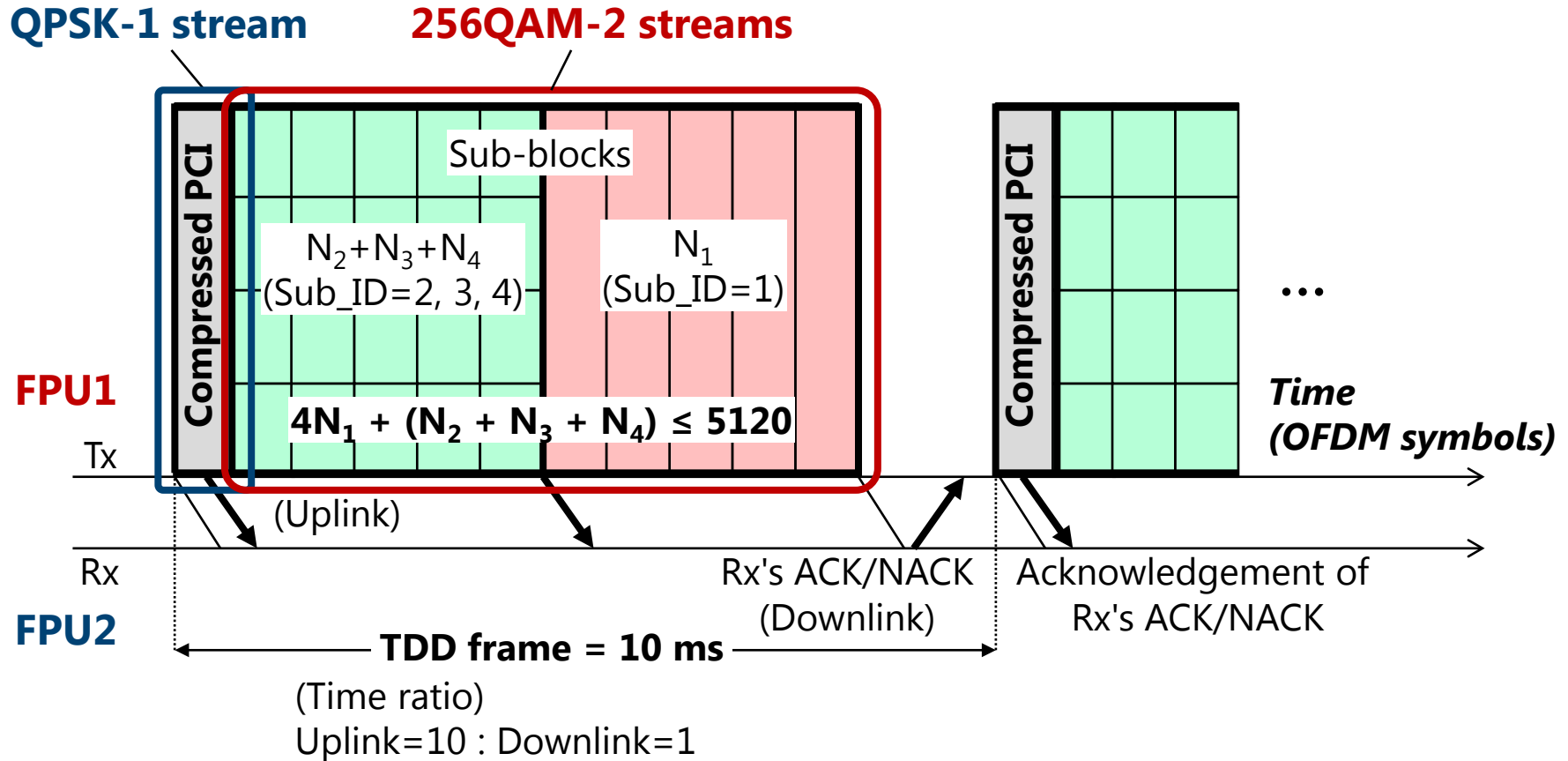


Compressed PCI is that it shows the number of HARQ sub-blocks by SUB\_ID.



# TDD Frame Format of Bidirectional FPU

Compressed PCI and HARQ blocks in bidirectional FPU's TDD frames

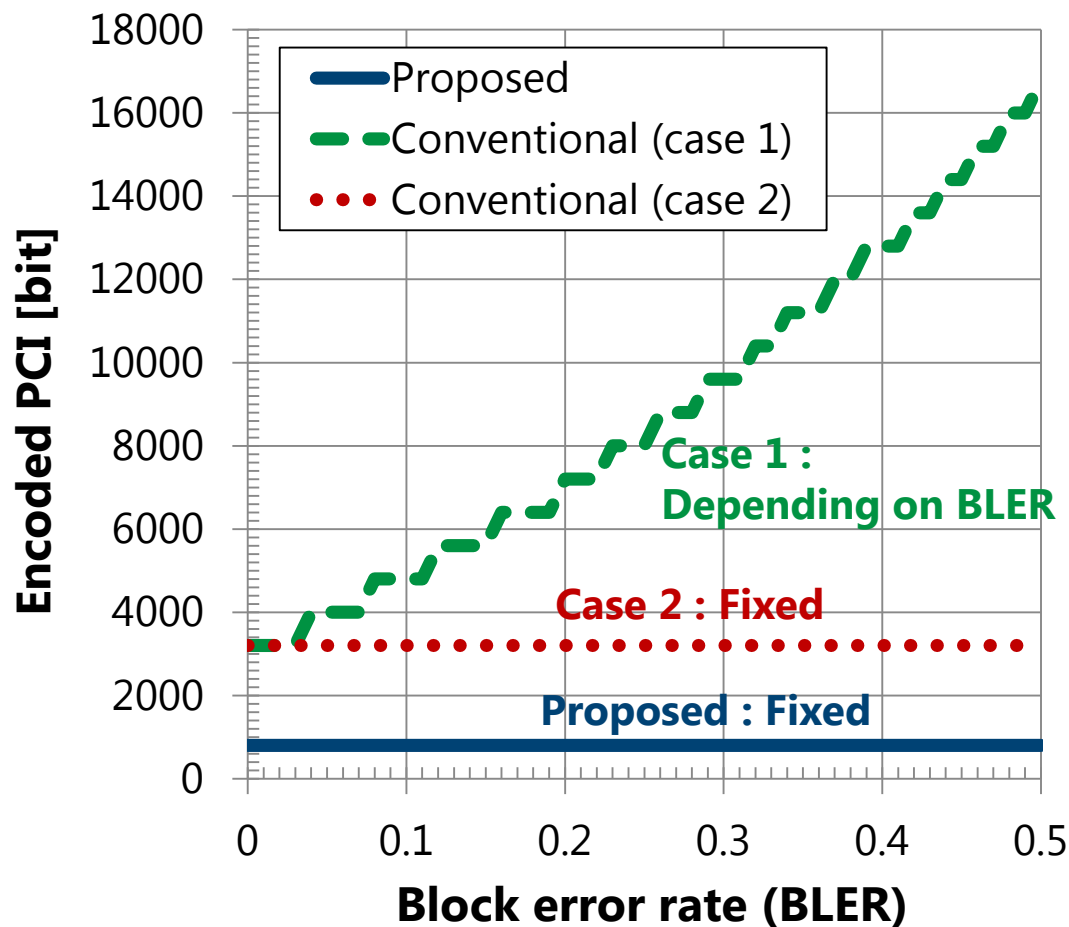


Size of "Compressed PCI" is **fixed** value and **48 + 1 bits** only.

➡ Encoded PCI in an RS(180,100) block (in 1 OFDM symbol [56.33μs])

# Amount of PCI for Bidirectional FPU

Comparing the amount of PCI  
using proposed method and using conventional (IEEE 802.16e) method



## Case 1

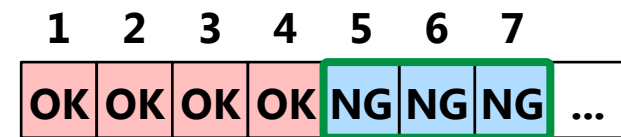
Retransmission HARQ block IDs :  
not adjacent



(PCI : shortened a little)

## Case 2

Retransmission HARQ block IDs :  
always adjacent



(PCI : shortened more)

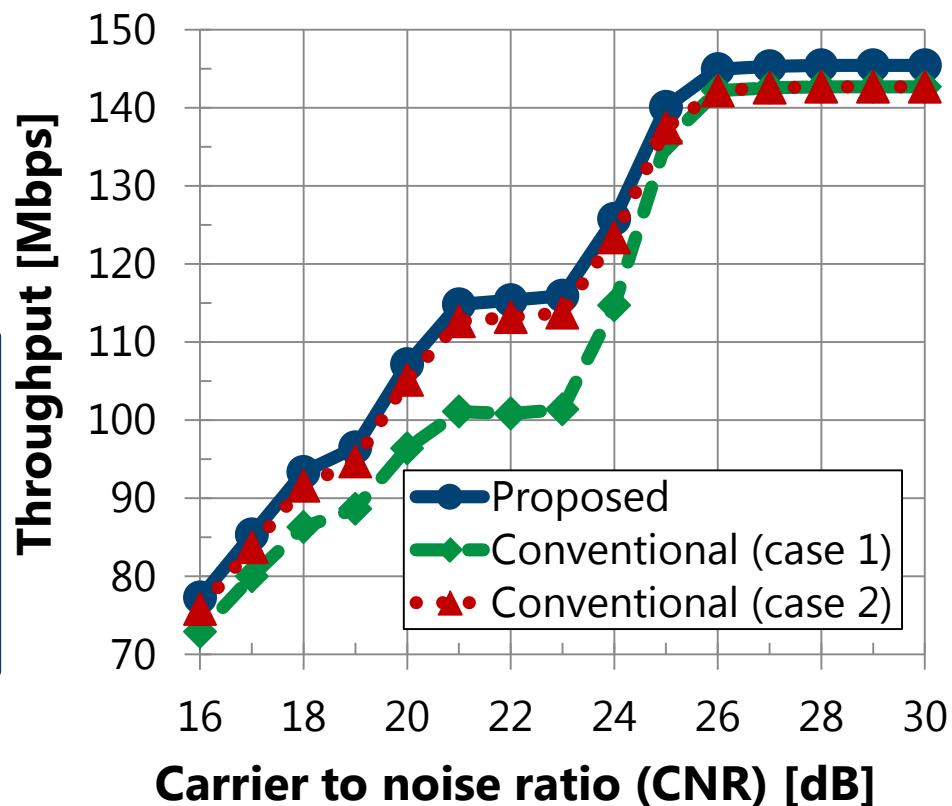
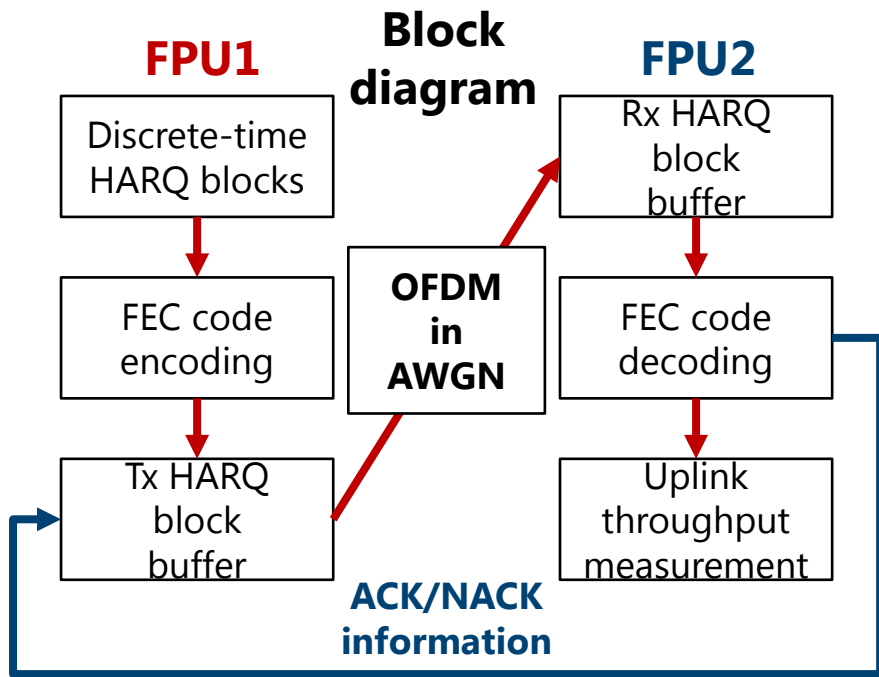
**Proposed method**



PCI size is **fixed** and **small**.

# Bidirectional FPU's Data Throughput

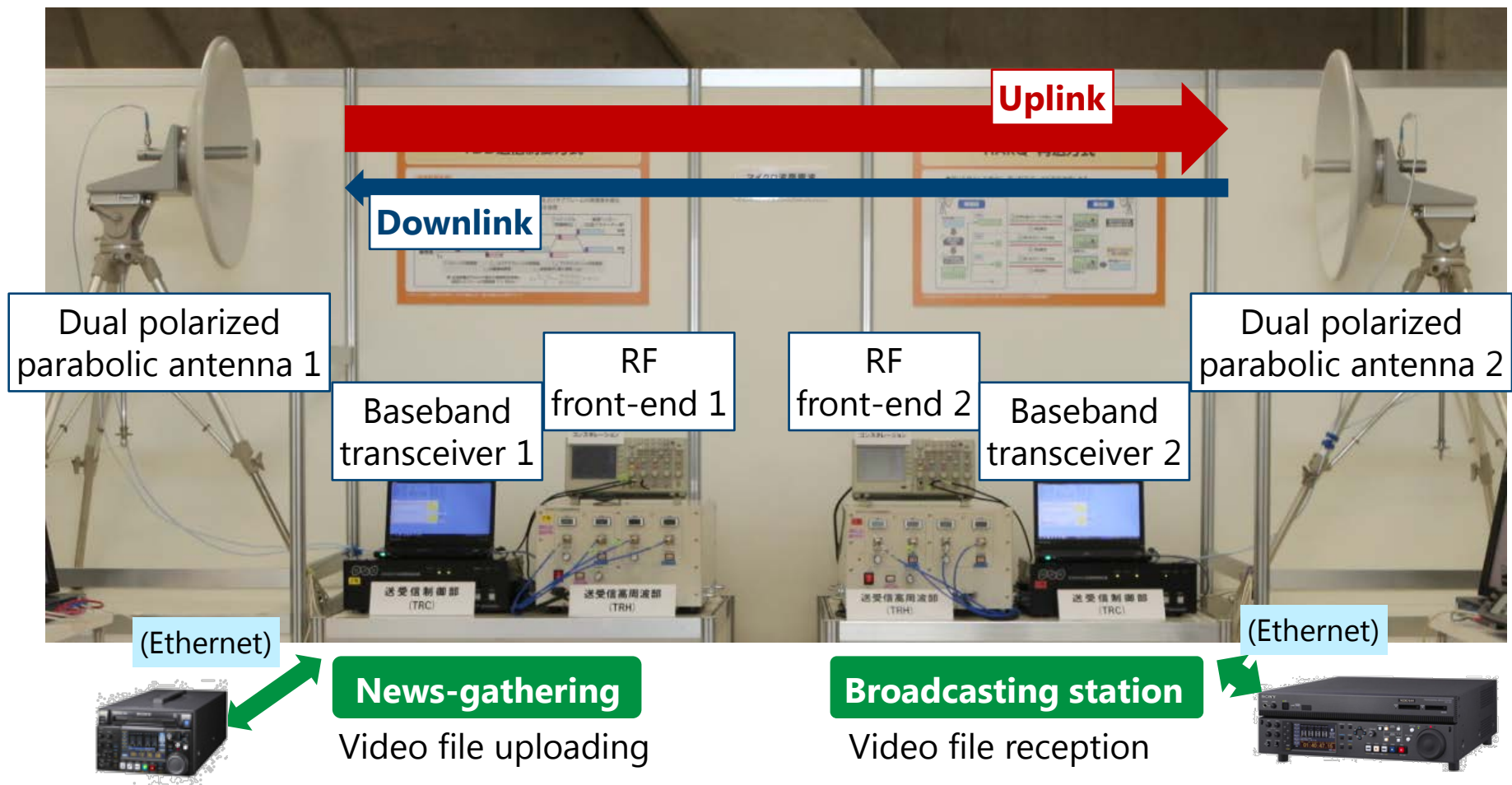
Comparing the data throughput through a computer simulation using proposed method and using conventional (IEEE 802.16e) method



**In either case (case 1 or 2), data throughput with proposed method is always higher than with conventional method.**

# Prototype of Bidirectional FPU

We implemented the proposed method in our prototype.



# Conclusions

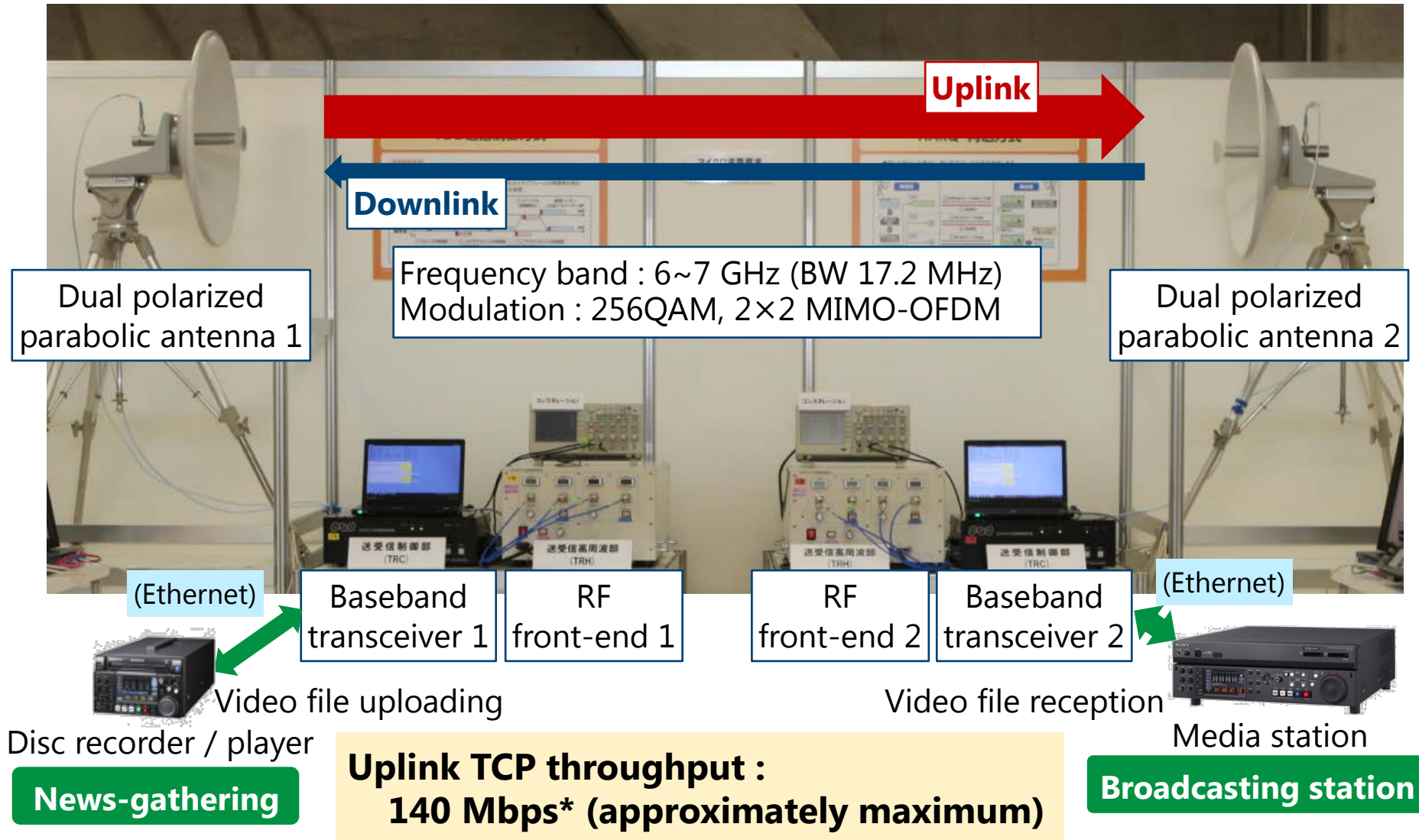
- > We have described our proposed method which aims to reduce the overheads caused by packet control information (PCI) suitable for type-II HARQ with SR-ARQ.**
- > The point of our method is to transmit the "compressed PCI" containing only the number of HARQ blocks with each sub-block (punctured parity bits) ID field.**
- > According to computer simulations for our bidirectional FPU (wireless link), our proposed method improved data throughput in simulated-error-occurrence environments.**

**Thank you for listening!**



# (Appended) Our Prototype of Bidirectional FPU

We implemented this proposed method.



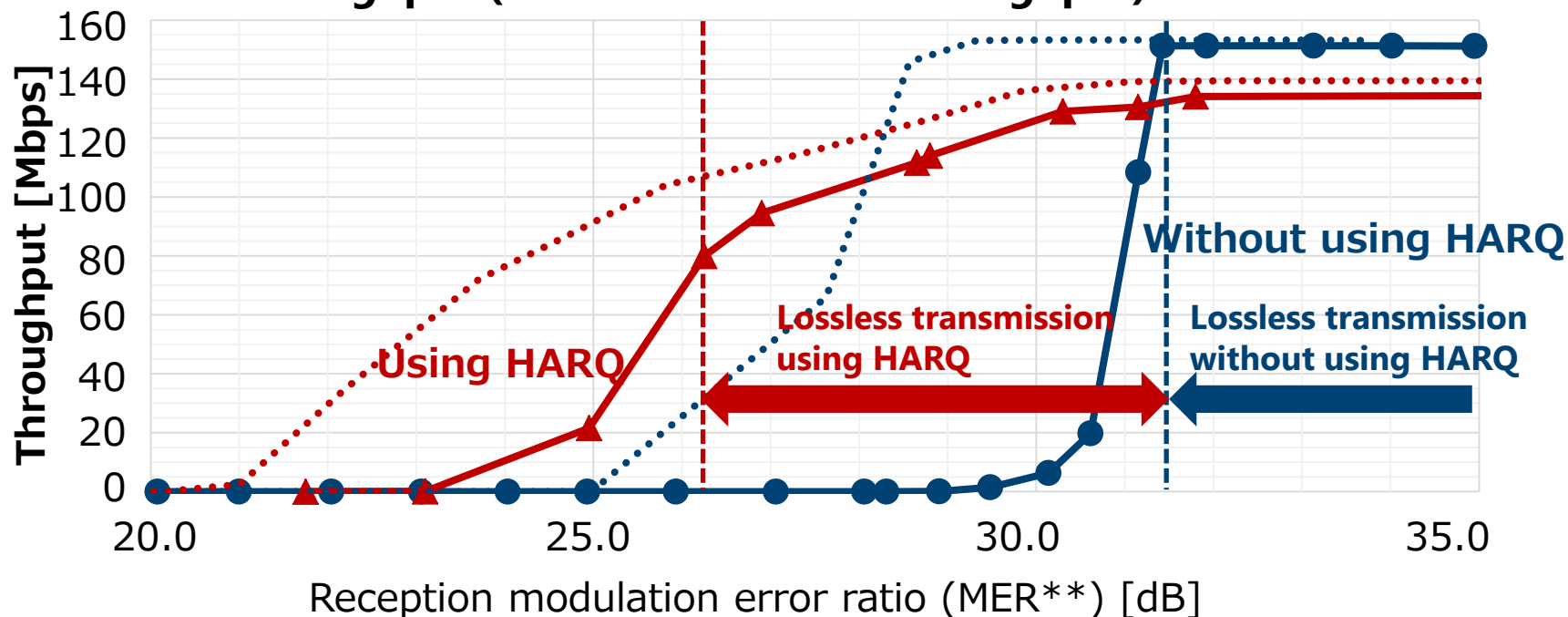
\*Using type-II HARQ with RCPC code  $r=8/9$

# (Appended) TCP Throughput of Our Prototype

Measurement of TCP throughput with CUBIC\*

Comparing "using HARQ" with "without using HARQ"

TCP throughput (Dotted line : Block throughput)



**HARQ retransmission prevents occurring packet losses and keeps high throughput under high error environments.**

\*CUBIC-TCP : An implementation of TCP congestion control algorithm used in Linux etc.

\*\*MER : Quantify the performance of communications system using digital modulation (equal to SINR (Signal-to-interference-plus-noise ratio))