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**TVX-in-Industry**  
**An MMT Layer-Aware FF-LDGM Code**  
**and Its Implementation**

**Takayuki Nakachi, Yasuhiro Mochida and Takahiro Yamaguchi**

NTT Network Innovation Laboratories,  
Nippon Telegraph and Telephone Corporation, JAPAN

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*The Adjunct Proceedings of ACM TVX2018, Seoul, Republic of Korea, June 2018. Copyright is held by the author/owner(s)*

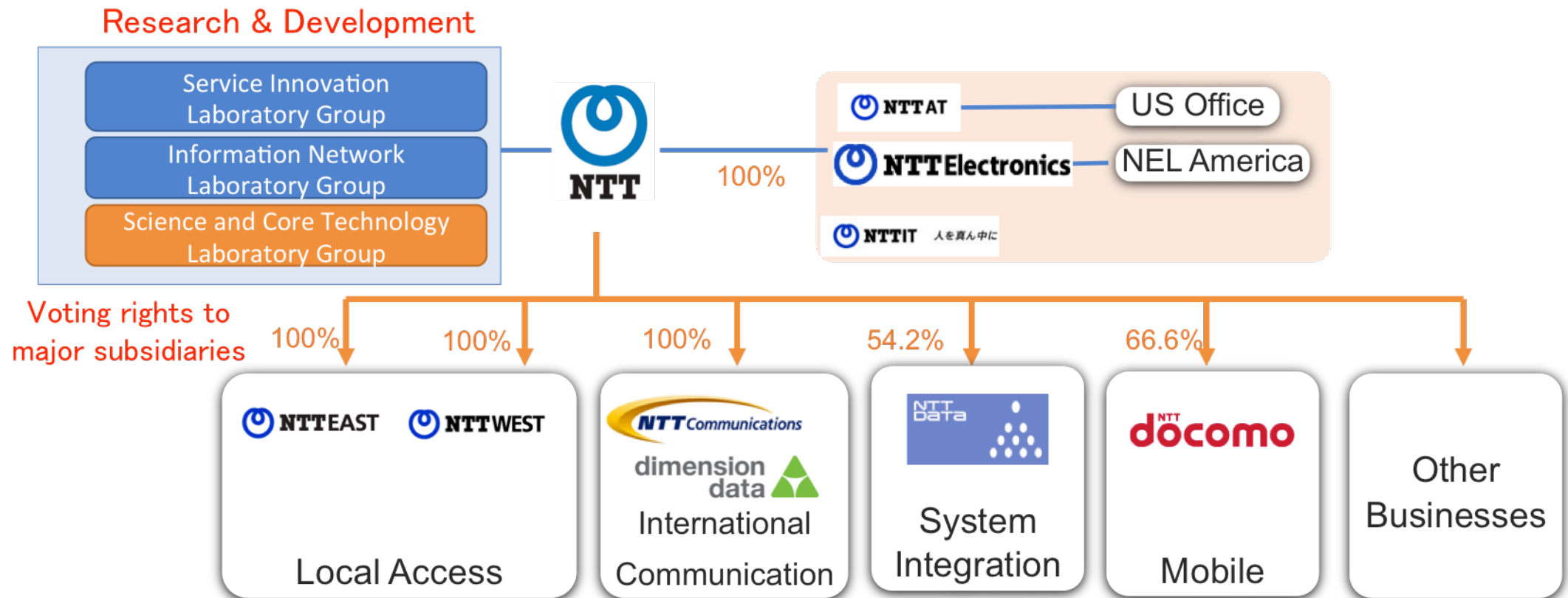


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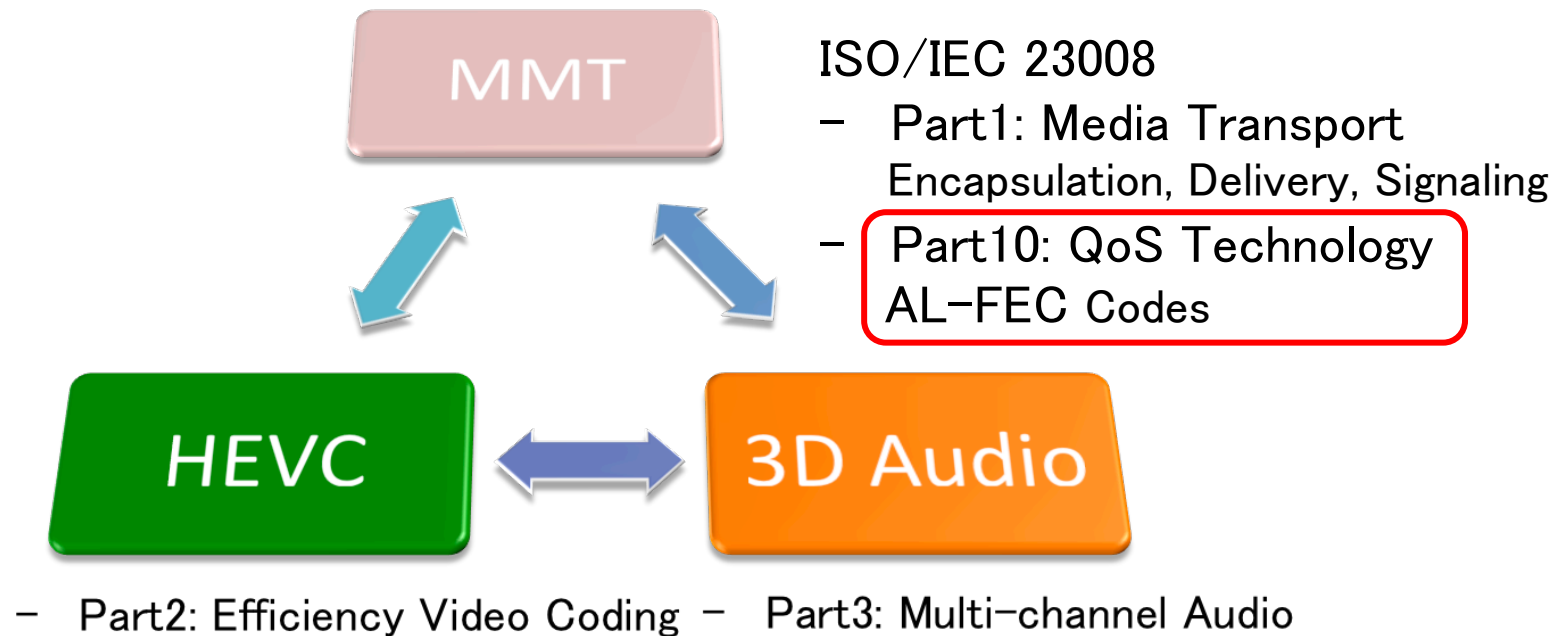
# NTT Corporation

- NTT (Nippon Telegraph and Telephone Corporation) is a Japanese telecommunications holding company.
- Main businesses are formulation of management strategies and Research & Development.



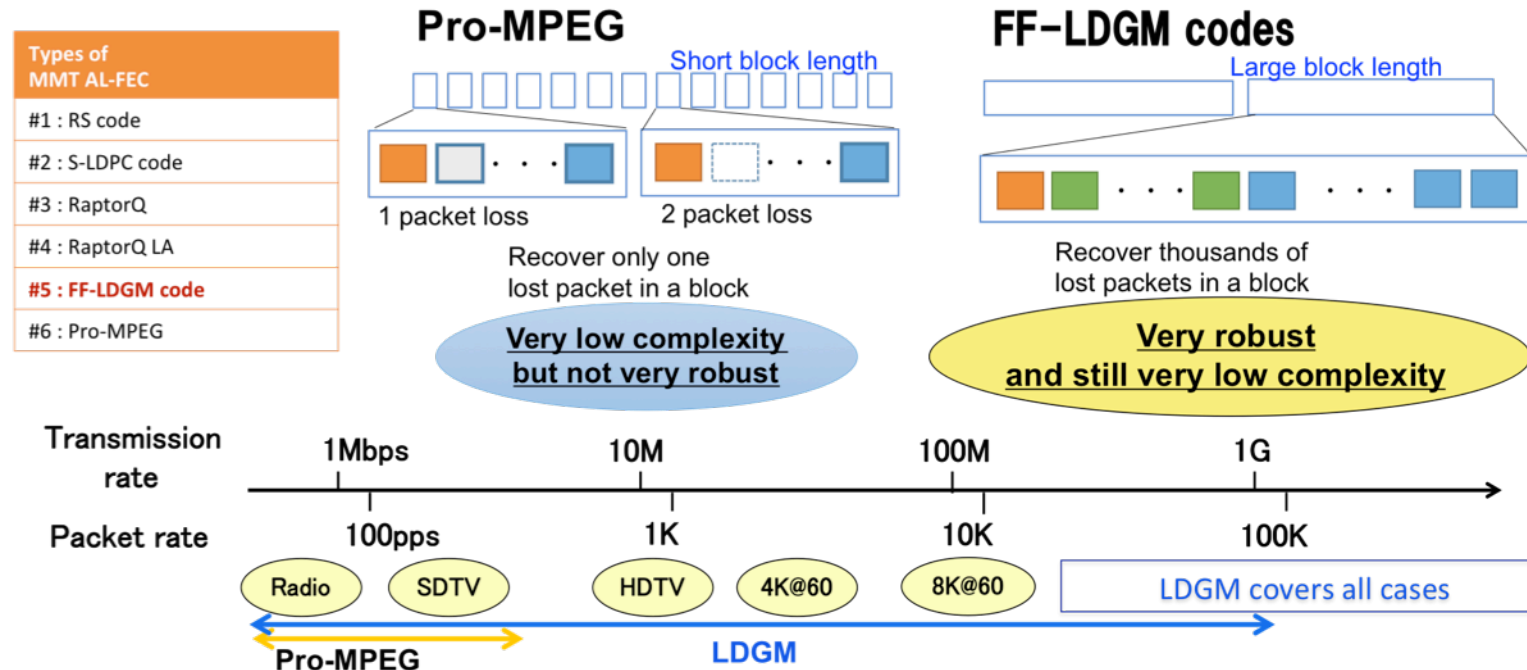
# MMT: MPEG Media Transport

- MMT is an ISO/IEC International Standard which replaces the current MPEG2-TS.
  - Media Transport technologies for the delivery of media data over concatenated IP networks.
  - QoS Technologies: AL-FEC (Application Layer Forward Error Correction) codes.
- This paper focus on the AL-FEC codes.



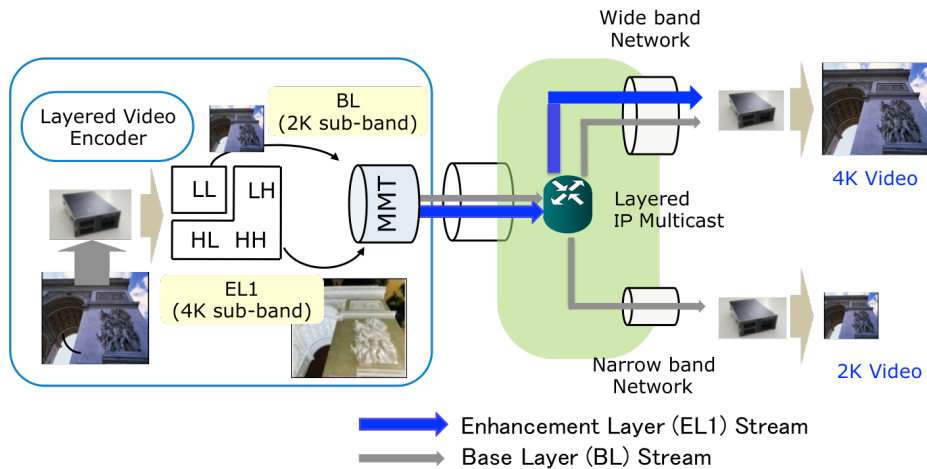
# MMT AL-FEC Codes

- AL-FEC is a QoS (Quality of Services) technology used for recovering errors in data transmission over packet based IP networks.
- MMT defines six AL-FEC codes. The Fire-Fort LDGM (FF-LDGM) code is a special case of sparse codes. It can easily handle from small number of packets to over thousands of packets. It is especially useful for 4K/8K real-time video transmission.

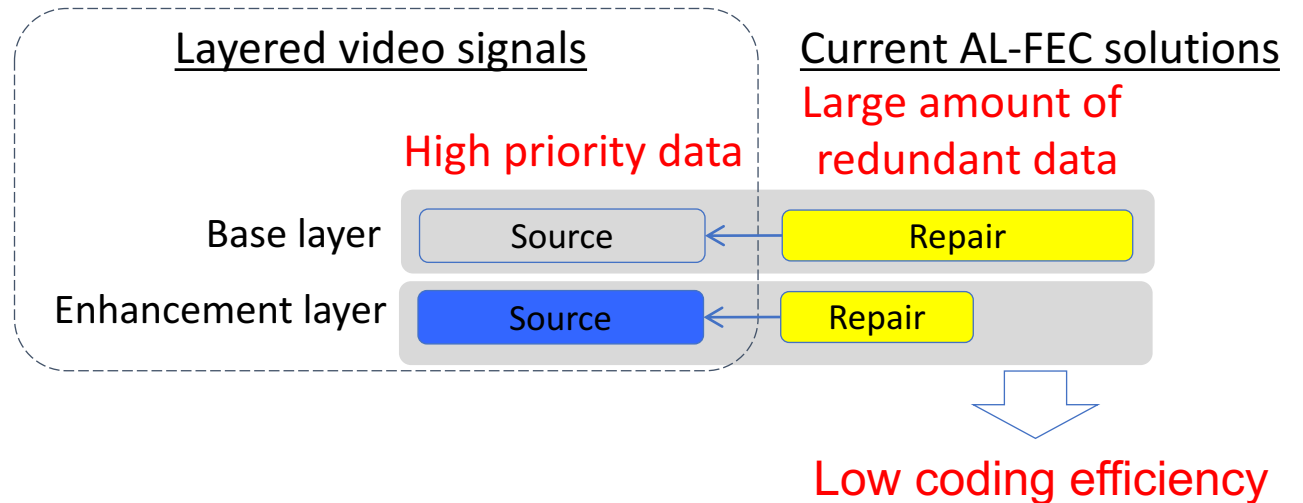


# The Problem & Current Solutions

- Layered video coding such as Scalable HEVC (SHVC) open up new opportunities for various consumer services such as mobile video distribution.
- The layered video coding can represent layered (temporal/resolution/SNR) media formats.
- Priority of the base layer is higher than that of the enhancement layer.
- Today's AL-FEC solutions are optimized to transmit single layer video. In order to protect the base layer strongly, large amount of AL-FEC redundant data are needed.

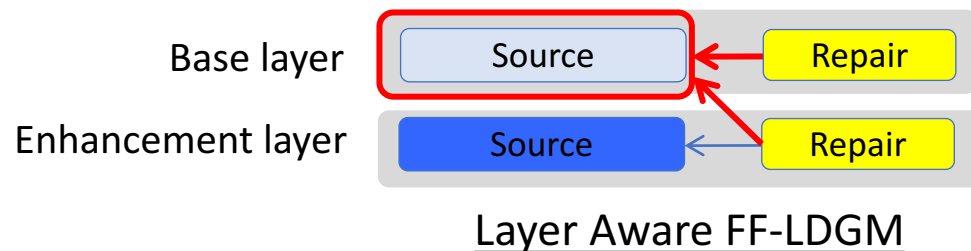


Layered video coding



# The Challenge

- A Layer Aware FF-LDGM code supports the layered image/video transmission.
- It protects the important video stream (base layer) without increasing additional redundant data (additional repair packets).
- It is designed that the base layer is protected by repair packets of both the base and enhancement layers.
- We apply it to **temporally scalable 60P/120P SHVC data which is specified in the ARIB<sup>(\*1)</sup> standard.**



- The base layer is protected by repair packets of both the layers.
- The Layer Aware scheme increases coding efficiency.

(\*1) ARIB: Association of Radio Industries and Businesses (ARIB) which is a standardization body for radio-communication systems in Japan.

# Implementation and Evaluation

- We implemented the Layer Aware FF-LDGM code in software (C++), that meets the MMT standard.
- We applied it to **scalable 60P/120P SHVC data which is specified in the ARIB standard.**
- **The Layer-Aware FF-LDGM code recovers lost packets of the base layer efficiently.**

## Simulation Conditions

### (a) Video coding

Video Codec	SHVC
The number of layers	2
Scalability	Temporal (60P/120P)

### (b) FF-LDGM code

	Base Layer	Enhancement Layer
The number of source symbols	1024	512
The number of repair symbols	128	64
Redundancy	10%	10%

## Results: Packet Loss Ratio

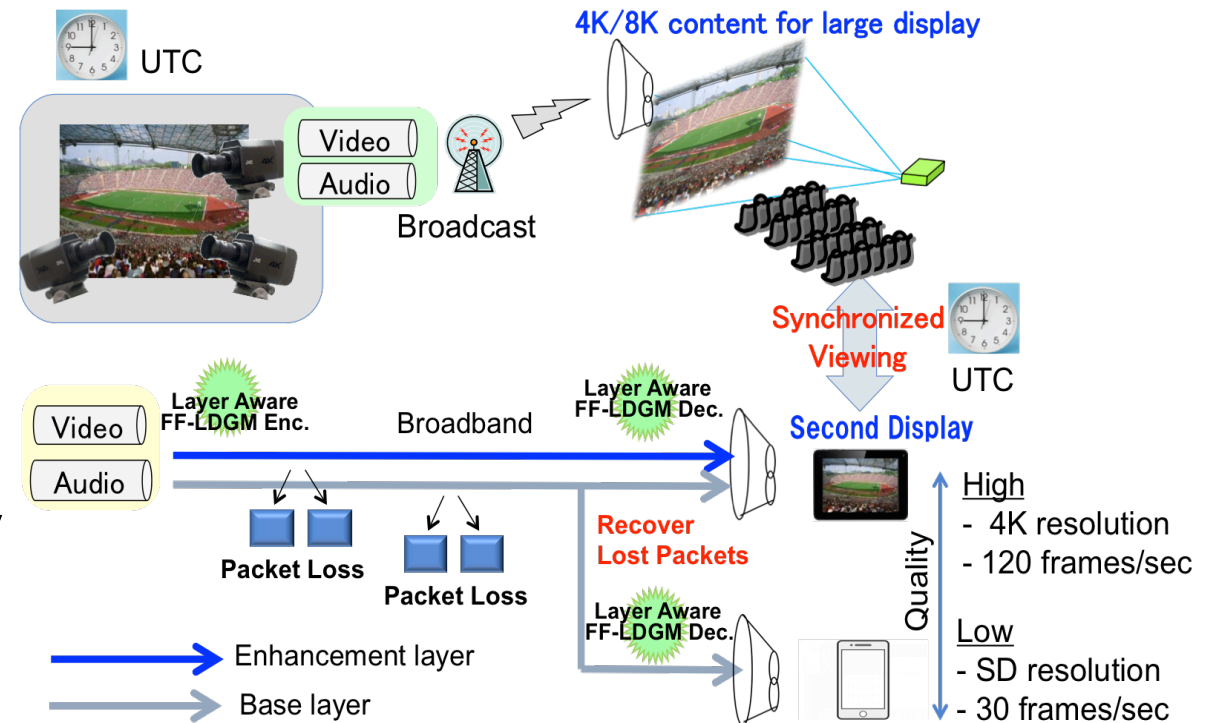
Before applying Layer Aware FF-LDGM		After applying Layer Aware FF-LDGM	
Base Layer	Enhancement Layer	Base Layer	Enhancement Layer
0	0	0	0
0.010207	0.010129	0	0
0.029909	0.029853	0	6.66E-05
0.048938	0.050676	0	6.66E-05
0.068947	0.067169	0	0.000333
0.08979	0.090424	0.000919	0.02169
0.109627	0.110782	0.044797	0.081395



# Product / Service

- A typical application of MMT is a next generation 4K/8K broadband/broadcast service.
- While the 4K/8K content is transmitted via broadcast, specific contents (multi-angle videos or an enlarged portion of a whole video) for each user are transmitted via broadband.
- ARIB has specified the usage of the MMT standard for a next-generation 4K/8K satellite broadcast service that will launch in 2018.
- ATSC3.0<sup>(\*2)</sup> has also adopted the MMT as one of the broadcast transport.
- The Layer-Aware FF-LDGM code efficiently recover lost packets of layered signals.

(\*2) ATSC: Advanced Television Systems Committee.



# Conclusions & What's next

- We introduced the MMT standard mainly focus on our proposed Layer-Aware FF-LDGM code as its application to the next-generation 4K/8K broadband/broadcast service.
- The Layer-Aware FF-LDGM code can protect high priority layer efficiently without increasing additional redundant data.
- We implemented the Layer-Aware FF-LDGM code that meets the MMT standard. Then we confirmed its high coding performance for temporally scalable 60P/120P SHVC data which is specified in the ARIB standard.
- Currently, ARIB does not standard the broadband specification of the next generation 4K/8K broadband/broadcast service.
- The broadband specification for the 4K/8K broadband/broadcast services is required.
- Advances services can be realized by specifying both the broadband/broadcast protocols.