UHD (8K) Television Coverage of Large Sports Events in Brazil

Reliable International Media Transmission by Using Redundant Transmission and FEC

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Introduction

Unique global joint project:
- Public viewing of 2014 FIFA World Cup Brazil
  - Transmit 8K Super Hi-Vision (SHV) over IP network
    - Only fiber networks (not satellites)
  - Long distance transmission: 23,000km from Rio de Janeiro to Tokyo
    - Connecting southern and northern hemispheres
    - Using various shared networks with different characteristics

Challenge:
Transmitting live video over “Shared networks”
→ How to secure the reliability of video transmission in real time?
Overview of 8K PV System

- Compressed with NHK’s H.264 encoder and multiplexed into 280Mbps MPEG Transport Stream (TS)
- Encrypted by AES and added LDGM-FEC
- Transmitted as 300-Mbps UDP/IP real-time video stream
Reliability of Transmission over the World Wide Network

**Challenge:**
How to secure reliability of multi-domain network against IP packet loss, where the system consists of many heterogeneous elements?

**Approaches:**
We applied the following both two methods
- Forward error correction (FEC) mechanisms at application level
- Redundant transmission
  - If FEC could NOT recover lost packets
Basics of Forward Error Correction

- Calculate redundant (FEC) data from video data to transmit.
- Reconstruct the lost data of video from the received data.
  - For example, the data with 10% loss can be rescued by adding 10% redundant data preliminarily.
  - Ideally, we can do this, but quite difficult in practice.
Software Implementation of FireFort LDGM-FEC

- PC/Linux box for 8K-PV
  - Large block size against long burst loss
    - Up to 150,000 blocks, 20% redundancy
    - Tolerance for loss of >20,000 packet sequence
  - AES128 encryption, MMT packet format
  - Proxy-type implementation
    - Just inserted into IP connection of CODECs.

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**Diagram Details:**

1. **SHV Encoder** connected to **2TS → IP**
2. **MMT Packet Transmission** with **Jitter** and **Packet Loss**
3. **Secure IP Terminator (TX)**
   - AES Encryption
   - LDGM-FEC Encode
   - MMT Packet TX
4. **Shared IP Networks**
5. **Secure IP Terminator (RX)**
   - MMT Packet RX
   - LDGM-FEC Decode
   - AES Dec
6. **IP → 2TS**
7. **SHV Decoder**

**Key Technologies:**

- **Real-time AES Encryption/Decryption**
- **Robust LDGM-FEC**
Redundant Transmission

- Transmit two 8K-video streams with FEC to recover from unexpected **long-term burst loss** caused by:
  - **Long-time disruption** by unscheduled maintenance
  - **Malfunction**, and **power outage** of network links and nodes
  - **Fiber cutoff**
Three transmission systems use the multi-path/single-path NW connections

- **FEC System A (Route #3 + #5):** Full-duplication of Networks & Nodes
- **FEC System B (Route #2 + #4):** Full-dup. of NWs, but common in Miami-node
- **FEC System C (Route #3 only):** Backup.
Summary

- Succeeded in 8K PV of 2014 World Cup Brazil
  - Keys to success:
    - Collaboration of R&E network organizations
    - High reliable IP transmission technology for shared networks
  - High reliable IP transmission technology based on:
    - High-efficiency LDGM-FEC
    - Redundant transmission with FEC
  - Configuration for redundant transmission
    - Designing multi-path network connections
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