Ultra-Low Delay Video: Towards Tactile Internet

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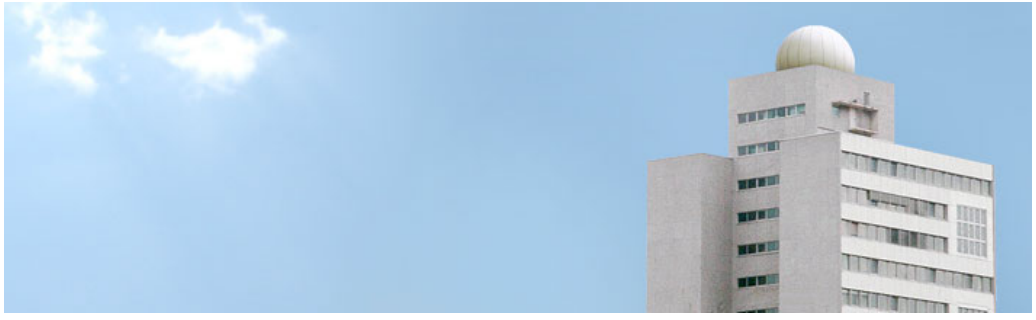


Overview

1. **Introduction**
2. **Standardization Efforts**
3. **Video Delivery Latency**
4. **Current Techniques**
5. **Future Work**

Introduction

Tactile Internet

- …extremely low latency => 1 ms End-to-End.
- …humans will wirelessly control real and virtual objects.

Emerging applications…

- … industry automation and transport systems, healthcare, education and gaming.

Examples…

- … Shared Haptic Virtual Environments: tasks that require fine-motor skills (tele-surgery, micro-assembly).
- … Connected vehicles: collision-avoidance by cooperative-driving manoeuvres.

[1] ITU-T Technology Watch Report (August 2014) - The Tactile Internet

Standardization Efforts

3GPP SA1…

- …Study Item SMARTER: New Services and Markets Technology Enablers (5G):
  - 20 Use Cases (20% done, [2])
  - Ultra-Low Delay use cases include:
    - Interactive services for high speed zones in office environments
    - Industrial control
    - Tactile Internet
    - Remote control (connectivity for drones)

[2] Draft Minutes of 3GPP TSG SA WG1 Meeting #70 (SMARTER)

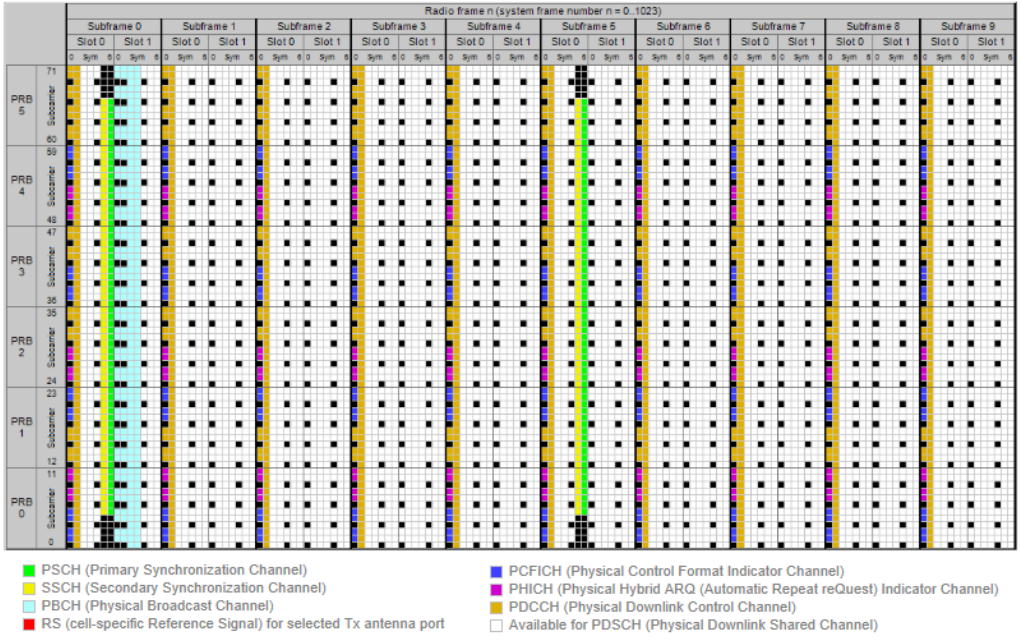
[3] NGMN White Paper on 5G

[4] 4G Americas' Recommendations on 5G Requirements and Solutions

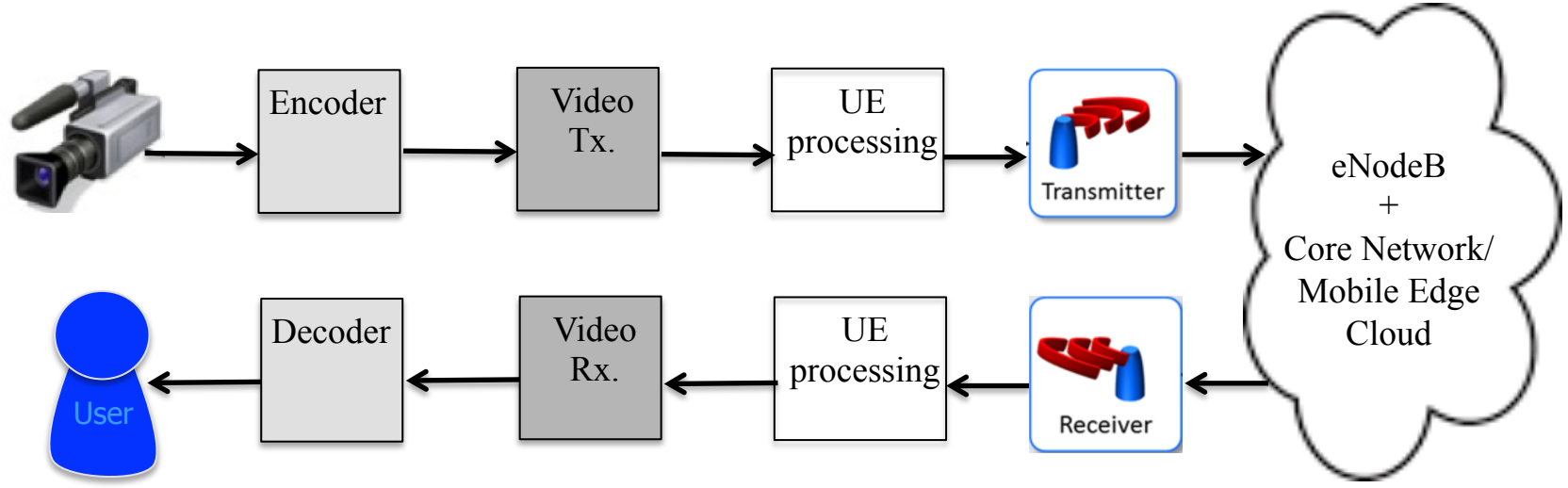
Standardization Efforts (Cont.)

3GPP RAN2…

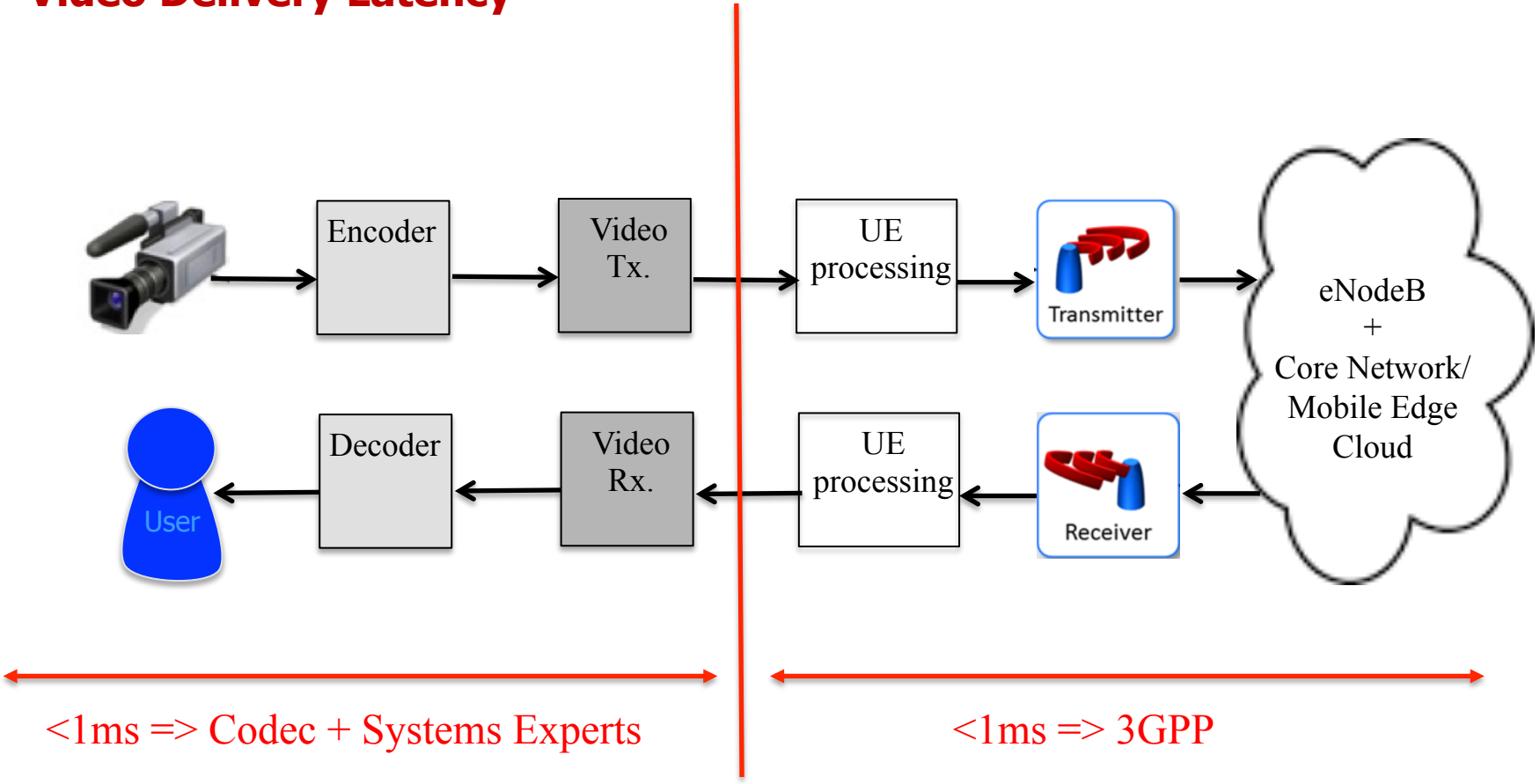
- …Study Item LTE_LATRED: Latency reduction techniques for LTE (Rel-13) [5]:
  - Level of completion (0% according to SR, finishes June 2016)
  - TTI shortening
  - Fast uplink access solutions
  - Reducing processing time
  - Improves TCP performance



Video Delivery Latency

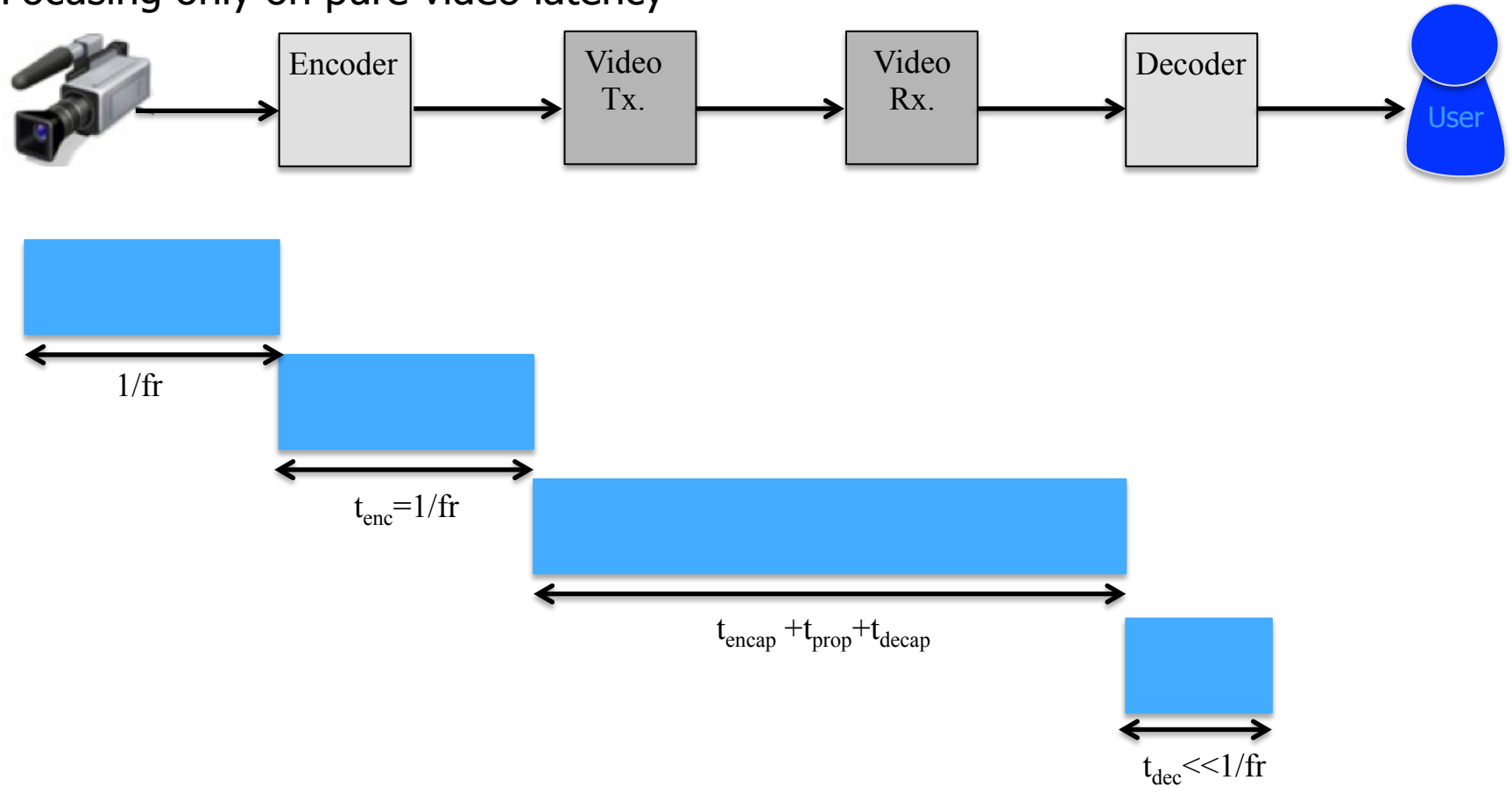


Video Delivery Latency



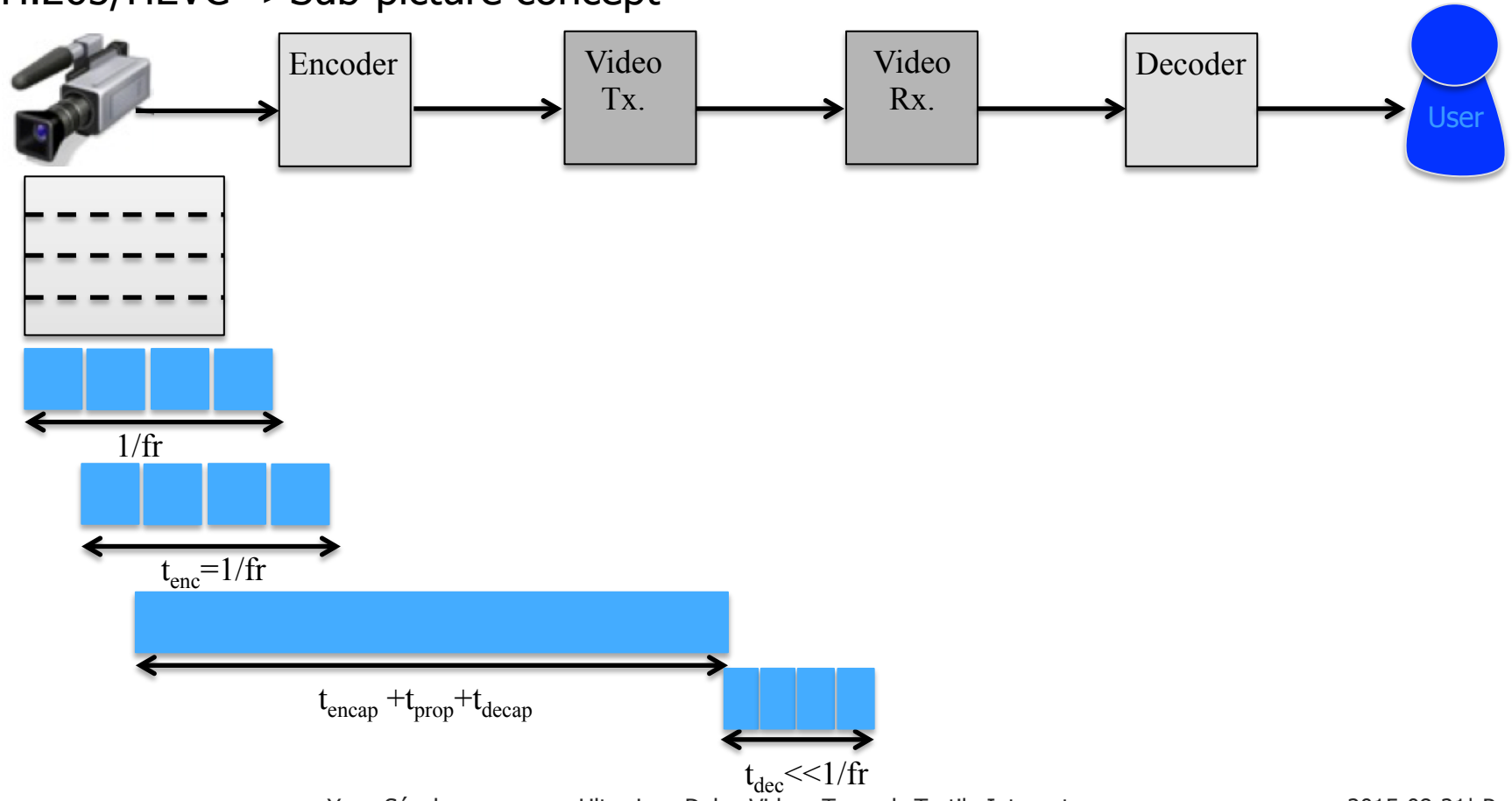
Video Delivery Latency (Cont.)

Focusing only on pure video latency



Current Techniques

H.265/HEVC=>Sub-picture concept



Current Techniques (Cont.)

H.265/HEVC=>Sub-picture concept

- dependent Slices: higher compression efficiency than regular (independent) slices
  - Reduced slice header
  - Entropy encoding across slices
- sub-picture timing: decoding not at picture level but finer granularity (slices)
  - AVC did not have sub-picture timing
  - HEVC allows for Ultra-Low Delay

Current Techniques (Cont.)

t_{encap} and t_{decap}

- RTP considered. Each slice in a different RTP packet as soon as available
- HEVC RTP Payload Format
  - Waiting for WriteUp Status. Very soon published as RFC

Future Work

- **Similar approaches for sub-picture processing in future video codecs**

  Can we do it even more efficient?

- **System Perspective**
  - High reliability
  - We need more interaction between physical layer and application layer
    - QoS guarantee