VTBO

(Video Traffic Bandwidth Optimization)

kt, global ICT convergence leader

James Won-Ki Hong, PhD

Senior Executive Vice President

Chief Technology Officer

Advanced Institute of Technology | 2013. 09

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Contents

■ Growth of video traffic leads to data explosion and wireless network resource depletion
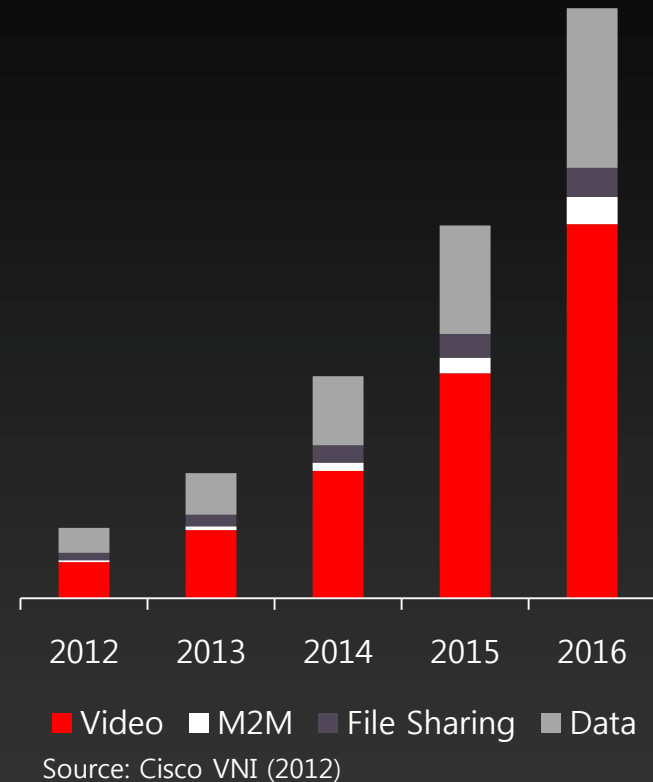
Smart Devices Generate Explosive Video Traffic
- 70% of Mobile Data Traffic to be Video (2016; Cisco)
- KT's mobile traffic increased 300X during the last 3 years

Limitations of Network Investment
- Insignificant revenue growth compared to CAPEX growth
- Scarce spectrum resources

Overall QoE[1] Degradation

2012 2013 2014 2015 2016

■ Video ■ M2M ■ File Sharing ■ Data

Source: Cisco VNI (2012)

[1]Quality of Experience

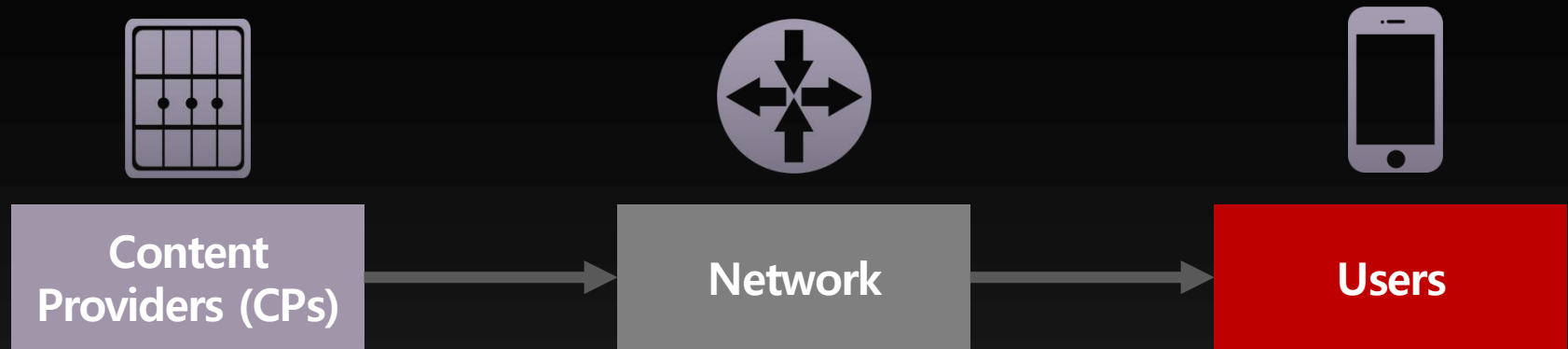# Stakeholders in Video Streaming Face Serious Issues

The Current Situation

- **Rapid diffusion of smart devices and customers' acceptance for video streaming service resulted in data explosion**

- **Customers experience inconvenience such as delays, motion stops, blurred and broken images in video streaming services**

	Concerns	Interim Solution
Content Providers (CPs)	• Low user satisfaction • Fierce Competition	• Adaptive Streaming/CDN • Higher Quality Video Files for Competition
Network	• Significant traffic burden on network	• Cache • Capacity Investment
Users	• Delays in loading • Low level of QoE • Wasted Data	• Better Smart Devices • Switch to another CP

Issues

- QoE vs. Cost

- Impact of large file size on network congestion

- Provision of a single video file for a variety of screen sizes and resolutions

Issues in Video Streaming

Content Providers (CPs)	→	Network	→	Users

- **How to assure QoE**
- **How to save cost of service**

  (Storage/Computing/Bandwidth)

- **How to control network traffic**
- **How to save cost of infrastructure**

  (Capex/Opex)

- **How to maximize quality**
- **How to save data**

■ Need for Video Traffic Optimization Solution

- Differentiate encoding bit rate for different types of device and content
- Control video delivery when network is congested

04 Evolution of Video Streaming Technology

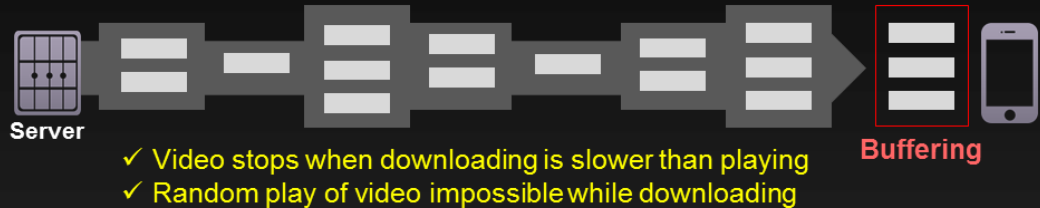**Before 2000**

Traditional Streaming [UDP]
- No guarantee of QoS and in-order delivery
- Flow control not supported

Packet dropped   **Packet dropped**

Server

✓ Lost packets cannot be recovered

Uniform bit rate

2000s

Progressive Download [TCP]
- Can waste bandwidth
- No bit-rate adaptation

Server

✓ Video stops when downloading is slower than playing
✓ Random play of video impossible while downloading

Buffering

2010s

Adaptive Streaming [TCP + Bandwidth adaptation or Real time transcoding]
- High cost of computing and storage resources

Server

✓ Random play of video possible (very small chunks)

Variable bit rate
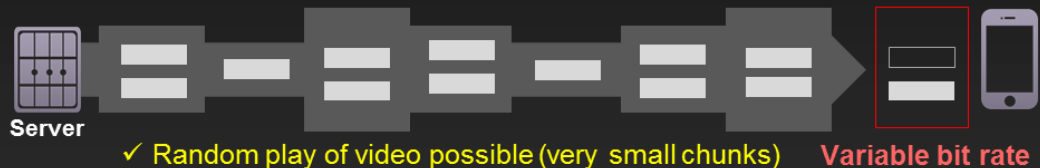
- The evolving streaming technologies still have limitations:
  - Video quality not optimized to human perception
  - Not possible to assure video quality when network is congested

➜ **Video streaming with network's help should be considered**

Video Traffic Bandwidth Optimization (VTBO)

- Proposal to overcome limitations of streaming technologies
  - Optimization of video quality and Priority-based traffic control

Optimize video quality
to prevent bandwidth waste

Assure video quality
when network is congested

Encoding Bit Rate Guideline

Video Traffic Packetizing & Labeling

Traffic Control

- **Different devices**
- **Different types of content**
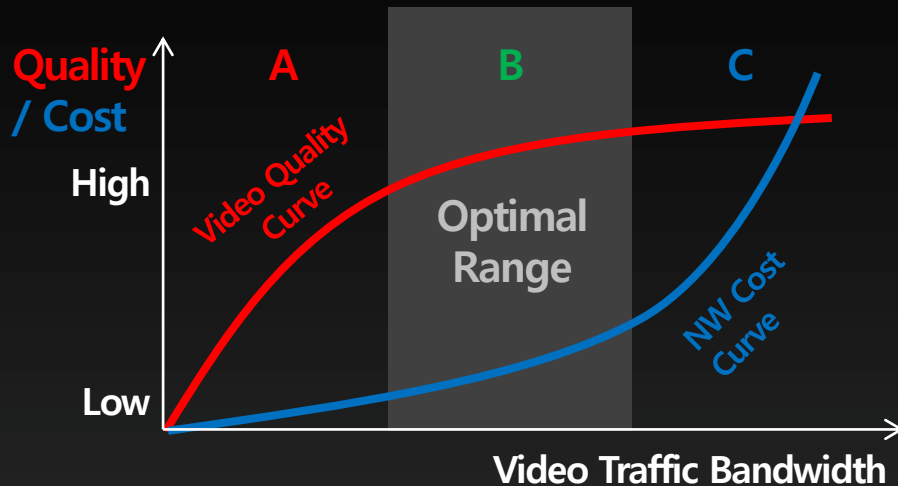
- **Priority label**

- **Congestion control**

Optimal Encoding Bit Rate Guideline (1/2)

- Issue: No consideration of device/content types in video encoding

Quality / Cost

A   B   C

Video Quality Curve

High

Optimal Range

NW Cost Curve

Low

Video Traffic Bandwidth

- Non-linear relationship between QoE and bandwidth usage

- Optimal encoding bit rate prevents excessive traffic generation

Suggest optimal encoding bit rate for different types of device/content

➡ **Reduce network bandwidth usage**

Optimal Encoding Bit Rate Guideline (2/2)

- Study in progress by KT and Yonsei University
  - Devices: iPhone 5, Galaxy S4, iPad Retina Display
  - Content types: Documentary, Sports, Drama, etc.

Test Example (Source: Full HD (1080p) 8Mbps Video)

| Source	Content Type			Device Type	Encoding Guideline	
Source	Genre	Spatial Frequency	Activity	Device	Video Resolution	Bit Rate (Mbps)
1	Documentary	Medium	Medium	iPhone	540p	4.0
				Galaxy S4	720p	5.0
				iPad	1080p	6.0
2	Sports	Medium	High	iPhone	540p	4.0
				Galaxy S4	1080p	4.0
				iPad	1080p	6.0
3	Drama	High	Medium	iPhone	540p	2.5
				Galaxy S4	540p	2.5
				iPad	720p	3.0
…	…	…	…	…	…	…

- Derived optimal encoding bit rate and video resolution required to have QoE similar to that of the source based on subjective QoE measurements
- Experiment (based on ITU-T 910 standard) conducted for 30 content sources

08 Video Traffic Packetizing and Labeling

- Issue: Difficult to sustain QoE when network is congested

- CPs decide on VTBO priority (High, Medium, Low) of video packets and mark them accordingly
  - Non-VTBO stream: best effort delivery
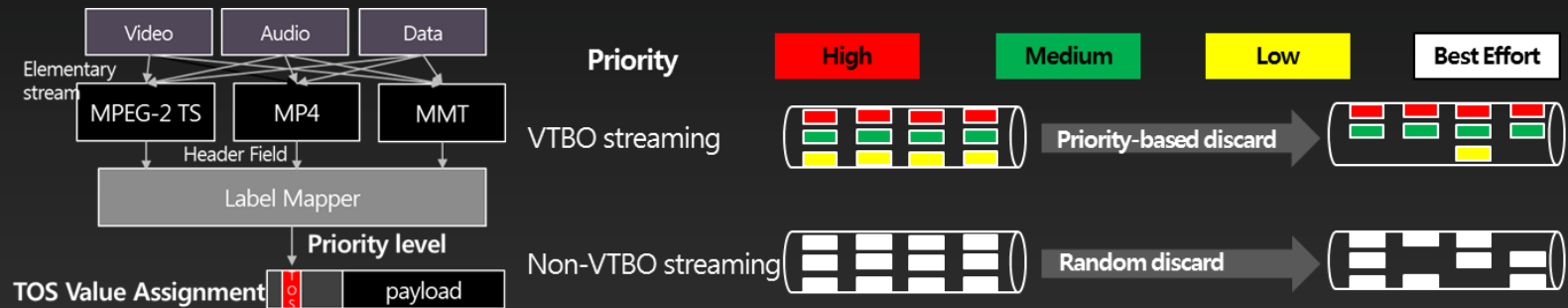
- Priority-based traffic control is expected to minimize QoE degradation when network is congested

Video Traffic Control (1/2)

- Issue: Need for video traffic control during network congestion

- Control with minimal changes in existing network
    - All video packets are delivered when network is not congested
    - VTBO Scheduler controls video packets with priorities during network congestion
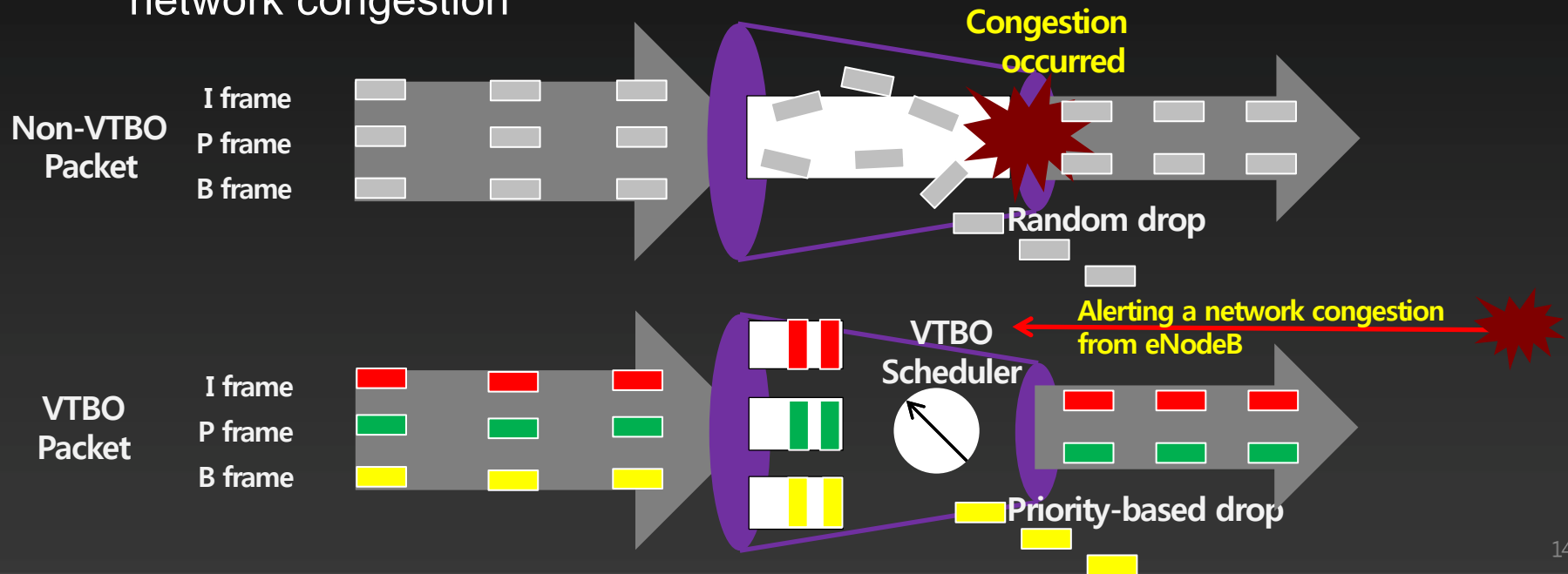
Video Traffic Control (2/2)

- Provide dedicated bearer with higher QoS for VTBO Streaming
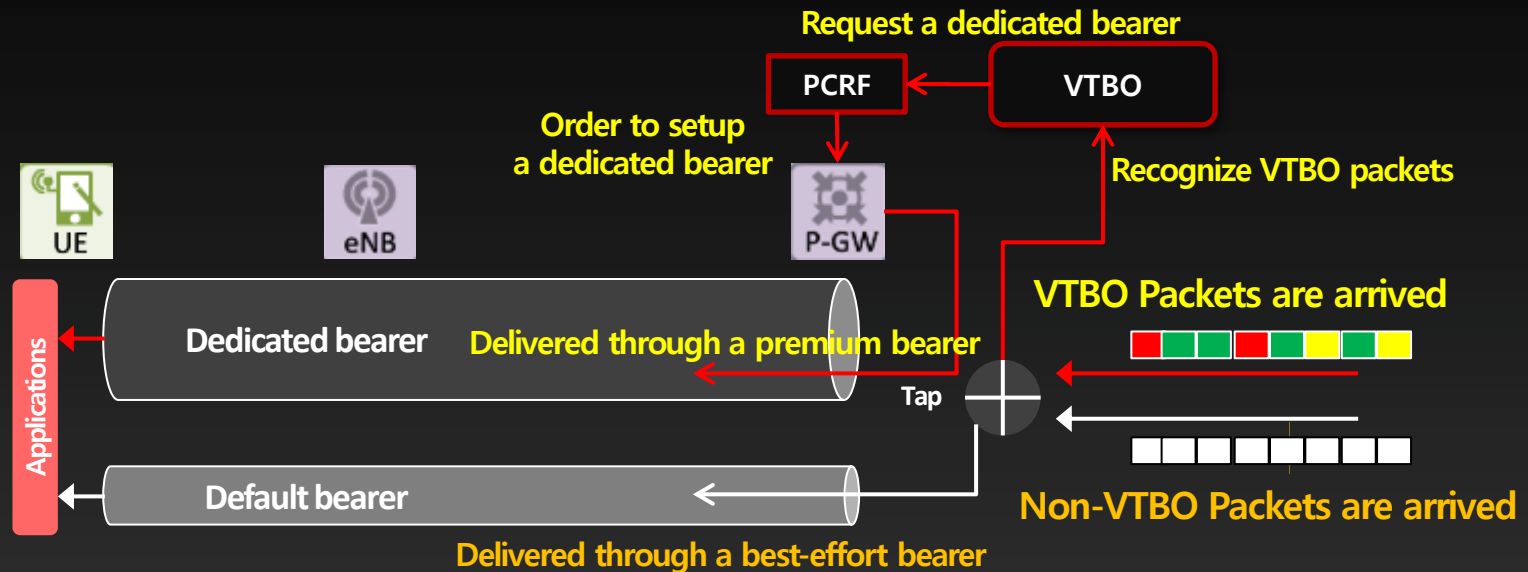
- VTBO is expected to introduce network's control over video delivery

Video Quality Comparison: Conventional vs. VTBO

Random Discard   Priority-based Discard

Test conditions
- Original video with bit rate 4Mbps and resolution 480p (640 x 480), 30fps
- Approximately 50% of frames dropped for both cases
- Priority-based discard: only low-priority frames (b-frames) were dropped
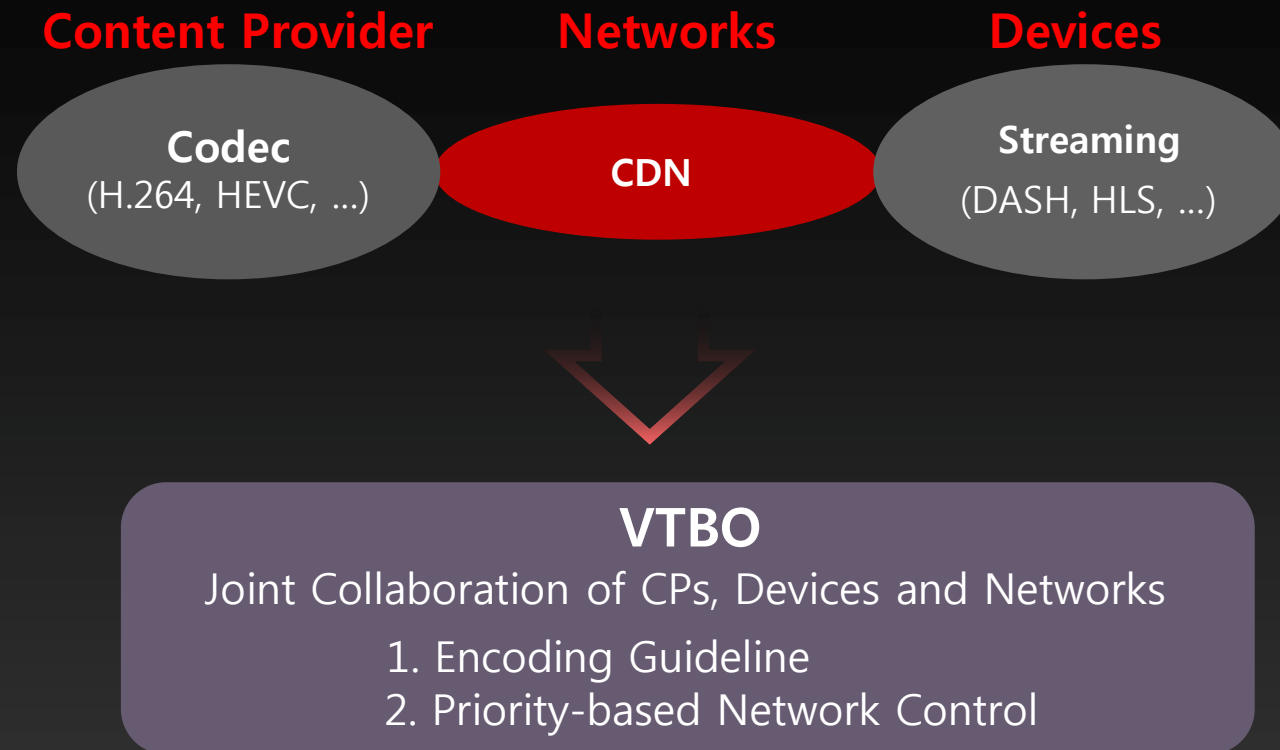- Random discard: frames were dropped randomly

Video Traffic Optimization Landscape

Content Provider   **Networks**   **Devices**

Codec
(H.264, HEVC, …)

CDN

Streaming
(DASH, HLS, …)

VTBO
Joint Collaboration of CPs, Devices and Networks

1. Encoding Guideline
2. Priority-based Network Control

Enhance QoE and the efficiency of video streaming

As-Is

To-Be (VTBO)

Win-Win-Win

CP/OTT
- Bandwidth & server cost

Mobile
Carrier
- Network load and congestion
- Network investment

User
- Data Overconsumption

CP/OTT
- Serve more Customers
- Reduce Cost

Carrier
- Reliable Network Service
- Reduce Cost

User
- Improve QoE
- Prevent unnecessary data charge
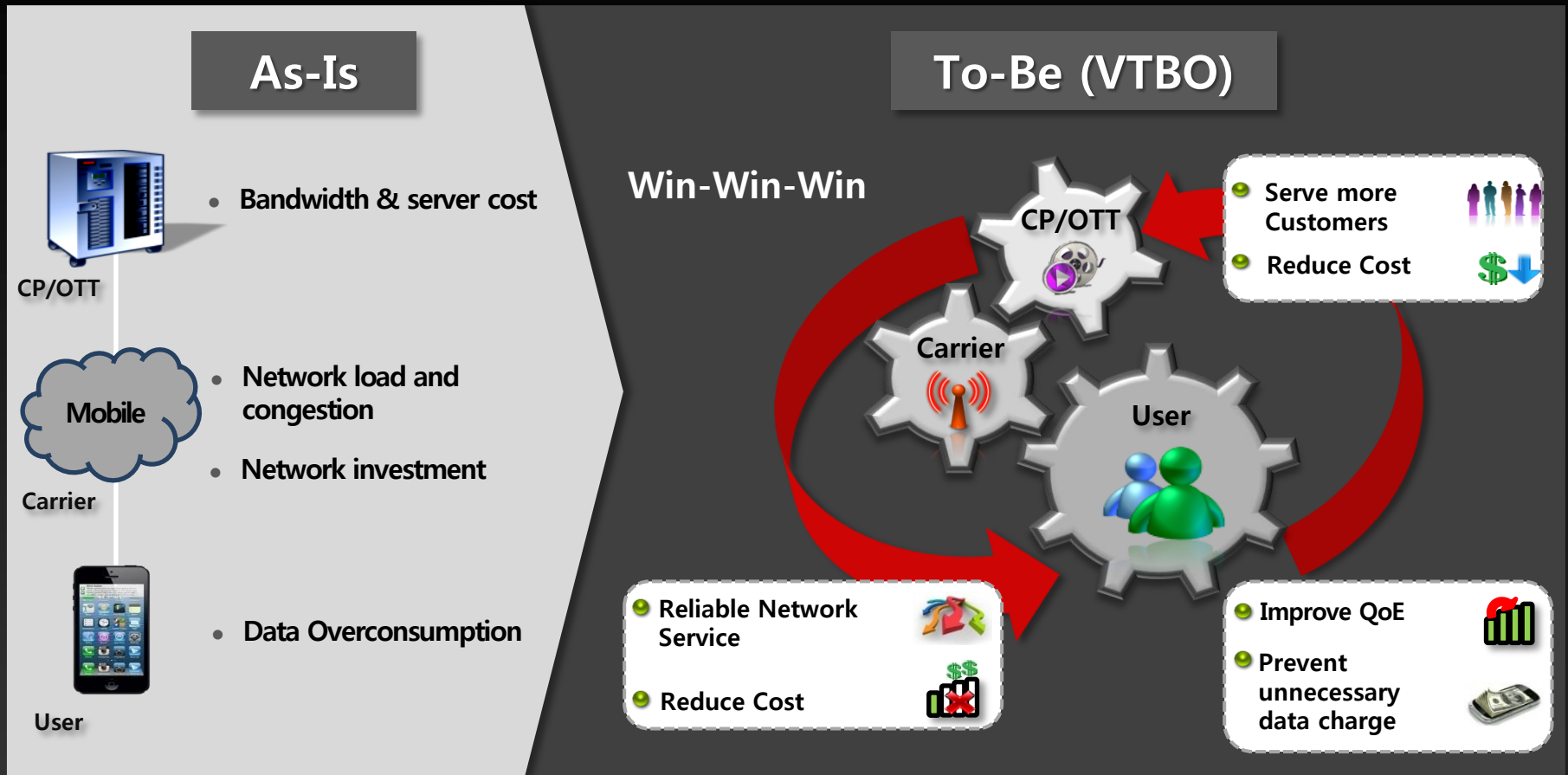
14 Future Work

Encoding Bit Rate Guideline

- Tests on more variety of devices and video formats (e.g., UHD)

Video Traffic Labeling & Packetizing

- Priority marking mechanism for transport layer

Video Traffic Control

- Methodology to provide different bandwidth for different priorities
- Criterion for traffic control operation

We are trying to make VTBO an international standard

Thank you | kt