

# VTBO

(Video Traffic Bandwidth Optimization)

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**4 Summary**

# 01 Background

- Growth of video traffic leads to data explosion and wireless network resource depletion

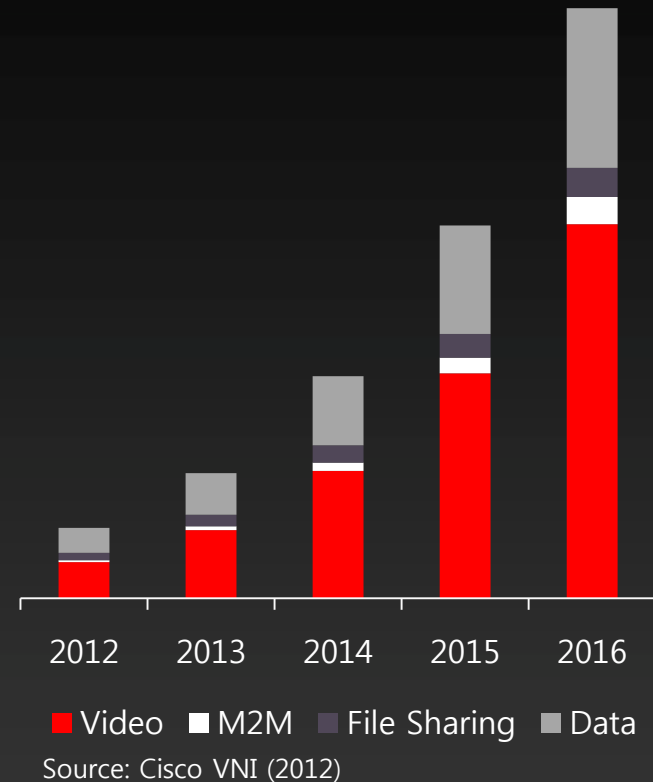
## Smart Devices Generate Explosive Video Traffic

- 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<sup>1</sup> Degradation



<sup>1</sup>Quality of Experience

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## 02 Stakeholders in Video Streaming Face Serious Issues

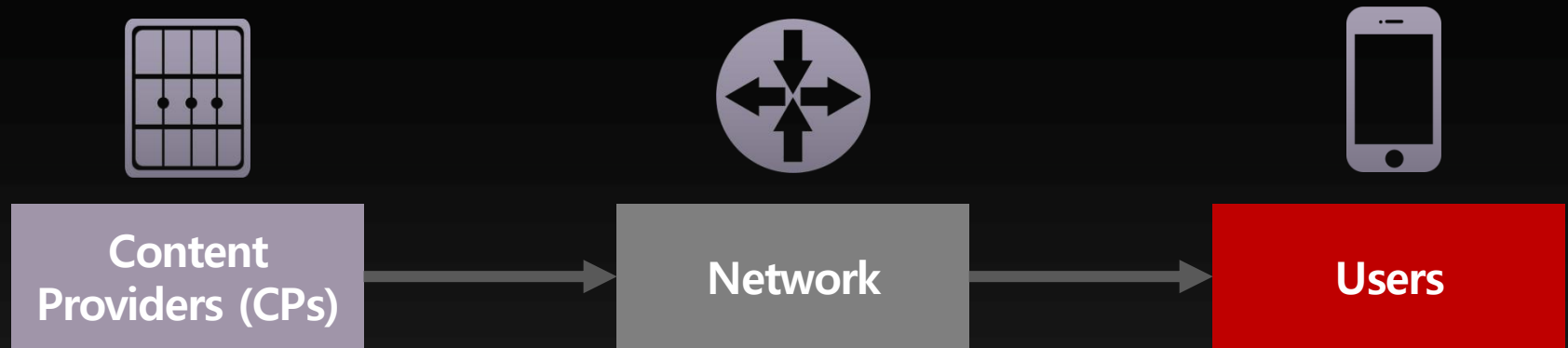
### The Current Situation



- 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	Issues
Content Providers (CPs)	<ul style="list-style-type: none"> <li>• Low user satisfaction</li> <li>• Fierce Competition</li> </ul>	<ul style="list-style-type: none"> <li>• Adaptive Streaming/CDN</li> <li>• <b>Higher Quality Video Files for Competition</b></li> </ul>	<ul style="list-style-type: none"> <li>• QoE vs. Cost</li> <li>• Impact of large file size on network congestion</li> <li>• Provision of a single video file for a variety of screen sizes and resolutions</li> </ul>
Network	<ul style="list-style-type: none"> <li>• Significant traffic burden on network</li> </ul>	<ul style="list-style-type: none"> <li>• Cache</li> <li>• Capacity Investment</li> </ul>	
Users	<ul style="list-style-type: none"> <li>• Delays in loading</li> <li>• Low level of QoE</li> <li>• Wasted Data</li> </ul>	<ul style="list-style-type: none"> <li>• Better Smart Devices</li> <li>• Switch to another CP</li> </ul>	

## 03 Issues in Video Streaming



- 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]

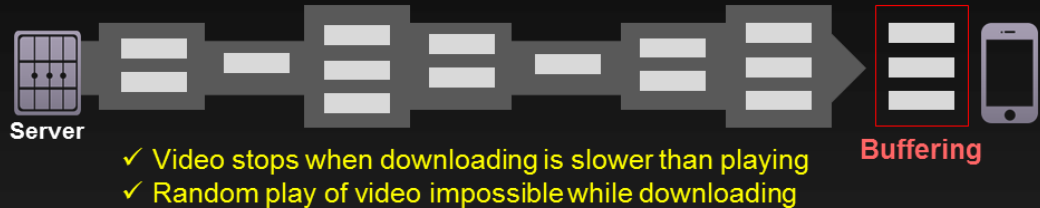
- No guarantee of QoS and in-order delivery
- Flow control not supported



2000s

## Progressive Download [TCP]

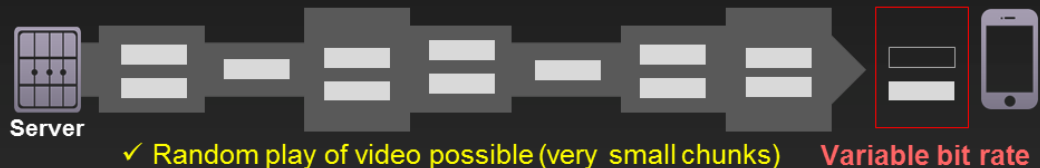
- Can waste bandwidth
- No bit-rate adaptation



2010s

## Adaptive Streaming [TCP + Bandwidth adaptation or Real time transcoding]

- High cost of computing and storage resources



- 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



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## 05 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

**Encoding Bit Rate  
Guideline**

- Different devices
- Different types of content

Assure video quality  
when network is congested

**Video Traffic  
Packetizing &  
Labeling**

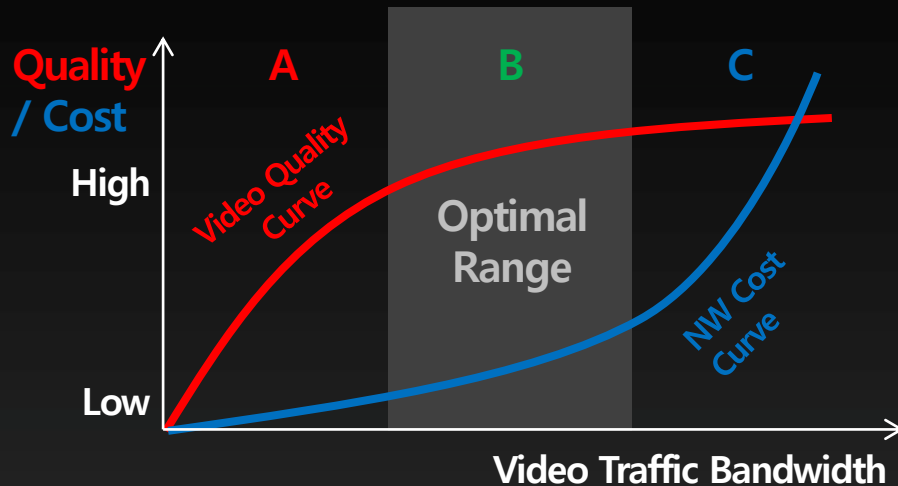
- Priority label

**Traffic Control**

- Congestion control

## 06 Optimal Encoding Bit Rate Guideline (1/2)

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



- 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

## 07 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)

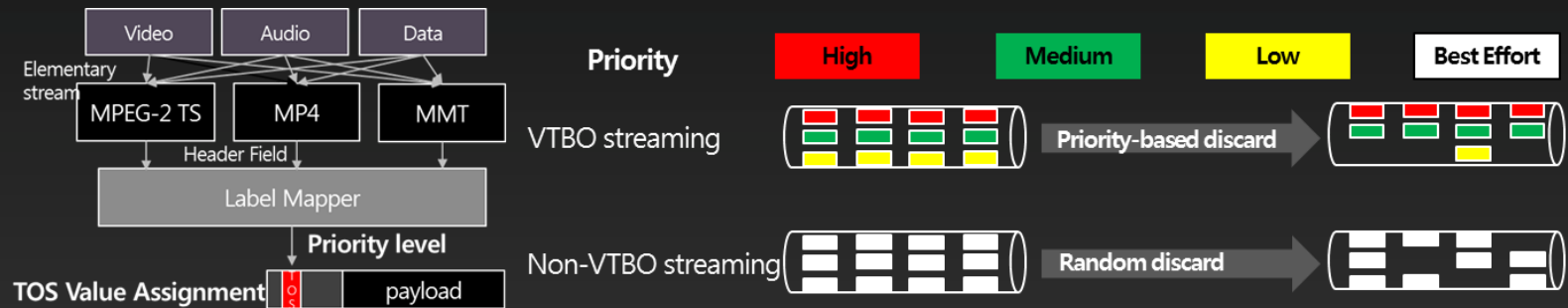
Source	Content Type			Device Type	Encoding Guideline	
Source	Genre	Spatial Frequency	Activity	Device	Video Resolution	Bit Rate (Mbps)
1	Documentary	Medium	Medium	iPhone	540p	4.0
				Galaxy S4	720p	5.0
				iPad	1080p	6.0
2	Sports	Medium	High	iPhone	540p	4.0
				Galaxy S4	1080p	4.0
				iPad	1080p	6.0
3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

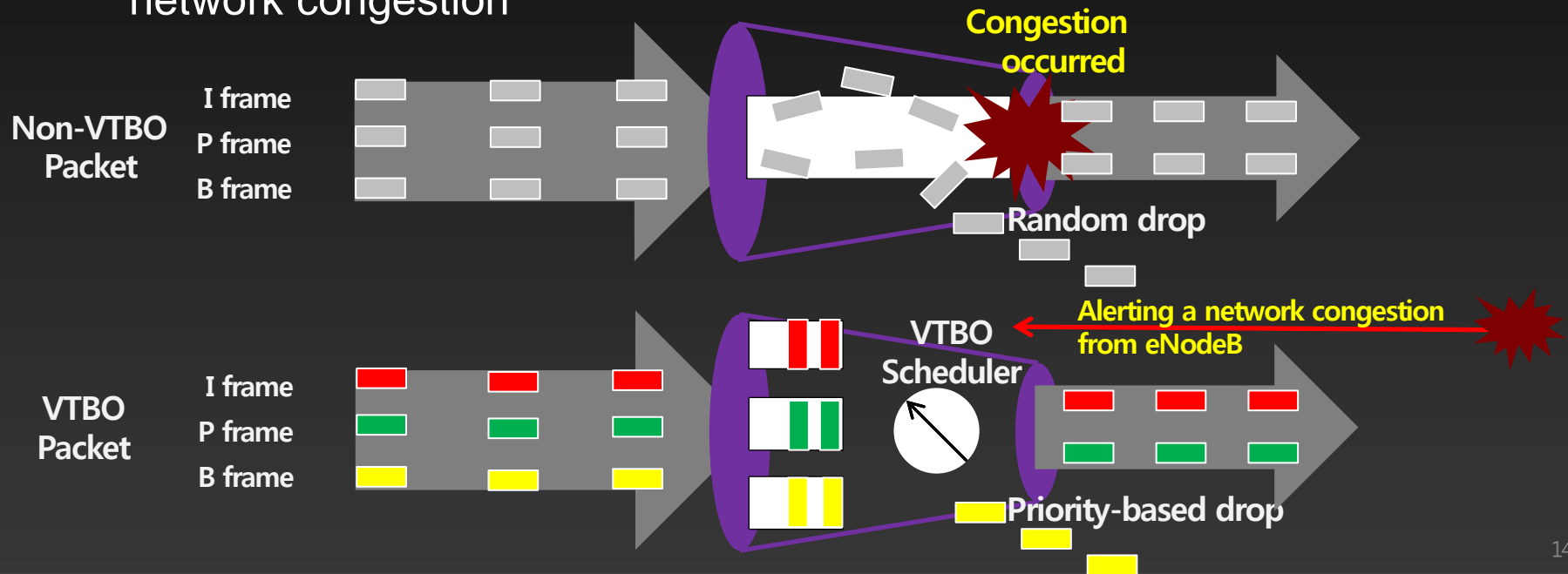
- CPs decide on VTBO priority (High, Medium, Low) of video packets and mark them accordingly
  - Non-VTBO stream: best effort delivery



- Priority-based traffic control is expected to minimize QoE degradation when network is congested

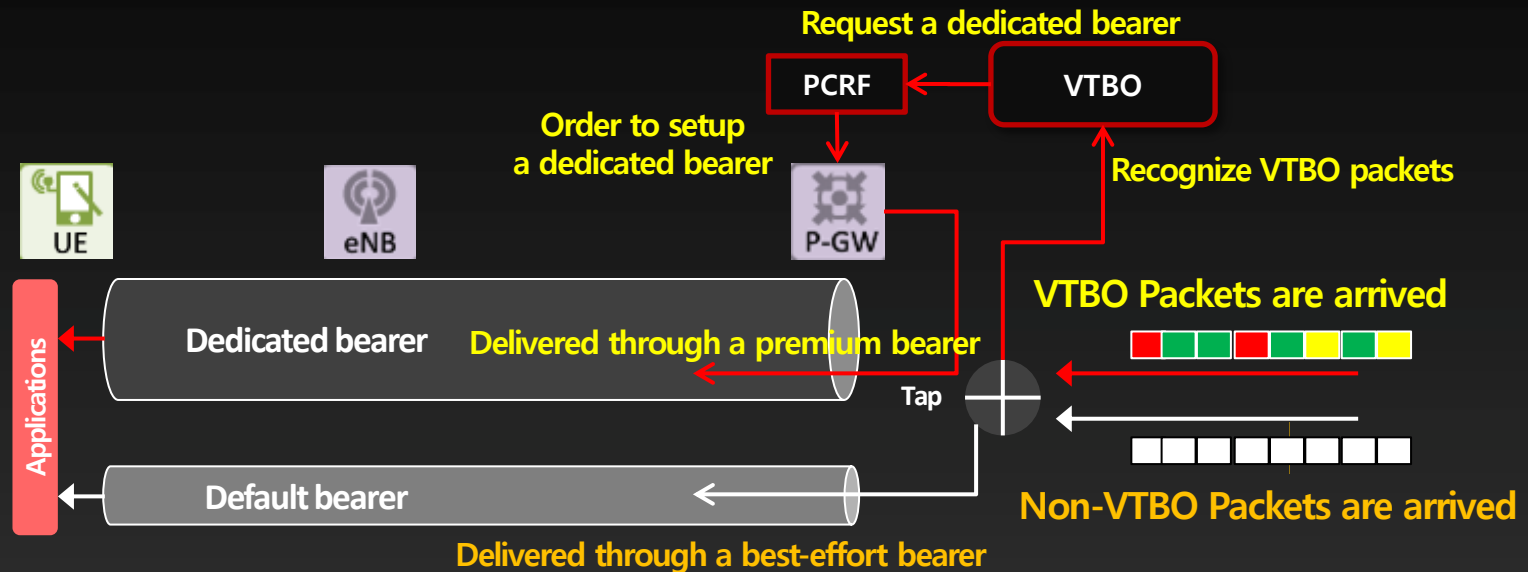
## 09 Video Traffic Control (1/2)

- 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



## 10 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

# 11 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



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**2** Issues in Video Streaming Delivery

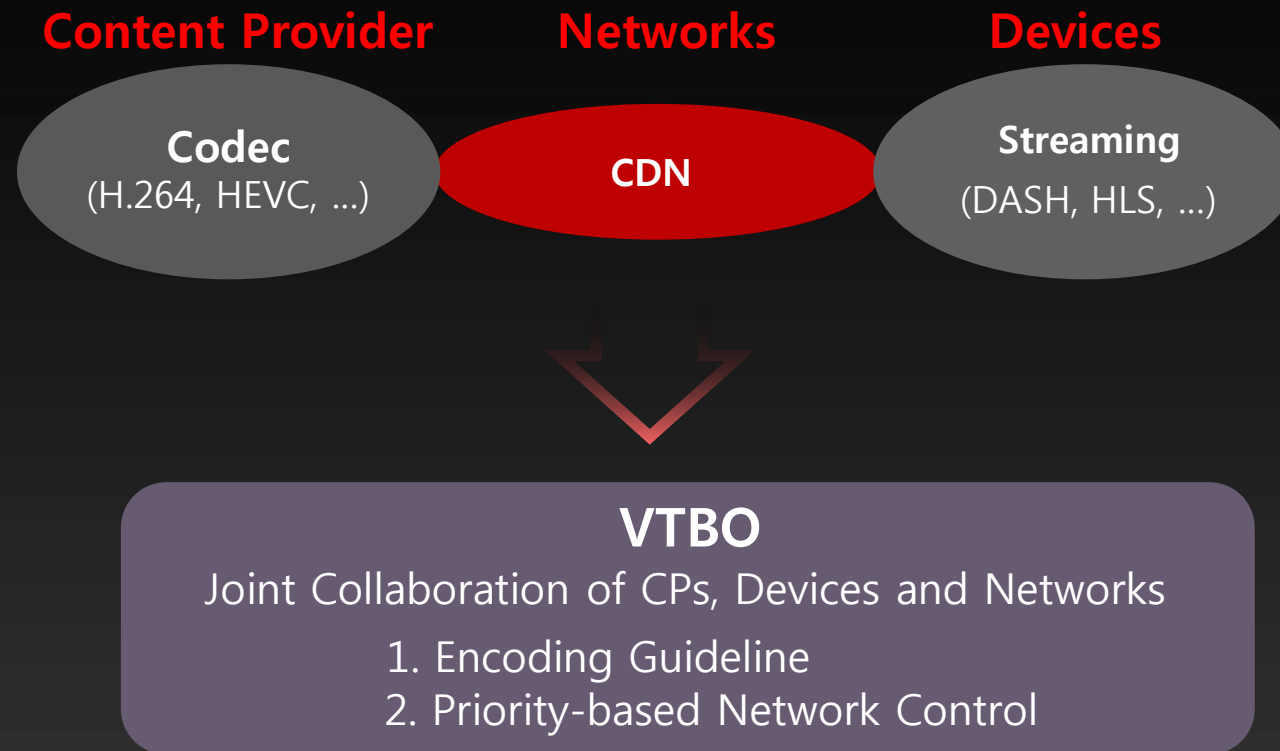
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**3** Proposal for Video Traffic  
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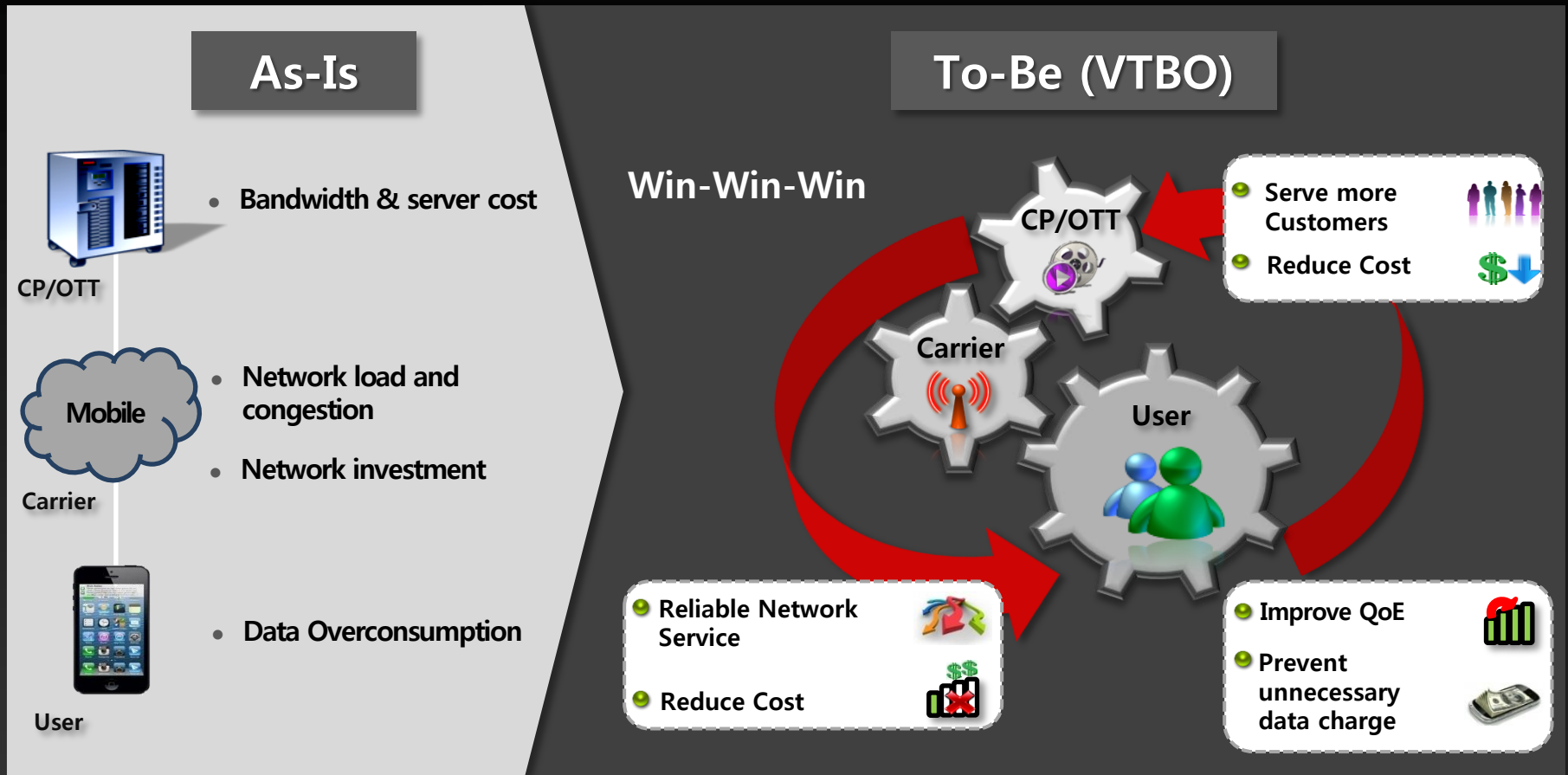
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## 12 Video Traffic Optimization Landscape



**Enhance QoE and the efficiency of video streaming**

# 13 Expected Benefits



## 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

