The CDN evolution under 5G
1. The multimedia service features under 5G scenario

2. The key technologies affecting CDN evolution under 5G
01 The multimedia service features under 5G scenario
For Big Video service, the video service is still the primary service in the mobile Internet under 5G scenario.

Different from Big Video service, IoT service generates huge amount of small data, e.g. status data. Acceleration is not the major requirement. But it needs high computation capability at the edge.
Typical 5G services

- Video communication
  - Video playing
    - Mobile on-line game
    - AR
      - Cloud desktop
      - Non-data downloading
      - Visual surveillance
      - IoV safe driving
  - Real-time video sharing
  - HD pic uploading
  - OTT message
  - Smart home control
  - Cloud storage
  - VR
8 user scenarios for 5G services

- High-density (office)
- High-mobility (highway)
- High-speed rail
- numerous connections (stadium)
- public assembly
- Metro
- Wide area coverage

residence
high-speed rail
Metro
The major services of future mobile communication

Main services

Mobile Internet

Streaming
- Audio
  - Voice
- Video
  - Visual
  - VR

Conversation
- Chat
- Visual
- VR

Interactive
- Search
- Game
- Trade
- Positioning

Transmit
- Mail
- File downloading
- File uploading

Message
- SMS
- MMS
- OTT

IoT

Sensor
- Low-speed sensor
- High-speed sensor

Control
- Latency sensitive
- Non-Latency sensitive

Note: the services such as video playing, game, AR, VR, downloading/uploading are considered to be accelerated by CDN technology.
The trend of streaming and conversation service

UHD, 3D, immersive are the future tendency

Service features and challenge

**Throughput**
- ✔ 8K (3D) non-compressed video ≈ 96Gbps
- ✔ Compressed video ≈ 960Mbps

**Traffic density**
- ✔ Ultra high traffic density

**Latency**
- ✔ Latency ≈ 50-100ms
The trend of interactive service

Interactive service

AR  On-line game  Could desktop  VR

Challenges

Quickly response
non-sensitive latency user experience (5-10ms)

Mass of data interaction
AR, VR, on-line game require real-time HD video interaction. The transmission rate of downstream and upstream meets challenges.
The trend of transmission and message service

Transmission service

- Cloud storage will be one of the primary service

Main challenge

- **High-speed transmission**
  Comparable to the optical fiber transmission rate (~1Gbps)

- **High traffic density**
  Tremendous traffic generated in a density occasion, challenges to the network capacity.

Message service

OTT message (Instant message) will be one of the primary service

Main challenge

- **Signaling costs**
  Plenty of data packets exchange cost signaling resource
The trend of IoT services

- Smart home
- Smart agriculture
- Environment surveillance
  - Tremendous devices connection
  - Plenty of small packets concurrence
  - Coverage
  - Low cost
  - Battery life

- Smart traffic
- Smart grid
- Industry control
  - Latency in ms level
  - almost 100% reliability

- Visual surveillance
- Mobile finance
  - Transmission rate
  - Multi-level security mechanism
## Service model (video)

<table>
<thead>
<tr>
<th>Typical service</th>
<th>Excepted capability</th>
<th>Requirement for transmission rate</th>
<th>Requirement for latency</th>
<th>Main challenge</th>
</tr>
</thead>
</table>
| Video communication     | Uplink: support transmission of 1080P                                                | ✓ Impact factors  
➤ definition  
➤ bits per pixel  
➤ fps  
➤ Compression ratio  
 ✓ Expect bandwidth:  
   ➤ 1080p, 12bits/pixel, 60fps → 15Mbps  
   ➤ 4K, 12bits/pixel, 60fps → 60Mbps  
   ➤ 8K, 12bits/pixel, 60fps → 240Mbps  
   ➤ 8K (3D), 24bits/pixel, 120fps, (ordinarily compression) → 960Mbps | 50~100ms                 | 15Mbps (UL&DL)                                |
| UHD video playing       | Downlink: 8K video transmission in static scene; 4k in medium-speed scene; 1080p in low-speed scene |                                                                                                       | 50-100ms (best QoE)    | 1080P:15Mbps (DL)  
4K:60Mbps (DL)  
8K:240Mbps (DL)                                              |
| AR                      | Uplink/downlink: support transmission of 1080P  
Non latency sensitive for user | 5-10ms                                                                                               | 15Mbps(UL&DL)  
5~10ms                               |
| VR                      | Downlink: 8K (3D) UHD video transmission support                                  |                                                                                                       | 50~100ms                 | 960Mbps (DL)                                |
| Real-time video sharing | Uplink: 4K video transmission support                                               |                                                                                                       | 50~100ms                 | 60Mbps (UL)                                |
| Visual surveillance     | Uplink: 4K video transmission support                                               |                                                                                                       | 50~100ms                 | 60Mbps (UL)                                |
## Service model (data)

<table>
<thead>
<tr>
<th>Typical service</th>
<th>Basic requirement</th>
<th>Transmission rate</th>
<th>Latency required</th>
<th>主要挑战</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cloud desktop</td>
<td>Data transmission on uplink/downlink</td>
<td>UL/DL ≈ 20Mbps</td>
<td>According to the fastest response time of the optic nerve in human eyes, unidirection E2E=10ms, excluding device processing time.</td>
<td>20Mbps (DL&amp;UL) E2E = 10ms</td>
</tr>
<tr>
<td>Download by wireless/Cloud storage</td>
<td>Comparable to the optical fiber transmission rate</td>
<td>DL ≈ 1Gbps , UL ≈ 0.5Gbps</td>
<td>No more difference</td>
<td>1Gbps(DL) 0.5Gbps(UL)</td>
</tr>
<tr>
<td>HD image upload</td>
<td>40M pixs image upload</td>
<td>File size ≈ 20MB (160Mb) , depends on different cases</td>
<td>No more difference</td>
<td>Depends on different cases</td>
</tr>
<tr>
<td>Smart home</td>
<td>10~20 home devices connection, high density requirement</td>
<td>No more difference</td>
<td>No more difference</td>
<td>Numbers of connection : 15/home</td>
</tr>
<tr>
<td>IoV</td>
<td>IoV Latency satisfied</td>
<td>No more difference</td>
<td>latency for car hitting protection</td>
<td>5ms</td>
</tr>
<tr>
<td>On-line gaming</td>
<td>Low latency required</td>
<td>No more difference</td>
<td>Action/shooting game: 15-40ms for unidirection E2E</td>
<td>15-40ms</td>
</tr>
</tbody>
</table>
Key features of 5G: high throughput, low latency

- High throughput
- Low latency

Potential requirements for the service framework under 5G:

- The flatter architecture
- More convenient content distribution
- More flexible network orchestration
- Simplified mobility management
- Efficient resource management
- More secure network

- 0.1 ~ 1 Gbps transmission rate
- 10⁴/km² connection density
- 10+Tbps/km² traffic density
- 10+Gbps of peak rate
- >500+km/h of mobility
02 The key technologies affecting CDN evolution under 5G
CDN ecosystem grows up in a high speed. Many enterprises including in SDN, security, NFV scope has been entering in the new ecosystem. The diagram (reference from Bizety 2015) shows the main companies and the potential technology evolution trend.
The challenge for CDN and solutions

CDN challenges:
- The cache node should be close to user but with low cost
- The new cache node created and deployment depends on the manual work
- Inflexibility of Function deployment
- Inefficient usage of computing, network, storage resource
- Inefficient configuration and management
- Insensitive to the new services changing

Possible solutions: vDC(vCDN)+SDN
- It is the trend of CDN evolution
- The high efficient and flexible service capability and resource usage
- Decrease the investment by virtualized system

1. Install CDN software with vDC resource
2. Intelligent CDN ingested

Functionality ingestion

Content distribution & acceleration

QoE improved
Basic 5G network framework

- **Access cloud**: access control is separated from bear, access resource cooperation, support multi-access scenarios (central/distributed/mesh), flexible network capability and topology.
- **Control cloud**: centralized network control, NFV, software-oriented, reconstructable, open network capability.
- **Forward cloud**: separated controller, forwarding near base station, converged service and forwarding capability.

Access cloud (flexible), control cloud (smart), forward cloud (high-efficient, low cost)
The key technology of CDN evolution under 5G

- MEC: Edge node closer to user
- NFV: CDN nodes virtualization
- SDN: Flexibly networking

5G
MEC—more convenient content delivery close to user

**Mobile Edge Computing**

✓ Mobile (sometimes called Multi-access)
  ➢ Refers to the access mode, such as LTE, WiFi, fixed-line, even ZigBee, LoRa, NBIoT (the IoT user case)
  ➢ Also refers to the ubiquitous consistent user experience.

✓ Edge
  ➢ For reducing the latency, the network functions and applications are deployed at the edge of network, close to the user as much as possible.

✓ Computing
  ➢ It’s Cloud + Fog computing. Cut down the cost of building and operating a large scale network.

**MEC** enables the services to be deployed at the edge of network. With the features of low latency, ultra high throughput and strong real-time performance, it is expected to be a ideal platform which could aggregate IT and CT services.
The typical MEC scenario

- Multi-access, multi-service, low latency, high bandwidth
- Cloud
- Fog

MEC
- VR/AR
- Living sport
- VS
- Local cache
- Living traffic
- Auto-drive
- Auto-navi
- Smart transport
- Enterprise
- Indoor positioning
- Smart home
- Shopping
- Monitor
- Wireless meter reading
- Smart traffic light
- Parking
- Smart logistics
- Intelligent manufacture
- Intelligent machine
- Smart factory

Deployment, operation and maintenance, data analysis

LTE
V2X
WLAN
WiFi
NB-IoT
LoRa
5G MEC Cache--mobile Internet cache acceleration

- **Scenario**: mobile Internet content cache
- **Deploy position**: near base station or Distributed gateway
- **Functions**:
  - Cache hot or specific content in Internet;
  - Redirect user request to the Web Cache system;
  - Web Cache system provides the request content or data;
- **Benefits**:
  - Avoiding downloading content from Internet directly
Cache & CDN Based on MEC Server, Video Site

Better video experience by:
- Intelligent video optimization
- Content pre-stored on the edge of mobile network

Network bandwidth used: 40%
Speedup to video network: 17 times
Speedup of HTTP download: 22 times
Speedup to Web: 3.5 times

Hot Content with Low Latency
Case 2: Simplified MEC Video Solution for Stadium Scenario

MEC video solution supports 5G-MBMS and OTT live video hybrid for all users:

- **MBMS User:** Handset supports 5G-MBMS, user can watch broadcast video by 5G-MBMS APP.
- **Non MBMS User:** Handset doesn’t support 5G-MBMS, user can watch video by operator’s OTT app client through unicast data traffic.
- **Outside MBMS Area:** User can watch video by operator’s OTT app client through unicast data traffic.
SDN-based CDN—more flexible network orchestration

**CDN**
- The principle of CDN is quickly and stably content delivery.
- CDN is a overlay network, over the current bearer network.
- Redirecting the user request to the server node closest to the user, according to the network traffic, server loading status, the geographic distance to user, response time, etc.
- Multiple services supported intention.

**SDN**
- The purpose of SDN (Software Defined Network) is to separate the transmission control from the data forwarding.
- The feature of SDN makes the network resource be orchestrated dynamically. Thus, the traffic control can be more flexible and intelligent.

**SDN-based CDN**
- Content distribution and delivery will be more efficient in data transporting stratum
- CDN service can be over cross different types of networks.
- A large scaled CDN node can be laid on the different DC by using SDN.
The framework of SDN-based CDN: tight coupled type

CDN (SDN APP)
- Distribution/cache
- Loading balance
- Content routing
- Media service

Orchestrator

SDN Controller
- Network loading balance
- L2/L3 forwarding
- Firewall
- L3 route
- Network topology
- Other functions

Data transport and processing
- OF switch
- OF router
- OF storage
- OF device
- OF device
- OF device
The framework of SDN-based CDN: loose coupled type

**SDN Apps (CDN functions)**

- Media service request/User routing request

**SDN Controller**

- Network topology
- L2/L3 forwarding
- L3 route
- Loading balance
- firewall
- Content route

**Data transport and processing**

- OF switch
- OF router
- OF cache
- OF device
- OF device
- OF device
- OF media server
- OF distributor

**Orchestrator**

**NBI**

**SBI**
NFV features

The Operator’s problem

- Numerous/Various dedicated equipments, but short lifecycle
- Difficult new service development, long-term, high operating cost.
- New type of equipments required, difficult deployment, high investment.

The target of NFV

- By through the virtualized service gateway and the unified hardware platform, NFV is able to quickly deploy service, improve efficient of management and maintenance, the fast new service development.
The virtualized CDN functional architecture

- **NFVI**
  - Computing
  - Networking
  - Storage

- **OS**
  - Tactics Control Subsystem
    - SLB
    - GSLB
  - Content distribution & delivery subsystem
    - SLB
    - Dispatch cache subsystem

- **VNFM**
  - NFV (Orchestrator)
  - VIM

- **Universal servers**

- **SDN Controller**
  - SDN NBI
  - SDN SBI

- **BMS**
  - OMS

Connections:
- Os-Ma
- Ve-Vnfm
- Or-Vnfm
- Nf-Vi
- Vi-Vnfm
The networking of NFV/SDN-based vCDN nodes
NFV&SDN-based CDN benefits

- **Visualized traffic**: network elements and traffic can be easily observed. It can precisely position the trouble point where the bad performance is detected.

- **Network controlled by CDN services**: the network traffic is controlled by SDN controller according to the CDN service requirement.

- **High efficient conf & maintain**: An unified MANO system enables the management over multiple DCs.

- **Traffic scheduling**: maximum usage of traffic in the dimension of link and time.

- **Multiple customers**: the unused computing, storage, networking resource can be rented to multiple customers.

- **The flexible VNF adaptation policy**: the VNF scale can be adjusted based on the various factors, e.g. peak time, CPU loading, service requirements.

- **Quick and auto-deployment**: the deployment of virtualized CDN nodes are much faster than traditional CDN nodes.

- **Policy-based VNF self-recovery**: if the CDN VNF is detected in trouble, it can be recovered easily based on the configuration policy.
谢谢！