Enhanced Use cases for Scaling Deterministic Networks

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Agenda

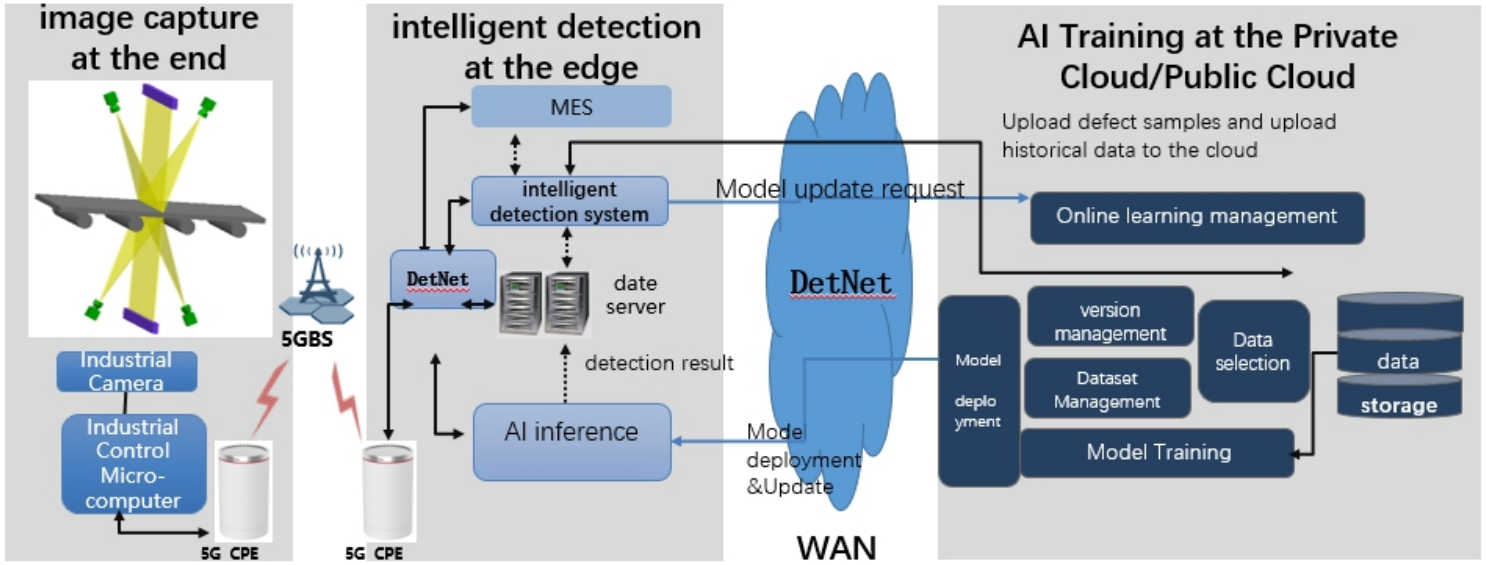
- Introduction
- Enhanced Use Cases and Network Requirements
- Classification of the Differentiated Applications

Introduction

- provides use cases and network requirements for scaling deterministic networks which is not covered in existing DetNet use cases as per RFC8578：
  1. Industrial Internet
     - Machine Vision
     - Remote Control
     - AGV intelligent control
     - AR Assistance
  2. High Experience Video
     - Cloud VR and AR
     - Cloud Games
     - Cloud Live Streaming
  3. Computing-aware Applications
     - HPC and big data applications
     - DC remote disaster recovery
- analyzes the SLAs requirements and desired behaviors in enhanced DetNet for the three typical use cases and applications.

Use Case 1: Industrial Internet-Machine Vision

- The scenario of Machine Vision



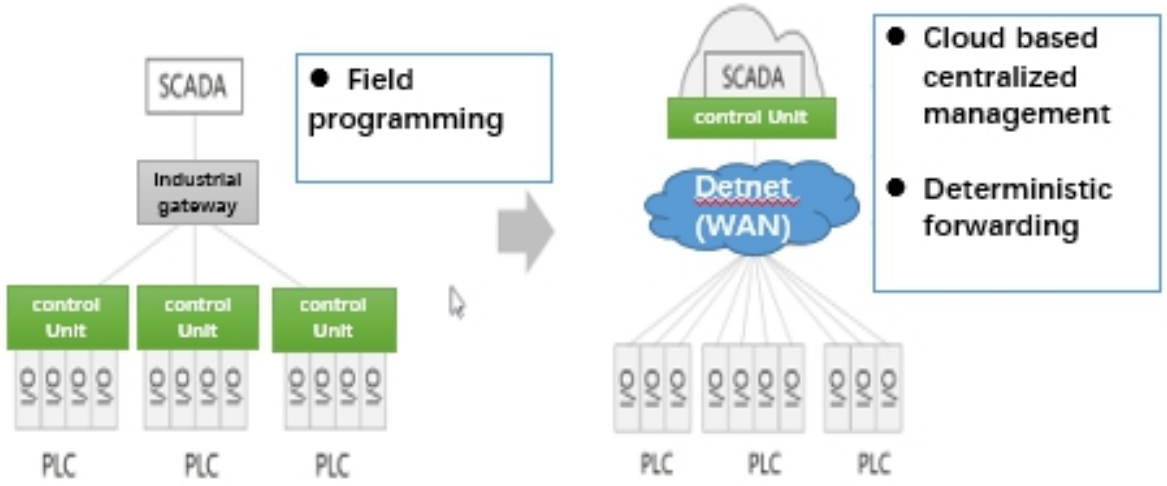
- real-time remote monitoring function, which requires high-speed connectivity characteristics
- Industrial camera images require high definition, with little or no compression, and high bandwidth requirements,

- Requirements of Machine Vision

Applications	Deterministic Network Requirements				
	bandwidth	delay	Availability	Note	
Machine Vision	Real time upload of image information:>50M	<10ms	99.99%	(1) Bandwidth sensitive (2) Cloud deployment and wide area bearing requirements	

Use Case 2: Industrial Internet-Remote Control

- The scenario of Remote Control



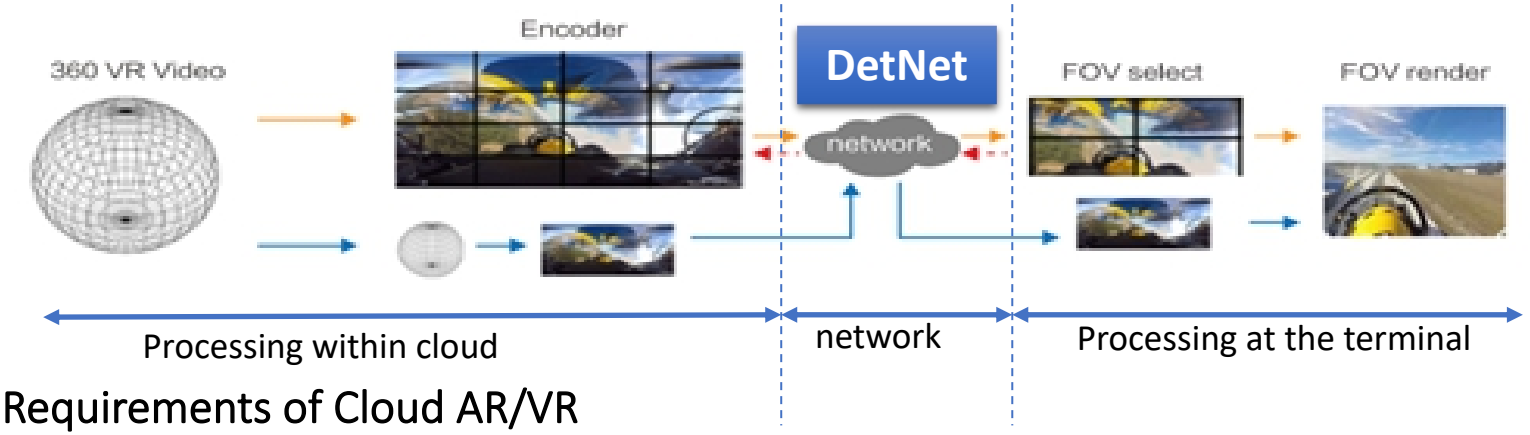
- The typical application of Remote Control is Cloud-based PLC (Programmable Logic Controller).
- jitter sensitive .

- Requirements of Remote Control

Applications	Deterministic Network Requirements				
	bandwidth	delay	jitter	Availability	Note
Remote Control	• Image/video stream upload, uplink>50Mbps; • PLC control command issued, downstream>50kbps;	• Within workshop level equipment<1ms • Workshop level equipment room<10ms • Remote operation in the park/city/wide area: image uplink<20ms; Command issuance<10ms;	<100us	99.999%	(1) Jitter sensitive type (2) Cloud based PLC has a need for wide area hosting

Use Case 3: High Experience Video-Cloud AR/VR

- The scenario of Cloud AR/VR



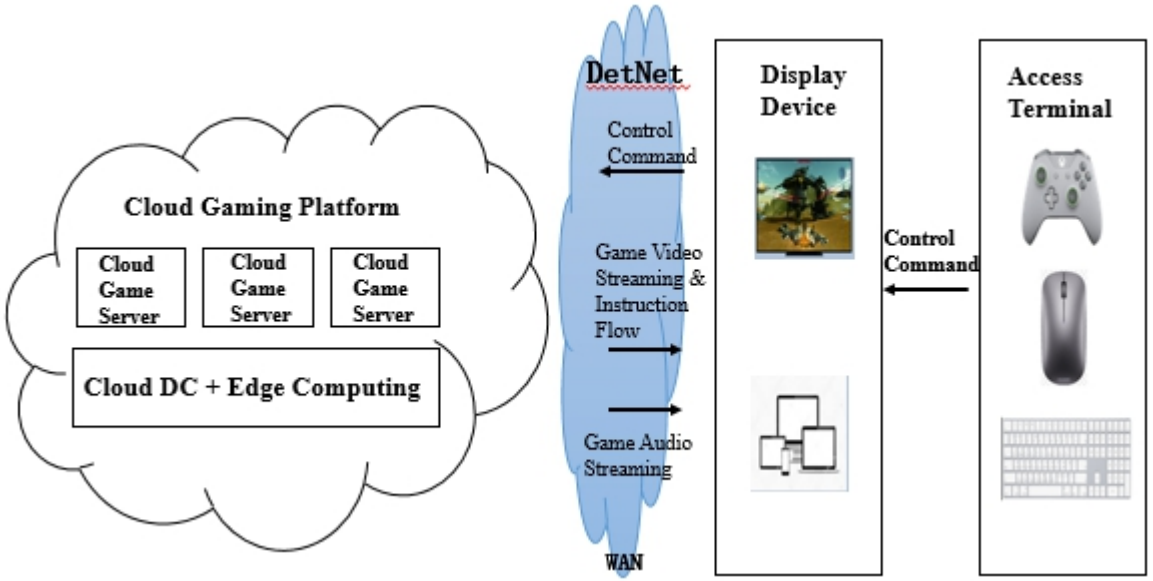
- rendering and streaming latency :cloud processing, network transmission, and terminal processing

- Requirements of Cloud AR/VR

Applications	Scenarios	Deterministic Network Requirements		
		bandwidth	delay	Packet loss rate
Cloud VR/AR	Cloud VR/AR Video_ Comfortable experience_ FOV	FOV: downstream≥ 75Mbps	≤50ms	≤1E-5
	Cloud VR/AR Video_ Comfortable experience_ Full perspective	Full view: downstream ≥ 140Mbps	≤50ms	≤1E-5
Cloud VR/AR with strong interaction	CloudVR/AR Strong Interaction_ Comfortable experience_ I frame	downstream ≥ 260Mbps	≤15ms	≤1E-5
	CloudVR/AR Strong Interaction_ Comfortable experience_ P frame	downstream≥ 260Mbps	≤15ms	≤1E-5
	CloudVR/AR Strong Interaction_ 8K Ideal Experience_ I frame	downstream ≥ 1Gbps (8K)	≤8ms	≤1E-6
	CloudVR/AR Strong Interaction_ 8K Ideal Experience_ P frame	Downstream ≥ 1Gbps (8K)	≤ 8ms	≤ 1E-6

Use Case 4: High Experience Video-Cloud Games

- The scenario of Cloud Games



- The online gaming technology based on cloud computing.
- enables lightweight devices to run high-quality games.
- gaming experience relies on a high-quality, low latency network environment.

- Requirements of Cloud Games

Applications			bandwidth	delay
Level of experience		Video resolution		
Cloud Games	Junior level	720P	8M	≤150ms
	3A professional level	1080P	12M	≤60ms
	Level of esports	4K	40M	≤60ms

Use Case 5: High Experience Video-Cloud Live Streaming

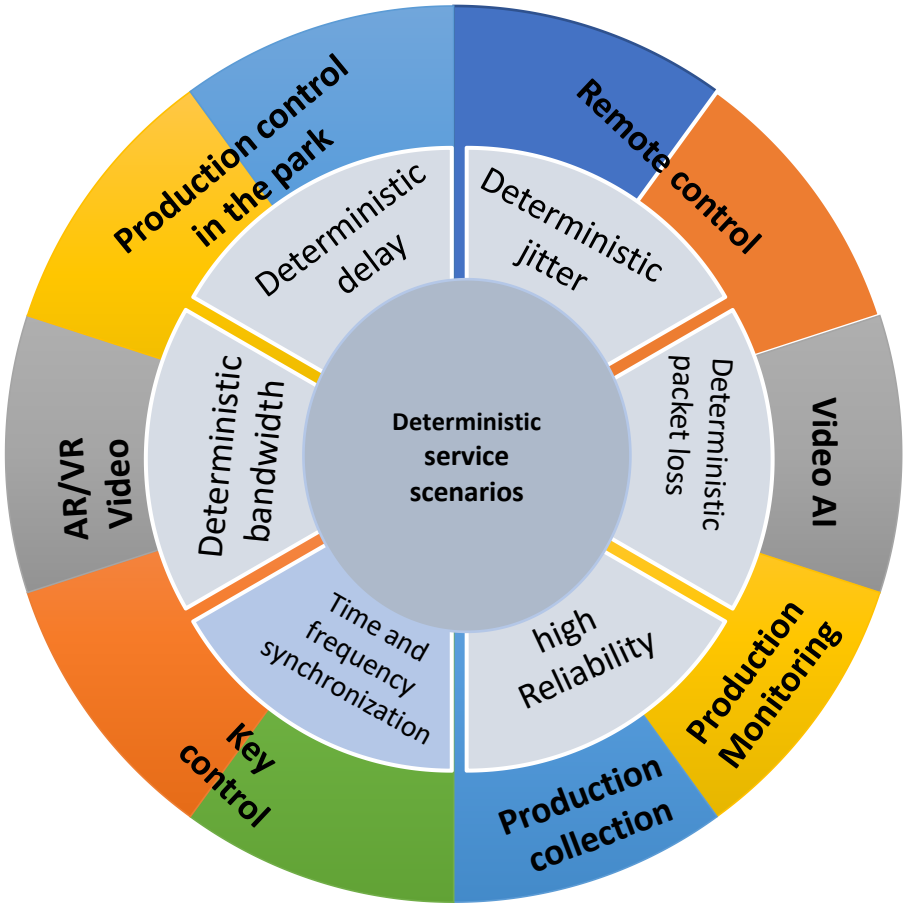
- The scenario of Cloud Live Streaming

- For scenarios such as concerts, press conferences, sports events, cloud live streaming uses 5G uplink high bandwidth to transmit 8K/VR videos.

- Requirements of Cloud Live Streaming

Applications	Cloud Video Application Scenarios	Deterministic Network Requirements			
		Frame rate	bandwidth	Delay	Availability
Cloud Live Streaming	8K live streaming 8K video Backhaul	60	Uplink 100Mbps	≤200ms	99.9%

Summry: Classification of the Differentiated Applications

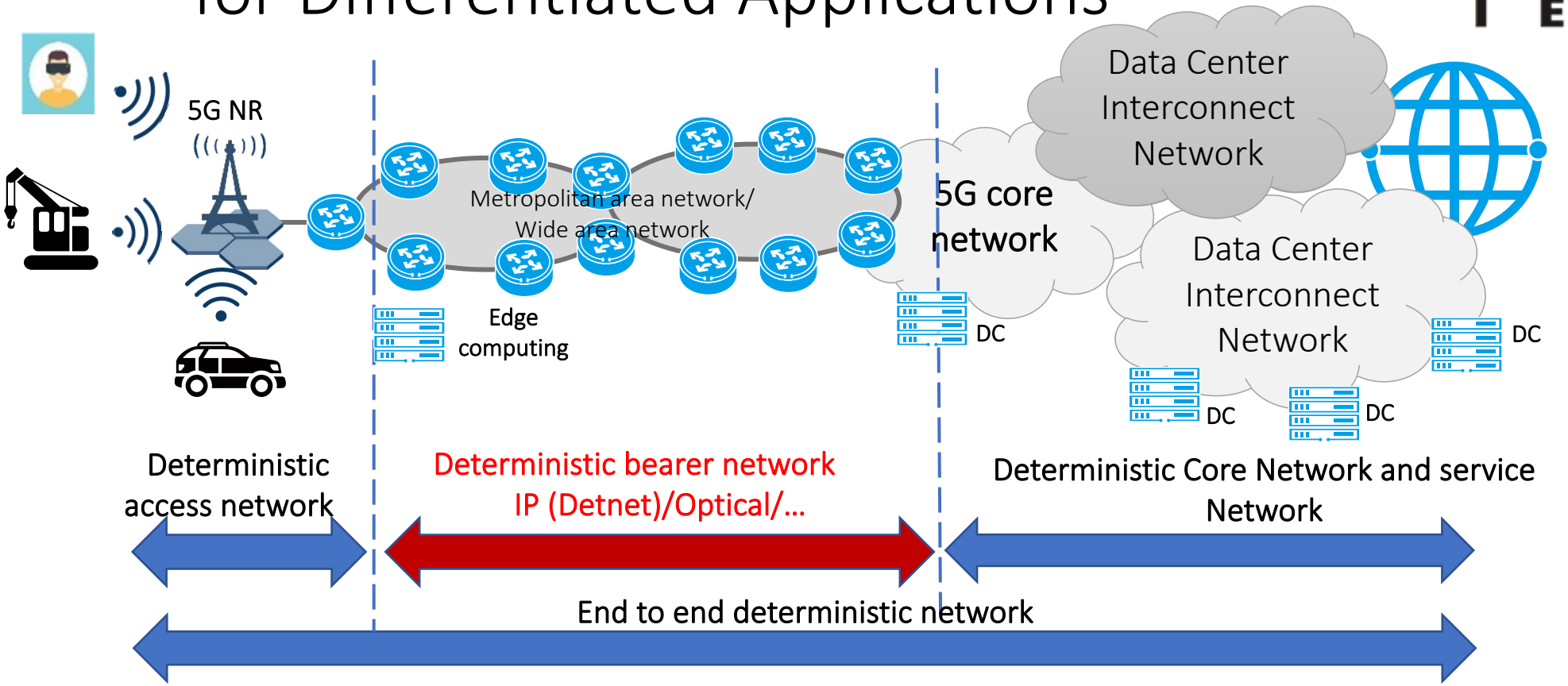


7 typical scenarios:

Typical Scenarios	Industry Applications	Bearing characteristics	Differentiated SLA				
			bandwidth	delay	jitter	Isolation	Reliability
1.Production control in the park	Industrial Internet PLC, etc	Local area: low jitter+ low latency+ low bandwidth	<=N*2M bps	<=2ms	<100us	TDM hard isolation	99.9999%
2. Remote control	Industrial Internet Cloud PLC, etc	Local/metropolitan/wide area: low jitter+ low latency+ low bandwidth	<=N*2M bps	<=5ms	<100us	TDM hard isolation	99.9999%
3.Production collection	Industry IoT data collection, etc	Local/metropolitan/wide area: deterministic latency+ large connections+ low speeds	<=N*2M bps	<=50ms	——	Soft isolation	99.9%
4.Production Monitoring	Industry production and safety video monitoring, etc	Local/metropolitan/wide area: determine medium bandwidth+ determine medium latency	<=N*50M bps	<=20ms	<5ms	Soft isolation	99.999%
5. AR/VR high experience video	Industry AR/VR assistance, consumer AR/VR, high experience cloud games, and cloud live streaming	Local/metropolitan/wide area: deterministic high bandwidth+ deterministic low latency	<=N* 100M~1G bps	<=3ms (high quality)	<10ms	Soft isolation	99.999%
6. AI for video	machine vision and high-definition quality inspection for Industry scenarios	Local/metropolitan/wide area: deterministic large bandwidth+ low latency jitter + high reliability	<=N*100Mbps	<=10ms	——	Soft isolation	99.9999%
7.Key control	Physical isolation class of power grid: differential protection, etc., critical control class related to life safety in the industry	Local/metropolitan/wide area: ultra high reliability and isolation	<=N* 100M~1G bps	<=3ms (high quality)	<10ms	TDM hard isolation	99.9999%

- **Cloud-based applications and remote control** :strict delay/jitter deterministic and high reliability ;
- **Smart grid:** high isolation+low latency+low jitter+high-precision synchronization;
- **Industrial Internet :** low latency+low jitter+high reliability+high bandwidth;
- **Consumer entertainment:** high bandwidth+low latency;
- **Computing-aware Applications：** high bandwidth+low latency/Jitter +high reliability;

End-to-end Deployment of Deterministic Networks for Differentiated Applications



- **End-to-end deterministic networks:** deterministic wired/wireless access network + deterministic bearer network + deterministic core network and service network;

- **Characteristics of deterministic networks :** deterministic delay + deterministic jitter + deterministic bandwidth + high reliability + service isolation .

Thank You