# Intelligent Video Surveillance Project

# Preliminary Design

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# 1 Overview

## 1.1 Purpose

本文从技术角度，对 A 国 W 市城市安全视频监控项目（以下简称 XX 项目）提出规划和建议，本文的目的如下：

1） 对 A 国 W 市城市安全视频监控进行总体设计，明确设计原则、总体需求和总体方案，界定需要建设的各子系统；

2） 对各组成子系统进行高层设计，明确子系统功能、组网方案、关键参数、设备配置和对外接口。

## 1.2 Assume

本文设计中存在的假设如下：

1） 通信设备调测实施时，沿线光纤已经铺设完毕；

## 1.3 The Scope and Structure of Document

本文分 14 章，各个章节的内容简要介绍如下：

第一章对全文进行概述，包括本文的目的、存在的假设，以及文档范围和结构等。

第二章描述项目背景，包括 W 市城市信息、区域划分、项目范围等等。

第三章描述总体需求，从业务角度，对需求进行分析和分类。

第四章描述项目总体方案，包括设计原则，总体方案组成等。

第五章到第十一章，分别描述了视频前端系统、LTE 网络系统、微波网络系统、IP 核心网系统、监控中心系统、端到端安全系统、数字机房系统共七个子系统，从各子系统的关键参数、设备配置、方案亮点等展开描述。

第十二章分别描述各个子系统对外的接口。

第十三章对各个子系统中包括的主要设备配置进行了描述。

第十四章对整个方案进行了简单的总结。

# 2 Project's Background

## 2.1 Overview

To against sabotage, illegal activities and extremist's action, and improve public security is extremely important in W City. Base on A country realistic situation, Safe City is suggested to be taken as the first high priority and first implement project.

The Safe City includes Intelligent Video Surveillance (IVS), Emergence Command Center (ECC), Intelligent Transport System (ITS), Digital Police, E-ID, fundamental network, etc. Huawei designed unified platform and fundamental network for all the applications, and it will help to set up an assistant for the A country Government.

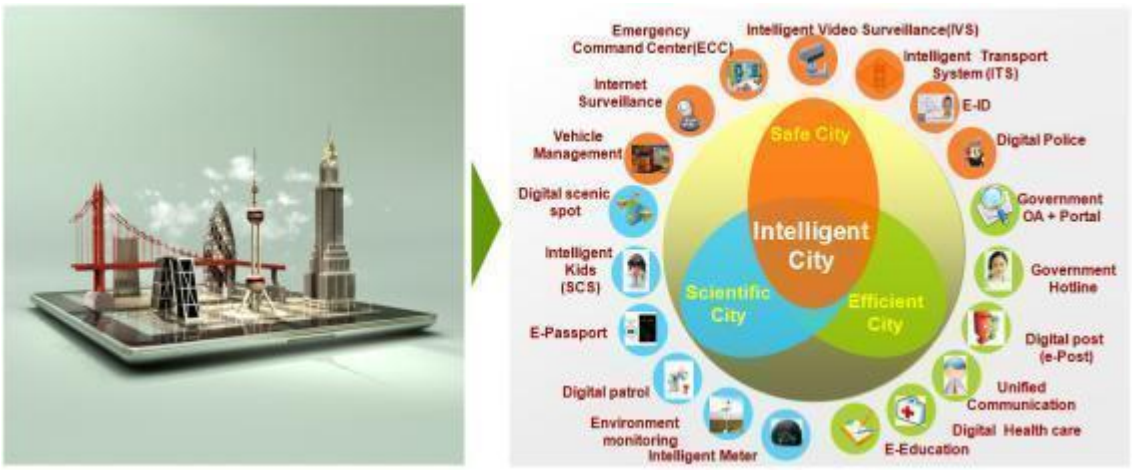



Figure 1 Huawei Safe City Platform overview

In this project, the IVS, ECC and fundamental network are detail designed, and this network is designed to support future expansion for both network and applications.

Huawei Safe City System Architecture:

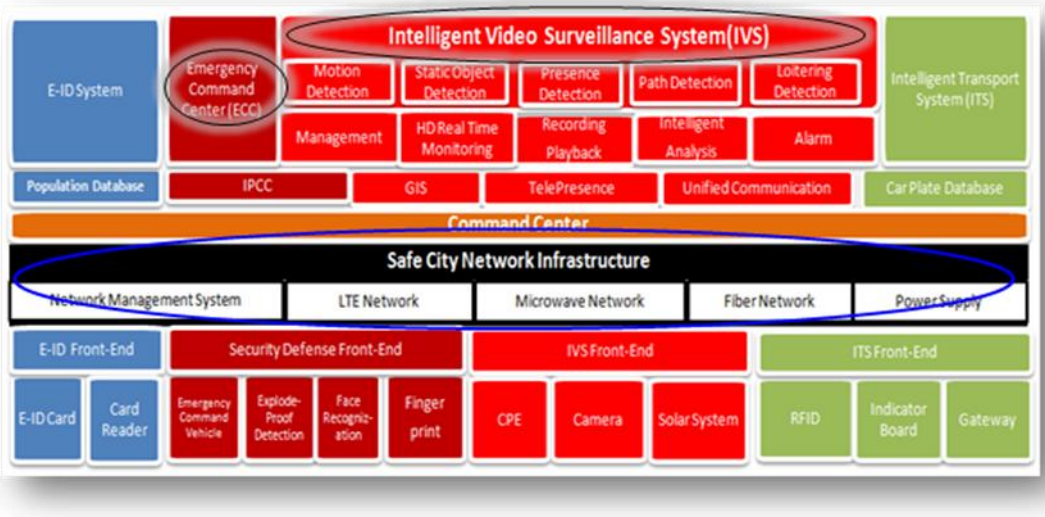



Figure 2 Huawei Safe City Platform Logical Structure

The purpose of this system, in this sensitive region, is to provide both real time monitoring and record of any illegal or unusual activities in the city, also automatically give an alarm for unexpected issues in some special area.

Huawei made the system design by considering all above factors, all the detail design is presented in the following chapters.

## 2.2 Scope of Work Overview

By deep study and analysis for the situation and environment in W City and the requirements, Huawei is pleased to present a latest surveillance technology and comprehensive design to realize the high quality and fast delivery for this project.

Huawei will be responsible for the system design, equipment delivery and testing, system configuration, launch, onsite training of end user personnel.

The unified deployment and construction content of system is as follows:

- IVS Front end system, including day & night IP cameras, infrared light device, CPE (Customer premises equipment), solar & power supply equipment.
- Intelligent Video Surveillance (IVS) platform, including intelligent analysis service, GIS, management platform, HD Real Time Monitoring and Alarm.
- Command Center with Storage and Information & Communication Platform including Unified communication, TelePresence.
- Safe City Network Infrastructure, LTE Access, Microwave Transmission and new optical fiber IP network, site material.

# 3 Overall Requirement

## 3.1 Overview

According to the MOI requirements and deeply study, Huawei totally understand it is urgent for the government to establish a security surveillance network to be the assistant for the society management. Detecting and recording the suspicious people, activities and objective and dispatch the resource to resolve the emergency in time, it will be high priority for the government and citizens.

## 3.2 Places Need to Be Monitored Requirements

1) Ministries and official departments;
2) High ways and Army canal;
3) Foundations for some ministries;
4) Embassies;
5) Colleges and universities and institutes;
6) Hospitals;
7) All main entrance of W City city;
8) All main roads and sequires and public sequires;
9) Banks (all governments banks);
10) Importants hotels;
11) Main parks;
12) TV and radio channels stations;
13) Main markets;

14) Industries areas;
15) Main Car exhibitions;
16) Police stations and directorate of W City head command department;
17) Entertainment places;
18) Any additional place that comity will added based on future requirements;

## 3.3 Technical Requirements

1) The cameras shall work continuously day and night without stop and in all the weather conditions.
2) Motion detection function for cameras.
3) PTZ ability(Horizontal and vertical and zoom) for the cameras.
4) Self-clean ability for the cameras.
5) The system shall include more than one source for electricity to guarantee the 24h work every day without stop.
6) Must connect the fiber-optic to all the command centers (all the levels).
7) The possibility to expand and develop the system in the future and connect with the other systems.
8) The system shall include an information storage and recording machinery not less than 30 days and storaged in archive (safe place).
9) Put the second-storage equipments at an alternative and secure location.
10) The related authority shall specify the factories for the equipments and devices for this system.

## 3.4 Organizational Requirements

1) The system should have two command center;
2) The system sould have a branch command center;
3) Give training for different teams to do the system operation and in different specification;
4) Training the project managements teams;
5) Specify the process procedure for accidents through available existing telecommunication system;
6) Specify the authority for employees in command center each one based on his specialization;
7) Make all necessary arrangements with CMC to specify all the required frequencies for the whole system;
8) W City entrance check points should have the ability to monitor the area that belong to them in addition to ability to be connected with the main system;
9) Huawei should made site survey for infrastructure that will have connection with this project;

## 3.5 Security and Intelligence Requirements

1) All telecommunication networks must be secure;
2) The system have the ability to review the accidents;

## 3.6 Rule and Restriction Requirements

1) Frequencies that will be used in LTE will be between 2300 -2400 Mhz ;
2) All MW frequencies will be assigned after finish all project designs and specifying frequencies bandwidth needed;

3) MOI select one place to be the sample for the whole project and this sample should satisfy all project requirements;

4) The Goal of this project is to design, implement and operate surveillance project have the ability to monitor and detect and track security objects.

# 4 Overall Architecture Design

## 4.1 Design Principle

1. 可靠性

在城市安全视频监控系统中，要求设备 7×24 小时不间断运行，因此可靠性至关重要。系统所采用的技术与产品必须是成熟和高质量的，当外界或内部条件发生突变时，系统能够经受住干扰和冲击，确保系统在运行期间 7×24 小时不间断工作。

2. 先进性

采用先进的技术与设备，除可以为客户提供高性能的业务外，也能满足未来一段时间内新业务的需求，更好地保护客户现有投资。高清晰的视频前端、大带宽的传输网络、低成本大容量的存储已是视频监控系统的发展趋势，在该项目的系统设计中将充分考虑系统的先进性。

3. 安全性

在物理设计上，保证各类线缆、设备辐射指标达到相关的安全要求；网络设计上采用与监控网络相对独立的专用网络，网内的视频、数据等信息对外界是隔离的；同时，监控平台在应用系统的设计上，适当采用信息加密、权限管理、访问控制等技术，保证信息安全。

4. 标准性

系统设计时，所采用的技术手段必须遵循业界标准，特别是要提供标准接口，使系统具有较高的灵活性，方便扩展及与其它系统互联；同时，标准性也为今后的升级或引进新技术提供了保障。

5. 可维护性

系统运行后，其管理（如设备的维护）是可操作的。这些管理、维护工作应尽可能简单、方便。这要求提供规范的系统与工程程序，提供智能化的软件或硬件模块。

6. 开放性

系统设计时，考虑提供丰富的二次开发接口，通过应用定制，其他外围系统可通过二次开发包方便的调用平台视频资源，与平台软硬件设备实时交互，实现丰富的系统集成功能，如 GIS 业务、三台融合、车牌识别等。

## 4.2 System Logical Architecture

W 市城市安全视频监控解决方案由视频前端子系统、数据传输网络子系统、监控中心子系统、视频监控平台子系统四大部分组成，整个解决方案的总体逻辑架构如下图所示。

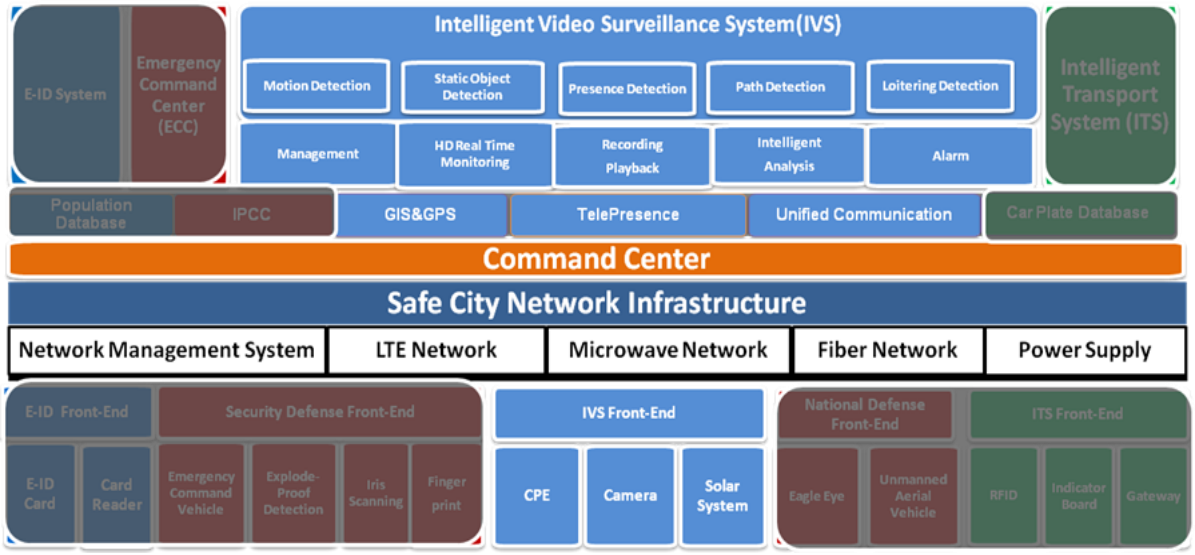



Figure 3 System logical architecture

上图中被阴影遮盖的部分，为未来解决方案的扩展模块，在本项目中不提供。其它部分为本项目实现的功能子系统，各个子系统的功能简要描述如下：

1） 视频前端子系统主要包括高清 IP Camera、无线 LTE 接入终端 CPE、太阳能供电等设备，主要实现前端视频采集编码和视频接入，将编码后的视频流接入传输网络回传给视频监控平台。

2） 数据传输网络子系统主要提供前端监控点视频数据的传输，以及管理平台之间、管理平台与监控资源、用户终端之间数据信息的传输、交换和控制，能够有效地进行通信和共享数据。数据传输网络包括 LTE 无线接入网络、微波回传网络、光传输网络。

3） 监控中心子系统通过部署监控主机、解码器、显示系统、数据存储系统及系统中心平台客户端软件，实现对前端监控点的图像管理、存储管理、设备管理、告警管理。通过建设 DID 或 DLP 大屏拼接系统实现对对监控演示中心的情况控制、突发事件的处理、事件查看、信息发布、监控调用、设备控制等功能的实现直接的大屏幕显示，实现对上述功能事件、功能系统、设备系统进行最直接最有效的点对点控制。

4） 视频监控平台子系统包括中心管理模块、业务控制模块、前端接入模块、客户端接入模块、媒体服务模块（分发、转发、存储）、视频智能分析模块等。在功能设计上主要完成监控管理、报警管理、存储管理、GIS 电子地图管理、网络设备管理、用户安全管理、日志管理、人机交互管理等基本功能，以及入侵检测、绊线检测、路径检测、移走检测、突然出现检测、加速检测和遗留检测等智能分析功能。

## 4.3 System Physical Architecture

W 市城市安全视频监控系统，分为三级监控中心。其中一个一级监控中心，负责存储一个月的整个城市视频数据；四个二级监控中心，负责存储七天的各自区域的视频数据；十二个三级监控中心，可进行实时视频浏览。系统总体物理部署图如下所示：

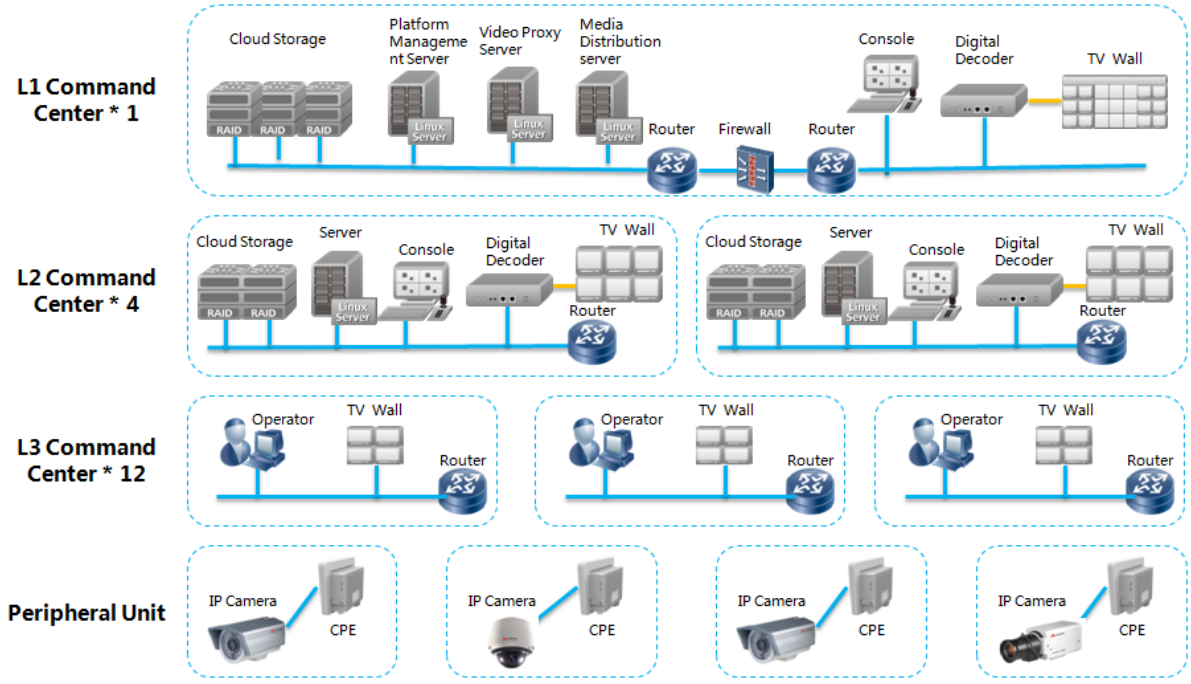



Figure 4 XX project System physical architecture

## 4.4 System Logical Network Architecture

XX 项目组网是采用分层次的网络架构设计，接入层采用的是无线 LTE 技术，汇聚层主要采用微波传输，骨干核心全部采用光传输，业务网络以 10GE 以太网为基础，XX 项目整体网络架构设计如下图：

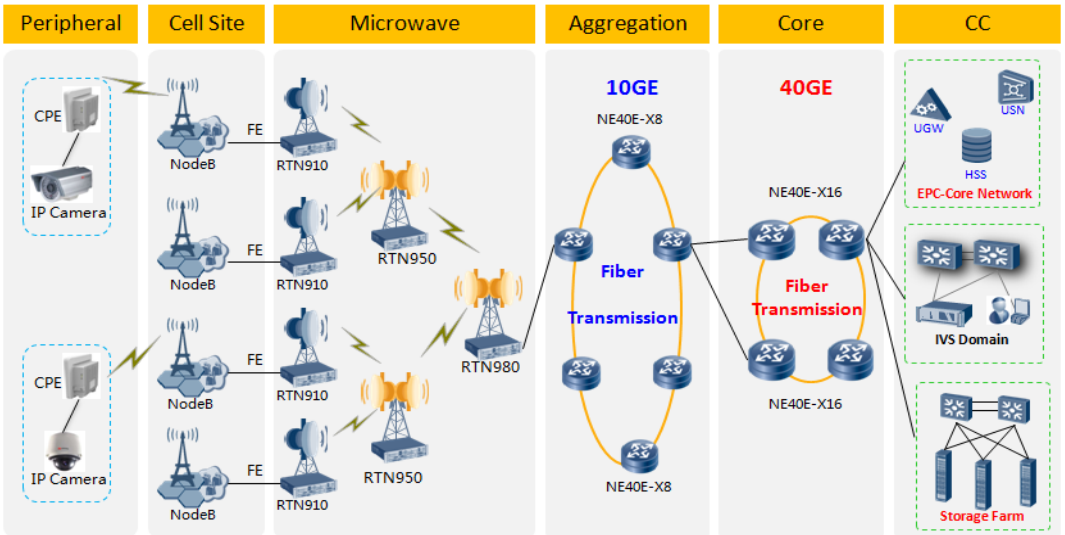



Figure 5 XX project System Network Architecture

# 5 Front-End System Design

## 5.1 Front-End Design Overview

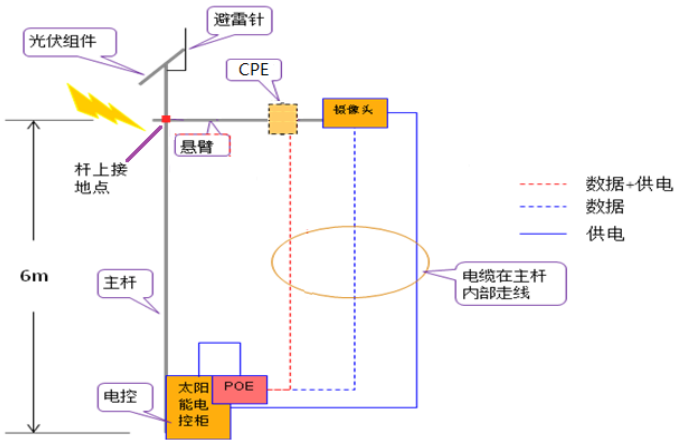
The Front-End equipment unit system comprises the following systems

- Video acquisition system(Camera),
- Transmission front-end access device
- Power supply system

The video acquisition system consists of different functional cameras, and other accessorial devices such as pole, camera housing, and brackets. It is the most important system which used to collect and encode the front-end video.

The main device of front-end access system is outdoor Customer Premises Equipment (CPE) which used for receiving the video stream from the cameras and sending to the wireless transmission network.

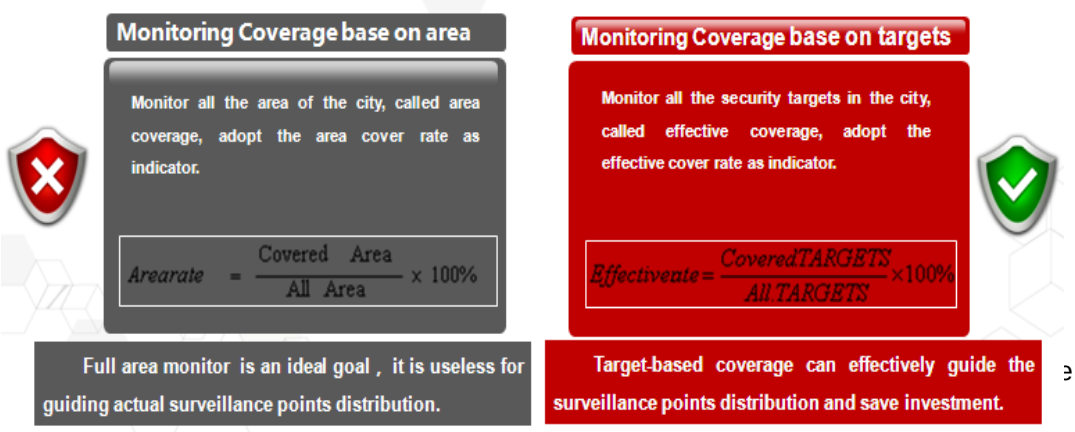
Power supply system provides the uninterruptible power supply for the front-end devices include the cameras, CPEs. It consists of the solar power solution and utility power solution depends on the local power situation.




## 5.2 Front-End Vedio Acquisition

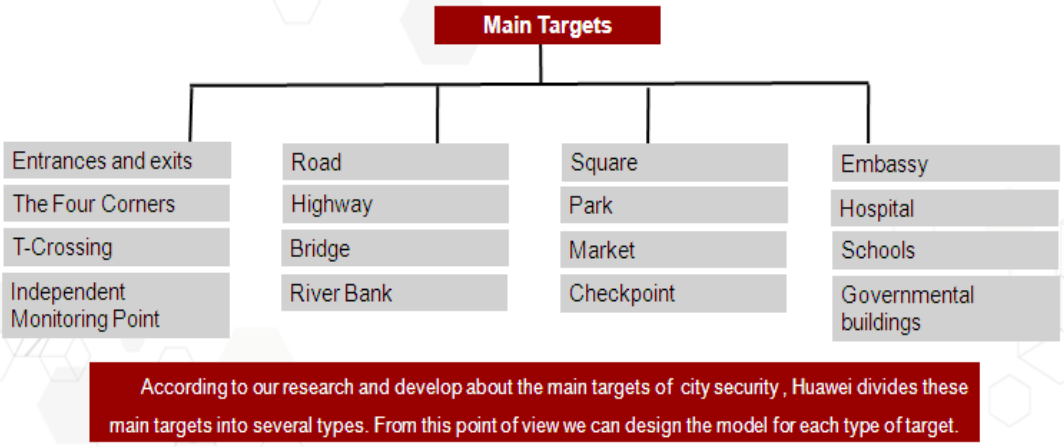
### 5.2.1 Design Principle

Usually the surveillance point density is the most important quantitative indicator to measure the safe city video surveillance level. But this indicator cannot completely reflect the security system efficiency. We need to both consider the monitoring Coverage base on targets and area but mainly focus on the important monitoring targets.



Considering the scenario is complex, according to our industrial experiences the main targets should be monitored includes the main roads, streets, checkpoints, Main entrances of the W City, important building and so on.

Huawei divides these main targets into different types as below




All complicated scenarios are based on the spots and lines, our surveillance points deign principle as below:

Basic Design Principle for Spot Target Monitor Model

**The typical Spot-targets include entrances and exits, traffic junctions and other independent monitoring spots. According to the characteristics can be further divided in the following table:**

| Type | Feature | Design Principle |
|---|---|---|
| Entrances and Exits | Single Entrance | 1 Fixed Camera |
| | Single Exit | 1 Fixed Camera |
| | Entrance and Exit | 2 Fixed Cameras |
| T-Crossing | T | 3 Fixed Cameras，1 PTZ Camera |
| The Four Corners | X | 4 Fixed Cameras，1 PTZ Camera |
| Independent Monitoring Spot | A specific morning object | 1 Fixed Camera |
| | A specific morning area | 1PTZ Camera |

Basic Design Principle for Line Target Monitor Model

The line-target generally refers to the continuous linear distribution of the monitoring area. Line monitor targets such as ordinary roads, highways, streets, rivers, etc.. The basic design principle for line target monitor model As follows:

| Type | Feature | Length | Design Principle |
|---|---|---|---|
| Road&Bridge | Separate driving directions, lanes < 3 | L | L/$D^{fix}$ |
| Highway or Main Street with Barrier | Separate driving directions, lanes≥3 | L | 2*L/$D^{fix}$ |
| Riverbank | Both bank | L | 2*L/$D^{fix}$ |

*L: length*
*$D^{fix}$ The monitoring distance of fix camera*

1. Crossing & Junction Surveillance

   Design Principle

   4 box cameras to monitor four directions and 1 PTZ Camera can patrol the full directions.

2. Road Surveillance

   Design Principle

   Each group has 2 box cameras share one pole to monitor two directions， and can be protected by nearby groups.

3. Highway Surveillance

   Design Principle

   1 PTZ Camera patrol the full directions, each camera can be protected by nearby groups.

4. Residential area Surveillance

   Design Principle

   According to the deign before

5. Bridge Surveillance

   Design Principle

   Full monitoring for the whole bridge using  box cameras, Each group has 2 box cameras share one pole to monitor two directions， and can be protected by nearby groups.

6. Square Surveillance

   Design Principle

   Using the PTZ camera to monitor the large open area, and using the box camera to monitor the Square main Entrances and Exits

7. Checkpoint Surveillance

   Design Principle

   Using the HD box cameras to monitor each path, and the super-definition PTZ cameras to support the full area monitoring

### 5.2.2 Surveillance Points Network Design

- 组网说明

无线承载采用 TD-LTE 技术，IPC 通过无线 CPE 接入承载网络，目前无线接入的规划为每个基站覆盖 6 个小区，每个小区可接入 8 个摄像头，一个基站支持 48 台摄像机接入。其网络组网如下图所示：

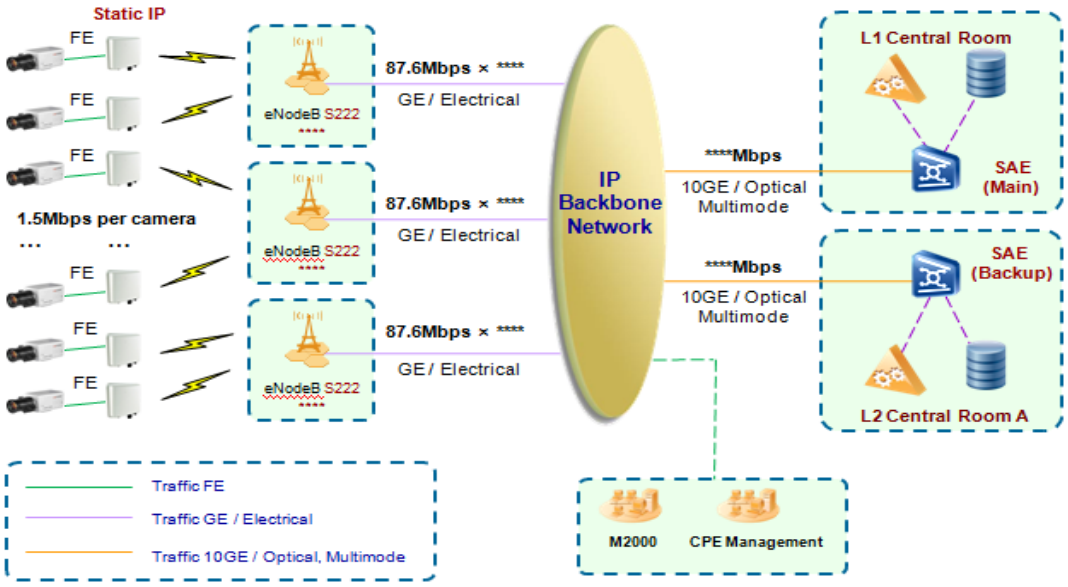



Figure 6 Front-end Camera Networking Diagram

➢ IP 地址规划

IPC 与 CPE 进行互通，CPE 和 IPC 采用固定 IP 地址，需要设置在同一个网段。双方互连接口的 IP 地址配置为：192.168.1.1/24(CPE)， 192.168.1.2/24(IPC)。CPE 部署 NAT 网关，IPC 工作于 NAT 网关内部，IPC 与监控中心支持透过 NAT 网关通信。IPC 与外部通信时，CPE 把 IPC 的 IP 地址伪装为 CPE 的空口 IP 地址，监控中心服务器使用 CPE 的空口 IP 作为 IPC 的 IP 地址与 IPC 通信。

### 5.2.3 Key Performance of Camera

In W City the personnel or vehicles that should be monitored must be clearly videoed for the convenience of locating the related personnel or vehicle once severe safety accidents happen. Therefore, it is no way for the irrelevant person to be wronged and the relevant ones to get away with. That is the reason why huawei provide the latest and high performance HD cameras in this project. As we know the transmission bandwidth will be increasing with the camera resolution increasing, Huawei HD camera adopt the latest compression technology to reduce the bandwidth requirement.

As we know H.264 is the latest video codec (compressor and decompress or standard, which follows on from the highly successful MPEG-2 and MPEG-4 video standards and offers improvements in both video quality and compression. Many of the current one and two megapixel HD cameras use MPEG-4 compression, resulting in higher video data rates. For HD to become usable in mainstream CCTV applications, H.264 compression technology needs to be deployed in the camera, to provide the lowest possible data rates. However, not all implementations of the H.264 standard deliver the same quality of compression. The data rates from different manufacturers' cameras can vary significantly, even when comparing cameras implementing H.264. The table below details the typical data rates for a single one megapixel camera monitoring a fairly static scene such as a building entrance:

| Implementation Technology | Typical Data Rate (Mbps) | Storage required for 30 days at 15fps continuous recording (Terabytes) |
|---|---|---|

| | | |
|---|---|---|
| MPEG-2 Implementation | 8~10 | 2.5 |
| MPEG-4 Implementation | 6~8 | 2.0 |
| Average Compression Technology(H.264) | 2~4 | 1.0 |
| Huawei Compression Technology(H.264) | 1.5~2 | 0.5 |

According to the table before we can see Huawei HD camera using the latest Video Compression technology has greatly minimized the transmission bandwidth.

Even though Huawei HD camera has the huge disparity in camera performance Huawei still offer the customer almost the same price with other HD camera manufactures. Using cameras with data rates of less than 2 Mbps means that makes the wireless transmission available and storage can be greatly reduced for everyday IVS applications.

The reasons why huawei can make up such a low bandwidth camera are:

- Using a true IP camera solution
- Excellent implementation of H.264
- Dedicated hardware architecture

True IP Cameras

Huawei IP camera completely eliminates any analog signal by connecting the digital signal processor, present in all analog cameras, directly to the compressor chip. This ensures no additional signal noise is introduced.

The Best Compression technology using H.264
There are three common compression standards used in current HD IP Cameras, MJPEG, MPEG-4 and H.264.

Video is compressed using two types of frames:

- I Frame, also known as the Index or Key Frame and contains the whole image
- P Frame, which only contains the information that is different from the previous frame.

MJPEG only uses I Frames, whereas MPEG-4 and H.264 use a combination of both I and P Frames and consequently use considerably less bandwidth them MJPEG. H.264 will require up to 50% less bandwidth than MPEG-4 to transmit the same quality image, therefore it is the chosen compression standard for the highest performance IP cameras.

The H.264 standard specifies a set of optional tools which can be used to compress video. A compliant decoder must implement every tool, whereas a compliant encoder can choose which tools to use. This means that there can be a big difference between encoders from different suppliers – some compress well, some compress badly. To determine what information is transmitted in a P Frame the image has to be searched for motion in each frame. The quality of the compression depends on how far and how well the search is completed on each frame. The limitation to this searching is the available processing power in the camera, even more so with HD resolutions at full frame rate.

Hardware Architecture

Huawei adopt the high performance compression engine Due to the huge processing demands of a low bandwidth HD IP camera using H.264 it is essential that the compression engine is implemented in dedicated hardware. With this type of design low bandwidth HD compression can be achieved with a guarantee of no dropped frames.

### 5.2.4 Advantages of Using Huawei HD IP Cameras

The advantages of HD IP cameras have been well documented, but in summary the three main areas where they can provide real benefits are:

General Surveillance –Huawei HD megapixel camera can replace several standard 4CIF cameras, thereby reducing costs. An HD megapixel camera can see more detail in the same field of view or view a wider field of view at the same level of detail.


Forensic Detail – Many existing analog CCTV systems simply do not provide enough resolution or quality for forensic evidence. Huawei HD Megapixel cameras solve many of these quality/resolution issues. They are ideal for applications where the system wants to identify and record faces, vehicle license plates or objects.

Digital PTZ – Huawei HD megapixel cameras can digitally zoom quicker and with greater detail than analog cameras whilst still recording the whole picture for later analysis. This provides superior performance and is more reliable than mechanical PTZ mechanisms.

Benefit from HD technology, at present typical applications for Huawei HD IP cameras include retail point of sale, banks, and casinos, car parks, building entrances, military installations and city centre monitoring.

## 5.3 Front-end access device – CPE

### 5.3.1 Requirements analysis

Based on the A country realistic situation, Huawei customized the outdoor CPE (Customer Premises Equipment), for the camera data transmission, which is based on the LTE TDD technology, with IP67 standard protection, and it can worked in the extremely abominable situation.

In order to enhance the UL throughput, Huawei researched and designed the special TDD ratio according to the 3GPP LTE TDD standard, UL:DL=3:1. More details can be referred to the chapter “LTE TDD frequency planning”.

The CPE support one FE interface, and camera can directly connect to the CPE device. The CPE adopts “ODU only ” design, and internal directional antenna, it makes the better antenna gain and large thoughput.By using this CPE device, the LTE TDD network can provide steady data transmission. The specification can be referred to chapter “LTE TDD Main Equipments Introduction”

### 5.3.2 Technical Specification of CPE

CPE eA660-123 主要特性如下所示：

- 2.3GHz。
- DHCP（Dynamic Host Configuration Protocol）和 NAT（Network Address Translation）。
- 安全：提供防火墙功能。
- 基于 Web 管理。
- 基于 TR-069 协议远程设备管理。
- 内建 LTE 高增益天线。
- IP67
- 5 类 FE 工业网线 POE 供电
- 工作温度满足-40° C ~ 60° C
- 存储温度-40° C ~ 70° C
- 模块内置防雷功能。
- 设计友好的 LED 指示灯，便于用户观察设备状态。

### 5.3.3 CPE Network Topology

XX 项目视频监控 CPE 拓朴如下：

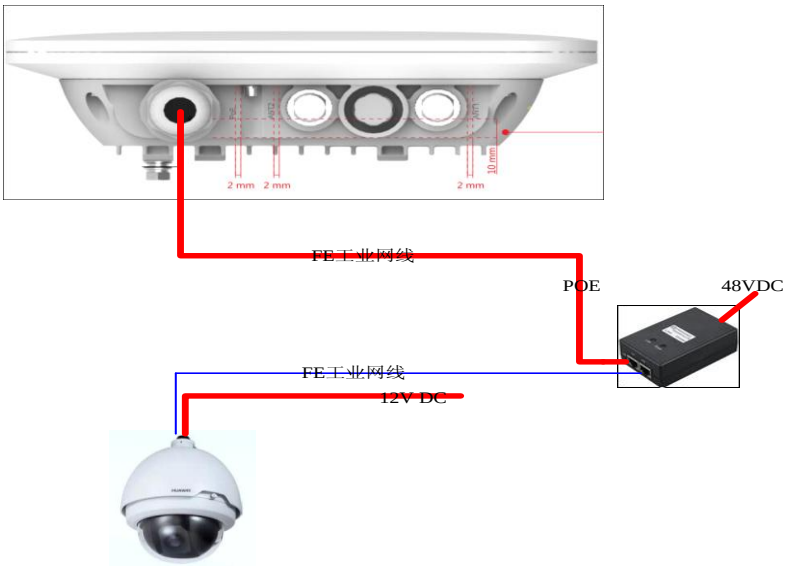
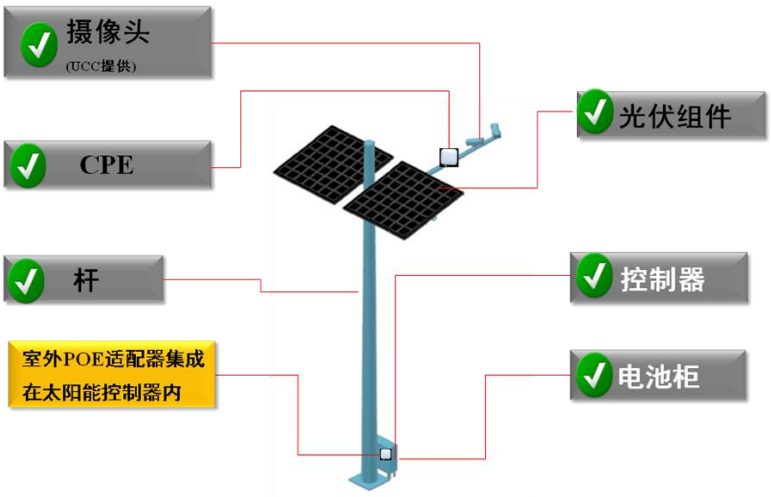



Figure 7 CPE Network Topology

太阳能直接提供 POE 适配功能




### 5.3.4 CPE Interface Type

Table 1 CPE Interface Type

| 设备类型 | 接口 | 备注 |
|---|---|---|
| eA660-123 | FE 1个10/100（RJ45） | RJ45 |
| | ANT1/ANT2 | 天线接口 |
| | SIM卡插槽 | 放在维护窗 |
| | 接地线 | |

| | | |
|---|---|---|
| | 指示灯 | |

## 5.4 Solar Power System Design

### 5.4.1 Requirement Analysis

Based on the technical design, and combine with the requirement from A 国 MOI, there are 4 phases included in this project, the project aims to launch a effective surveillance system all around the W City city (In a agreed specified area), based on the design, totally 13116 cameras are required, which will be located in 8001 different locations.

This detailed design will introduce Huawei site solution for these 8001 camera sites (called front-ends) including power supply system and installation pole for camera and LTE CPE. According to the information provided by MOI, 25% of front-end will be supported by commercial grid power, while 75% shall be covered by solar power. Based on this, below quantities of each phase is calculated in considered in Huawei quotation to MOI:

Table 2 Requirement of Solar Power

| | Phase 1 | Phase 2 | Phase 3 | Phase 4 | Total |
|---|---|---|---|---|---|
| Solar power | 1,496 | 1,295 | 2687 | 526 | 6,004 |
| Commercial grid power | 498 | 430 | 894 | 175 | 1,997 |

Since all the cameras and LTE CPEs are designed to installation on the poles, therefore, 8001 pole are proposed, the pole will strong enough to support solar power, commercial grid power, camera and LTE CPE.

### 5.4.2 Design Principle

The solar power solution for Video Surveillance design has considered the following factors:

- Considered the different solar irradiation according to different station site.

  Longitude and latitude of different station site has different geographical and meteorological characteristics, such as solar irradiation intensity, environment temperature, ground reflection coefficient, atmosphere cleanliness level, terrain and so on. These factors will all influence solar irradiation intensity.
- Taken the least month solar irradiation into account in communication power supply system so that the system reliability.
- Solar power system's inner energy losses should be taken into account. Inner energy losses are including the following factors:

  Dust cover losses, PV module aging de-rating, and efficiency of temperature effect and so on.

  Cable losses, including the one from the module center to the controller and from the battery to solar controller have been considered.

  Battery coulomb efficiency and battery charge-discharge energy efficiency.

  Solar controller efficiency
- Battery backup time also should be sufficient considered the long continuous rainy days in local.

- Pole system shall strong enough to support installation of PV panel and Camera, CPE. Design of pole based on ASCE 10-97.

Commercial power solution for Video Surveillance design has considered the following factors:

- Outdoor environment reliable work.
- Rectifier capacity is able to power the equipment meanwhile charge battery.
- Installation method support hanging on the pole.
- Battery backup time in the event of commercial grid power disconnected
- Pole system shall strong enough to support installation of power box and camera, CPE. Design of pole based on ASCE 10-97.

### 5.4.3 Application Scenario Description

The solar power and commercial grid power are used to provide uninterrupted power for camera and LTE CPE, therefore, power consumption of camera and CPE must be calculated, camera and CPE power consumption is selected as followed:

Table 3 Information of Solar Power Scenarios

| Scenario | Configuration | Rated Voltage | Power(W) | Quantity | Total Power(W) |
|---|---|---|---|---|---|
| Scenario 1 | Box-camera | DC 12V | 20 | 1 | 67 |
| | PTZ-camera | | 8 | 1 | |
| | Infrared lamp | | 7 | 1 | |
| | LTE CPE | | 12 | 2 | |
| | Protective housing | | 8 | 1 | |
| Scenario 2 | Box-camera | | 8 | 2 | 70 |
| | Infrared lamp | | 7 | 2 | |
| | LTE CPE | | 12 | 2 | |
| | Protective housing | | 8 | 2 | |
| Scenario 3 | PTZ- camera | | 20 | 1 | 32 |
| | LTE CPE | | 12 | 1 | |
| Scenario 4 | Box camera | | 8 | 1 | 35 |
| | Infrared lamp | | 7 | 1 | |
| | LTE CPE | | 12 | 1 | |
| | Protective housing | | 8 | 1 | |

There are 4 different configurations of front-end according to the form information above. Consider that the total power consumption of scenario 1 is close to scenario 2, scenario 3 is close to scenario 4. 70W

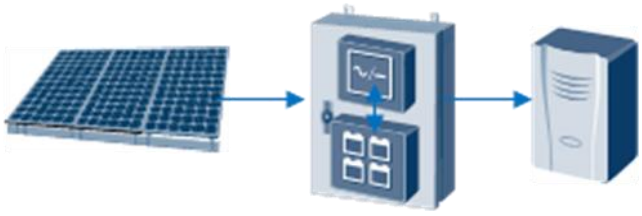
and 35W are considered as the typical load power consumptions. Therefore, 70W capacity power system and 35W capacity power system for both solar and commercial grid power rectifier are proposed in this time project and included in our quotation.

Since all the camera and LTE CPE required 12VDC power input, the proposed solar power shall be capable of outputting 12VDC, and also the commercial grid power rectifier shall capable to switch commercial 220VAC to 12VDC.

All above mentioned solar power, commercial grid power, camera and LTE CPE will be installed on a 6m height pole, the pole will provide 1m console on top of it in order to provide installation plat form for camera and CPE.

### 5.4.4 Solar Power Solution

Solar Power Solution Diagram



Operating principle

Based on the local climate conditions, the solar solution has several operation modes. The main factor is the solar irradiation.

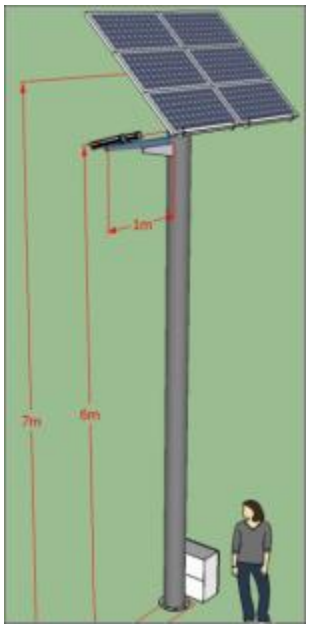
- Scenario 1: Sunny: When the solar energy is sufficient to supply power to the loads, solar controller manage and control that PV modules convert the solar energy to electric energy and supply power to camera and LTE CPE, meanwhile charge for battery.
- Scenario 2: Cloudy: When the solar energy is insufficient to supply power to the load, camera and LTE CPE are powered by the electric energy converted from both the solar energy and battery.
- Scenario 3: Night or rainy: When the solar energy cannot supply power to the loads, the camera and LTE CPE are powered solely by battery.

Design assumption

- PV panels will be installed on the top of pole with flange connection, while solar controller box including controller and battery will be installed and fixed on the concrete ground near pole from the human safety point of view.
- The solar controller box will be equipped grounding system in order to provide grounding connection for the PV panels, CPE and camera. While the system and pole is not equipped lightning rod and system in consideration of A country climate.
- 90 hrs battery backup shall be considered for the continuous rainy day.

Above assumption are considered in the quotation.

Appearance of solar power site




### 5.4.5 Technical Specification of Components

#### 5.4.5.1 Technical Specification of PV Module

PV module is a device that converts solar energy into electric energy. PV module is designed for the direct charging for battery.

Electrical Characteristics

| | |
|---|---|
| Optimum Operating Voltage(Vmp) | 17.2 V |
| Optimum Operating Current(Imp) | 8.15A |
| Open- Circuit Voltage (Voc) | 21.68V |
| Short -Circuit Current (Isc) | 8.67 A |
| Maximum Power at STC(Pmax) | 140 W |

| | |
|---|---|
| Cell Efficiency | 17.40% |
| Operating Temperature | -40℃ to +85℃ |
| Maximum System Voltage | 1000 V DC |
| Maximum Series Fuse Rating | 15 A |
| STC: Irradiance 1000W/㎡, Module temperature 25 ℃,AM=1.5 | |

Temperature Characteristics

| | |
|---|---|
| NOCT | 45±2℃ |
| Temp. coefficient of Pmax | -0.43%/℃ |
| Temp. coefficient of Voc | -0.32%/℃ |
| Temp. coefficient of Isc | 0.059%/℃ |

#### 5.4.5.2 Technical Specification of Pole

Huawei designed pole for the camera installation:

- L type (6+1)m pole are proposed in this project, 6m in main pole and 1m in console member for installation of camera and CPE. Displacement for is designed less than +/- 0.5 $^{o}$C after installed solar and camera, or power rectifier box.
- Flange connection is equipped for pole bottom. In order to connect with foundation by using anchor bolt. For solar power pole, the pole top also equips flange used to install solar panels.
- Pole material, Q235 or S235.
- Two types pole are proposed based on usage scenario:
  - Type1, Main pole 6m: Ø 219.1x7.1mm, Console pole 1m: Ø 76.1x3.6mm), support installation of: Solar panel : 8kg*6 pcs=48kg ; 1195*541*30 mm * 6pcs, Solar structure: 50kg
  - Type 2, Main pole 6m: Ø 159x 6, Console pole 1m Ø 76.1 x 3.6mm), support installation of power rectifier box on 5m height location.

Pole Specification

- Tailor design with Huawei power and front-end equipments
- Easy for installation
- High steady with strong wind resisting capacity
- Cooperating with anti-theft bolt to strengthen anti-theft performance;
- Roomy space for equipments under the support structure, which can resistance solar directly irradiate;

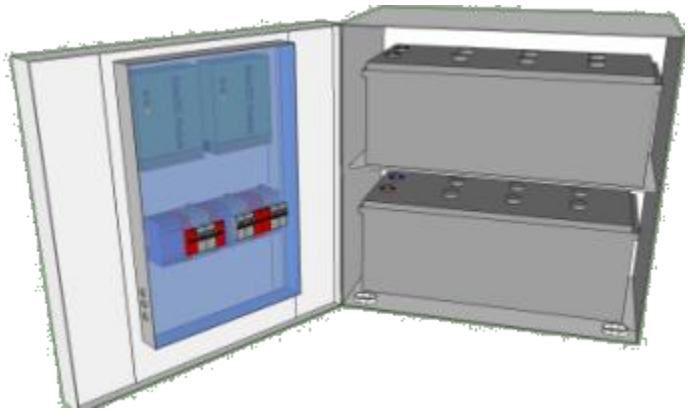
The relation between installed angle and puncheon dimensions.

| Pole Specification Item | Type 1-with solar power | Type 2-with power rectifier box |
|---|---|---|
| Type | L-type | L-type |
| Installation | 6 solar panels and support is installed on top of pole with flange connection | A rectifier box with battery hanged on pole 5m height location. |
| Material | galvanized steel | galvanized steel |
| Design/Operation wind speed | 144/100 kph | 144/100 kph |
| Connection mode | Flange connection | Flange connection |
| Pole Height | 6m | 6m |
| Pole external diameter | 219.1mm | 159mm |
| Pole wall thickness | 7.1mm | 6mm |
| Horizontal cantilever Length | 1000mm | 1000mm |
| Horizontal cantilever external diameter | 76.1mm | 76.1mm |
| Horizontal cantilever wall thickness | 3.6mm | 3.6mm |
| Deflection Criteria | 0.5 °C | 0.5 °C |

#### 5.4.5.3 Technical Specification of Solar Power Cabinet

- Appearance

Solar Power cabinet



- Solar controller Specifications

Solar Controller controls the power to the battery and equipment supplied by solar energy, and thus ensures that the storage battery and equipment work in a normal range of voltage and current. It is a 12V system. Solar Controller supports basic functions as system monitoring, system alarm and recording.

Mechanical Specifications of Solar Controller

| Mechanical Items | Description |
|---|---|
| Type | 12V |
| Cooling mode | Natural cooling |
| Dimension (width x depth x height) | 600mm*600mm*350mm |
| Weight | 50 kg |
| Cabling mode | Bottom in/out |
| Installation | On pole / above ground<br>bove ground selected in this project |

Electrical Specifications of Solar Controller

| Electrical Items | Description |
|---|---|
| Working mode | PWM |
| Output voltage | 12V |
| Max. Charging/Load Current | 20A/40A |

Electrical Specifications of Solar Controller

| Electrical Items | Description |
|---|---|
| Working mode | PWM |
| Output voltage | 12V |
| Max. Charging/Load Current | 20A/40A |
| Self consumption | <4mA |
| Controller capacity | 20A |
| Environment temperature | -20~+50℃ |
| Altitude | 0-4000m |

Feature:

- LCD-Charge and discharge status display;

- Audible alert before load disconnect;
- Load status indicator;
- Deep discharging protection;
- Four-stage PWM charging (series type);
- Integrated temperature compensation function.

#### 5.4.5.4 Technical Specification of Battery Specification

SCB battery

Technical specifications of SCB battery

| Battery Type | Rated Voltage (V) | Rated Capacity ($C_{10}$, Ah) | Weight (kg) |
|---|---|---|---|
| SCB-200A | 2 | 200 | 18 |
| SCB-300A | 2 | 300 | 25 |

#### 5.4.5.5 Technical Specification of Grid Power Rectifier Cabinet

- Appearance

  Grid power cabinet

- Specification

  Technical specifications of power system

| Electrical Items | Description |
|---|---|
| Input voltage | 220 VAC |

| | | |
|---|---|---|
| Output voltage | | 12VDC |
| Capacity | | >12.5 A |
| Environment temperature (℃) | | -20~+65 |
| IP rating | | IP55 |
| Cooling | | Natural |
| Installation | | On pole / above ground<br>On pole selected in this project |
| Communication port | Serial port | RS485 |
| | Output Dry contact | 2 |
| Power distribution | Output branch | 8 |
| | Branch of the storage battery | 2 |

#### 5.4.5.6 Technical Specification of Battery Specification

Backup battery(the picture is only for reference)

Technical specifications of battery

| Battery Type | Rated Voltage (V) | Rated Capacity ($C_{10}$, Ah) | Weight (kg) |
|---|---|---|---|
| GEL-100Ah | 12 | 100 | 37.5 |
| GEL-65Ah | 12 | 65 | 29 |

### 5.4.6 Configuration of Solar Power System

#### 5.4.6.1 Information of Load

| Scenario | Configuration | Rated Voltage | Power(W) | Quantity | Total Power(W) |
|---|---|---|---|---|---|
| Scenario 1 | Gun-camera | DC 12V | 20 | 1 | 67 |
| | Gun-camera | | 8 | 1 | |
| | Infrared lamp | | 7 | 1 | |
| | LTE CPE | | 12 | 2 | |
| | Protective housing | | 8 | 1 | |
| Scenario 2 | Gun-camera | | 8 | 2 | 70 |
| | Infrared lamp | | 7 | 2 | |
| | LTE CPE | | 12 | 2 | |
| | Protective housing | | 8 | 2 | |
| Scenario 3 | Dome camera | | 20 | 1 | 32 |
| | LTE CPE | | 12 | 1 | |
| Scenario 4 | Gun-camera | | 8 | 1 | 35 |
| | Infrared lamp | | 7 | 1 | |
| | LTE CPE | | 12 | 1 | |
| | Protective housing | | 8 | 1 | |

#### 5.4.6.2 Configuration List

- Bill of Main Material for Solar Power System
- For 70w Load

| No | Item | Description | Unit | Quantity |
|---|---|---|---|---|
| 1 | PV Module | PV Module,140Wp, | PCS | *4* |
| 2 | Support Structure | Support structure | SET | *1* |
| 3 | Solar Controller | Solar Controller, 12VDC,40A | PCS | *1* |
| 4 | Battery | 12V,*600 Ah* | SET | *1* |
| 5 | Pole | Galvanized L type pole (Main pole 6m: Ø 219.1x7.1mm, Console pole 1m: Ø 76.1x3.6mm) | PCS | *1* |

- For 35w Load

| No | Item | Description | Unit | Quantity |
|---|---|---|---|---|
| 1 | PV Module | PV Module,140Wp, | PCS | *2* |
| 2 | Support Structure | Support structure | SET | *1* |
| 3 | Solar Controller | Solar Controller, 12VDC,20A | PCS | *1* |
| 4 | Battery | 12V,*300 Ah* | SET | *1* |
| 5 | Pole | Galvanized L type pole (Main pole 6m: Ø 219.1x7.1mm, Console pole 1m: Ø 76.1x3.6mm) | PCS | *1* |

➢ Bill of Main Material for Grid Power Rectifier System

- For 70w Load

| No | Item | Description | Unit | Quantity |
|---|---|---|---|---|
| 1 | Rectifier box | TP1230H, pole mounted, 200VAC input 12VDC output | PCS | 1 |
| 2 | Battery | 12V,100 Ah | SET | 1 |
| 3 | Cable 1 | Power cable from power point to rectifier box | METER | 20 |
| 4 | Cable 2 | Grounding cable from rectifier box to grounding system | METER | 5 |
| 5 | Pole | Galvanized L type pole (Main pole 6m: Ø 159x 6, Console pole Ø 76.1 x 3.6mm) | PCS | 1 |

- For 35w Load

| No | Item | Description | Unit | Quantity |
|---|---|---|---|---|
| 1 | Rectifier box | TP1230H, pole mounted, 200VAC input 12VDC output | PCS | 1 |
| 2 | Battery | 12V,65Ah | SET | 1 |
| 3 | Cable 1 | Power cable from power point to rectifier box | METER | 20 |
| 4 | Cable 2 | Grounding cable from rectifier box to grounding system | METER | 5 |
| 5 | Pole | Galvanized L type pole (Main pole 6m: Ø 159x 6, Console pole Ø 76.1 x 3.6mm) | PCS | 1 |

# 6 LTE Network Design

## 6.1 LTE Technology Introduction

LTE or Long Term Evolution has been heralded as the next evolutionary quantum leap forward for the mobile broadband industry at large. LTE TDD is a fully specified and standardized high-performance TDD (Time Division Duplex) mobile broadband technology for both large-scale coverage deployment and a host of special applications.

The LTE TDD network architecture is shown below:

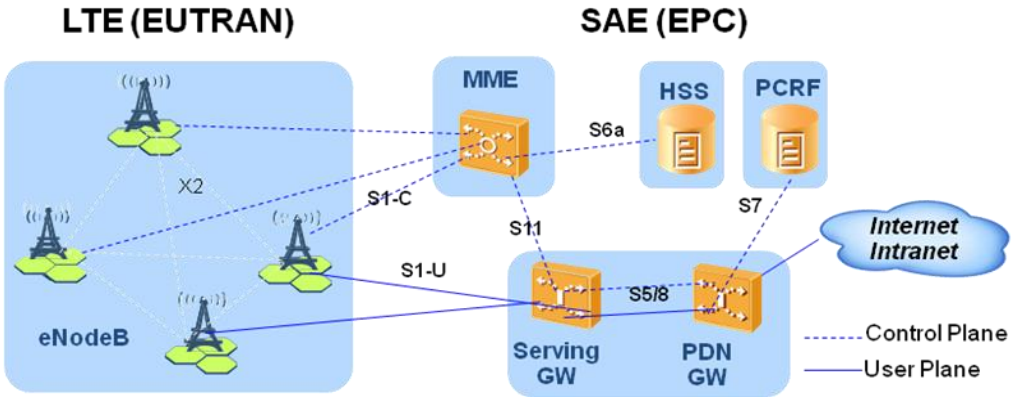



Figure 8 LTE TDD Network Architecture

In this surveillance project, Huawei provides latest wireless solution LTE TDD for wireless access network and LTE SAE core network for fast deployment and high UL throughput for surveillance service, the whole network can be easily upgrade to satisfy future expansion requirement.

Compared with traditional wired solution, the benefits of wireless network video surveillance solution (NVS) as follow:

- Saving cost

  Due to less cable cost and civil work like digging ditch for burying fiber optics, video surveillance system with wireless network is more economic than wired one.

- Fast deployment

  Besides, wired transmission solution takes longer delivery time than wireless one, which saves much time of fulfillment. For the city with river, it is sometime not easy to lay fiber optics, while wireless signal is ubiquitous without physical line.

- Easy expansion

  It will be easy for expansion in the future by adopting wireless solution. When more areas shall be covered with more cameras, only base station or carrier and storage and the software license need to be added. Comparing with wired solution, the heavy civil work will be repeated during each phase of expansion. Also, the position of cameras is very easy to change because there is no attached cable.

- Easy maintenance

  Trouble shooting by wired solution is a painful process, due to difficult to determine the cause by camera or cable. By contrast, locating the problem is much easier by using wireless way.

## 6.2 LTE Network Overall Solution

### 6.2.1 LTE TDD Network Architecture

The LTE TDD network architecture is shown below:

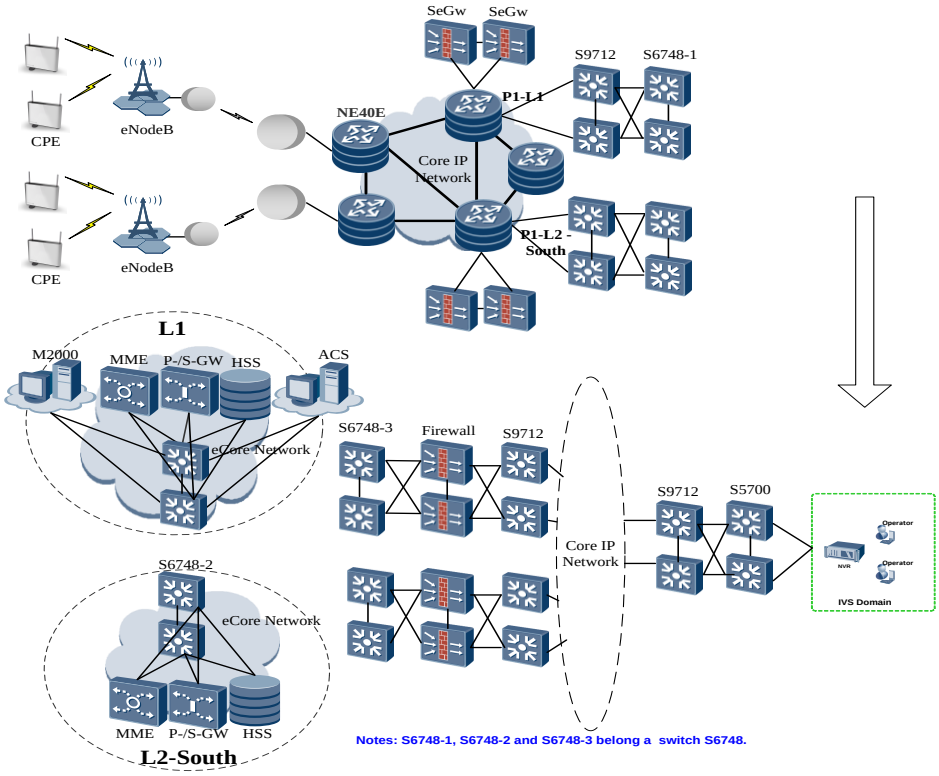



Figure 9 LTE TDD network architecture

LTE TDD 网络提供视频监控数据的回传，骨干网络采用 IP 承载网；

- 摄像机通过无线 CPE 终端接入到 LTE TDD 网络，经 LTE TDD 网络接入到视频监控管理平台；
- 在 L1 及 L2 各部署 1 套 EPC 支持物理区域容灾，EPC 之间通过 IP 承载网互通实现互助；
- eNodeB 与 EPC 间，通过微波、光纤网、IP 承载网互通，支持 EPC 的负荷均衡；
- eNodeB 与 EPC 间部署两组安全网关，每组 2 套 IPSec 支持主备。安全网关侧挂路由器，采用动态路由 OSPF 的方式对 eNodeB 及 EPC 各提供一个 tunnel ip；
- LTE TDD 网络的 SGi 出口部署防火墙，防火墙支持主备；

### 6.2.2 RF Design

1. 天线

XX 项目中，基站使用 RRU3232，射频端口输出功率 20W，共 4 端口。RRU 配置成 4T4R，每扇区双载波，即站型为 S222。为了获得最佳的覆盖效果，建议基站使用 4 端口高增益天线。天线规格如下：

Table 4 L1 Antenna Specification

| Antenna Info |
|---|

| | |
|---|---|
| Antenna Type | AGISSON A25451803 |
| Specification | Port Number:4<br>Frequency:2300~2700<br>Gain:18dBi<br>Horizontal Beam Width: 65<br>Dimensions(H×W×D): 1060×289×85<br>Weight(kg): 15<br>Operation Temperature(℃): -55 ~ +65 |
| Quantity | Phase 1: 204<br>Phase 2: 177<br>Phase 3: 369<br>Phase 4: 72 |
| Appearance |  |

2. 频谱

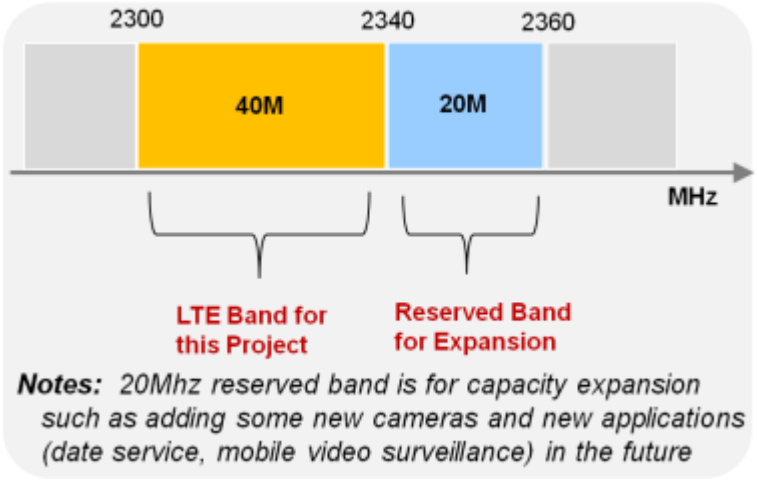
XX 项目中，使用的 TDD LTE 技术拥有最高的频谱利用效率，并且通过改变上下行子帧配比，可以获得灵活的业务速率。

评估项目对频谱的需求，基于以下的考虑：

- 每个摄像头估计使用 1.5M 带宽
- 根据项目原始需求，需要对 W 市整个市区部署视频监控摄像头，总计估计摄像头数量为 xxx 个。
- 3GPP 定义的 LTE 信道带宽为 1.4MHz、3MHz、5MHz、10MHz、15MHz、20MHz。为了尽可能提高系统容量，建议使用单小区使用 20M 带宽
- 视频监控业务主要使用上行资源。华为 TDD LTE 设备可以使用 Type0 的子帧配比，即上下行比例为 3：1。通过系统仿真，使用 Type0 的配置，单小区可以提供不低于 14M 的上行吞吐率。按照每个摄像头需要 1.5M 速率需求，并预留一定的余量，单小区可以支持 8 个摄像头业务，单个 S111 配置的基站，可以支持 24 个摄像头。整网 xxx 个摄像头，需要 xxx 个基站。视频监控的很多场景，摄像头密度很高，单小区 8 个的规格无法满足，所以建议使用 S222 站型，即单扇区配置 2 个频点，每个频点 20M 带宽，总计需要 40M 带宽。这样，每个 S222 配置基站支持 48 个摄像头，站点个数减少为：xxx/48=xx。

| Uplink-downlink configurations | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Uplink-downlink configuration | Downlink-to-Uplink Switch-point periodicity | Subframe number | | | | | | | | | |
| | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 0 | 5 ms | D | S | U | U | U | D | S | U | U | U |
| 1 | 5 ms | D | S | U | U | D | D | S | U | U | D |
| 2 | 5 ms | D | S | U | D | D | D | S | U | D | D |
| 3 | 10 ms | D | S | U | U | U | D | D | D | D | D |
| 4 | 10 ms | D | S | U | U | D | D | D | D | D | D |
| 5 | 10 ms | D | S | U | D | D | D | D | D | D | D |
| 6 | 5 ms | D | S | U | U | U | D | S | U | U | D |

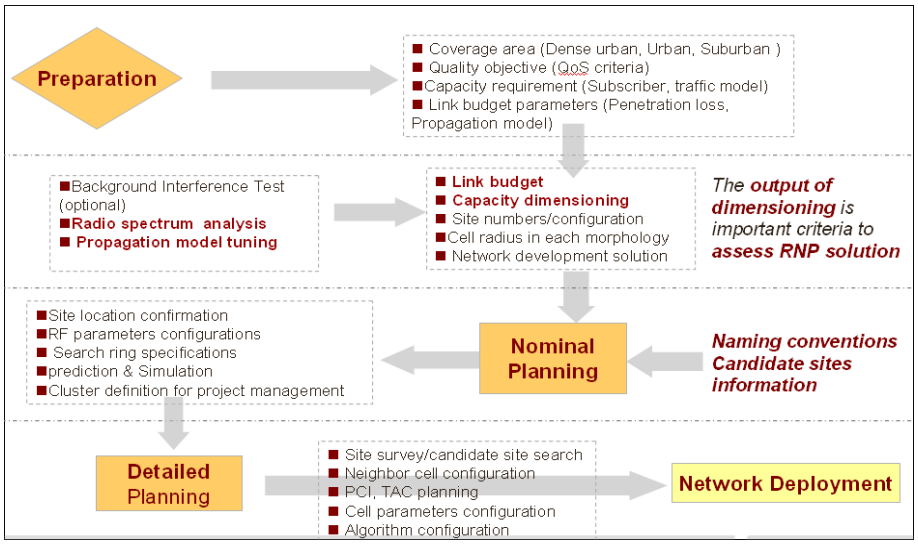
- 考虑到未来的扩容需求，建议预留额外的 20M 带宽。综上，在 Band40 频段上，需求的频谱分布如下：




### 6.2.3 Radio Network Planning

1. Planning Procedures

The figure below illustrates the entire lifecycle of the LTE RNP process specified from the perspective of RNP general routines. What is the most relevant to this context comprises two major phases: nominal planning and detailed planning.



Preparation phase need to collect related Information for RNP, information collection proceeds at the early stage of network planning. It serves link budget, network dimensioning, and network simulation.

Radio network nominal planning is the initial planning over the network before site survey at the early stage of project. It includes the following stages:

- Network dimensioning
- Initial site selection
- System simulation

At the detailed planning of radio network, engineers survey and verify sites one by one based on radio network nominal planning (If the sites cannot meet the requirements or are inaccessible), and select their location according to Search Ring output by nominal planning, determine the engineering parameters related to RNP for guiding project construction, verify the configuration of cell parameters and planning effect by simulation.

Network Optimization process includes Drive Test optimization, KPI optimization, Network Monitoring and Technical Support. Huawei will begin optimization only when a certain number of continuous sites are put on service (for example, 90% of the continuous sites are put on service). For the specified optimization project where there is no site launch at all, the first step is to collect and check site database (engineering parameter table). DT optimization and KPI optimization are committed at the same time. According to the plan of project, self-check should be involved to make clear whether the network quality achieve acceptance criterion. If acceptance criterion has been achieved and the acceptance time has not arrived, the project moves to Network Monitoring process. The support what we said here includes optimization team, R&D team and marketing team, not only optimization technical support team.

2. Fundamental Information

The fundamental information of LTE system is shown below, including frequency, bandwidth, etc.

| Base Information of System | |
|---|---|
| Resource of frequency (MHz) | 2300-2340MHz |
| Channel bandwidth (MHz) | 20+20MHz |
| Duplex | TDD |

3. Antenna Selection

The introduction of MIMO brings more antenna numbers. The space has also become a necessary network planning issues to be considered. Antenna selection is a very important part of LTE radio network planning. It is mainly based on the coverage requirement and installation space. Focusing on the requirements of MOI, we will use below types of antennas for the eNodeB. The main parameters of antennas are described below:

| Main parameters of eNodeB Antenna | |
|---|---|
| Antenna Type | Directional antenna |
| Polarization | Dual-polarized |

| | |
|---|---|
| Gain (dBi) | 18 |
| Half-power beam width | 65° |
| Front-to-back ratio(dB) | ＞25 |

4. Frequency Planning

According to the requirements of MOI, the technical solution has to Offer capacity for

a) Outdoor Video Surveillance Access for more than 10000 cameras .The accurate number of cameras is based on our calculation.

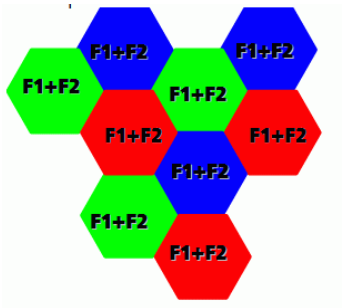
b) Capacity requirement, UpLink:1.5Mbps per camera .

To meet the requirements before-mentioned for Outdoor Video Surveillance Access, Huawei highly recommends S222 solution that supply 20MHz+20MHz double frequencies for each sector. Because it reaches the highest sector Uplink throughput and spectrum efficiency in 40MHz bandwidth. The solution can achieve best performance for the cameras.

- The detail is as following:

| Frequency Planning | |
|---|---|
| Resource of frequency (MHz) | 2300-2340MHz |
| Duplex | TDD |
| Sector Configuration | S222 |
| UL:DL Subframe ratio | 3:1 |
| Bandwidth (MHz)for each Sector | 20MHz+20MHz |

- Cluster and frequency layout :




5. Coverage Planning and Link Budget

- Coverage Area Analysis

Firstly, the whole coverage area was classified into four phases, and each region was further classified into different scenarios:

| Phase | Scenario | Total Area ($Km^2$) |
|---|---|---|
| Phase1 | Dense Urban | Xx |
| Phase2 | Urban | Xx |

| | | |
|---|---|---|
| Phase3 | Urban | Xx |
| Phase4 | Sub Urban | Xx |
| Total | | Xx |

UL Cell Edge Rate

| | Dense Urban | Urban | Suburban | Rural |
|---|---|---|---|---|
| Cell Edge Rate:UL(kbps) | 1500 | 1500 | 1500 | 1500 |

Assumed Parameters and System Parameters

- eNodeB Antenna Height

The antenna heights in different morphologies are proposed below:

| Morphology | Dense-Urban | Urban | Suburban | Rural |
|---|---|---|---|---|
| Antenna Height (m) | 25 | 25 | 30 | 30 |

- Std.Dev.Of Slow Fading

For LTE system, the Std. Deviations. of Slow Fading in different morphologies are shown below:

| Std.Dev.Of Slow Fading | Dense-Urban | Urban | Sub-urban | Rural |
|---|---|---|---|---|
| Indoor | 11.7 | 9.4 | 7.20 | 6.2 |
| Outdoor | 10 | 8 | 6 | 6 |

6. Link Budget Result

For getting the result of link budget, we need to input the parameters as shown below:

Through the link budget, we can get the cell radius in different morphologies. In all morphologies, the system coverage is limited by uplink, so the coverage parameters are shown in the Table below:

- Dense Urban and Urban:

| Morphology | Dense Urban | | Urban | |
|---|---|---|---|---|
| SCH Type | PUSCH | PDSCH | PUSCH | PDSCH |
| Duplex Mode | TDD | | TDD | |
| TDD DL/UL Configuration | #0 5ms 1:3 | | #0 5ms 1:3 | |
| TDD Special Subframe Configuration | #7 10:2:2 | | #7 10:2:2 | |
| User Environment | Outdoor | | Outdoor | |
| Channel Bandwidth (MHz) | 20 | | 20 | |
| Channel Model | ETU 3 | | ETU 3 | |

| MIMO Scheme | 1×4 | 4×2 SFBC+FSTD | 1×4 | 4×2 SFBC+FSTD |
|---|---|---|---|---|
| Cell Edge Rate (kbps) | 1500 | 1500 | 1500 | 1500 |
| Tx | | | | |
| Max Total Tx Power (dBm) | 23 | | 46 | 23 | 46 |
| Allocated RB | 10 | | 30 | 10 | 30 |
| RB to Distribute Power | 10 | | 100 | 10 | 100 |
| Subcarriers to Distribute Power | 120 | | 1200 | 120 | 1200 |
| Subcarrier Power (dBm) | 2.21 | | 15.21 | 2.21 | 15.21 |
| Beamforming Gain | 0 | | 0 | 0 | 0 |
| Tx Antenna Gain (dBi) | 12 | | 18 | 12 | 18 |
| Tx Cable Loss (dB) | 0 | | 0.5 | 0 | 0.5 |
| Tx Body loss (dB) | 0 | | 0 | 0 | 0 |
| EIRP per Subcarrier (dBm) | 14.21 | | 32.71 | 14.21 | 32.71 |
| Rx | | | | | |
| SINR (dB) | 2.64 | | 3.64 | 2.64 | 3.64 |
| Rx Noise Figure (dB) | 3.5 | | 7 | 3.5 | 7 |
| Receiver Sensitivity (dBm) | -126.1 | | -121.6 | -126.1 | -121.6 |
| Rx Antenna Gain (dBi) | 18 | | 12 | 18 | 12 |
| Rx Cable Loss (dB) | 0.5 | | 0 | 0.5 | 0 |
| Rx Body loss (dB) | 0 | | 0 | 0 | 0 |
| Target Load | 50.00% | | 50.00% | 50.00% | 50.00% |
| Interference Margin (dB) | 3.95 | | 9.47 | 3.95 | 9.47 |
| Min Signal Reception Strength (dBm) | -139.65 | | -124.13 | -139.65 | -124.13 |
| Path Loss & Cell Radius | | | | | |
| Penetration Loss (dB) | 0 | | 0 | 0 | 0 |
| Std.of Shadow Fading (dB) | 10 | | 10 | 8 | 8 |
| Area Coverage Probability | 95.00% | | 95.00% | 95.00% | 95.00% |
| Shadow Fading Margin (dB) | 7.93 | | 7.93 | 5.9 | 5.9 |
| Pathloss | 145.92 | | 148.91 | 147.96 | 150.94 |

| Propagation Model | Cost231-Hata(Huawei) | | Cost231-Hata(Huawei) | |
|---|---|---|---|---|
| eNodeB/UE Antenna Height (m) | 25 | 5 | 25 | 5 |
| Frequency (MHz) | 2600 | 2600 | 2600 | 2600 |
| Cell Radius (km) | 1.4 | 1.7 | 2.8 | 3.39 |

- Sub Urban and Rural:

| Morphology | Suburb | | Rural | |
|---|---|---|---|---|
| SCH Type | PUSCH | PDSCH | PUSCH | PDSCH |
| Duplex Mode | TDD | | TDD | |
| TDD DL/UL Configuration | #0 5ms 1:3 | | #0 5ms 1:3 | |
| TDD Special Subframe Configuration | #7 10:2:2 | | #7 10:2:2 | |
| User Environment | Outdoor | | Outdoor | |
| Channel Bandwidth (MHz) | 20 | | 20 | |
| Channel Model | ETU 3 | | ETU 3 | |
| MIMO Scheme | 1×4 | 4×2 SFBC+FSTD | 1×4 | 4×2 SFBC+FSTD |
| Cell Edge Rate (kbps) | 1500 | 1500 | 1500 | 1500 |
| Tx | | | | |
| Max Total Tx Power (dBm) | 23 | 46 | 23 | 46 |
| Allocated RB | 10 | 30 | 10 | 30 |
| RB to Distribute Power | 10 | 100 | 10 | 100 |
| Subcarriers to Distribute Power | 120 | 1200 | 120 | 1200 |
| Subcarrier Power (dBm) | 2.21 | 15.21 | 2.21 | 15.21 |
| Beamforming Gain | 0 | 0 | 0 | 0 |
| Tx Antenna Gain (dBi) | 12 | 18 | 12 | 18 |
| Tx Cable Loss (dB) | 0 | 0.5 | 0 | 0.5 |
| Tx Body loss (dB) | 0 | 0 | 0 | 0 |
| EIRP per Subcarrier | 14.21 | 32.71 | 14.21 | 32.71 |

| | | | | |
|---|---|---|---|---|
| (dBm) | | | | |
| Rx | | | | |
| SINR (dB) | 2.64 | 3.64 | 2.64 | 3.64 |
| Rx Noise Figure (dB) | 3.5 | 7 | 3.5 | 7 |
| Receiver Sensitivity (dBm) | -126.1 | -121.6 | -126.1 | -121.6 |
| Rx Antenna Gain (dBi) | 18 | 12 | 18 | 12 |
| Rx Cable Loss (dB) | 0.5 | 0 | 0.5 | 0 |
| Rx Body loss (dB) | 0 | 0 | 0 | 0 |
| Target Load | 50.00% | 50.00% | 50.00% | 50.00% |
| Interference Margin (dB) | 3.95 | 9.47 | 3.95 | 9.47 |
| Min Signal Reception Strength (dBm) | -139.65 | -124.13 | -139.65 | -124.13 |
| Path Loss & Cell Radius | | | | |
| Penetration Loss (dB) | 0 | 0 | 0 | 0 |
| Std.of Shadow Fading (dB) | 6 | 6 | 6 | 6 |
| Area Coverage Probability | 95.00% | 95.00% | 95.00% | 95.00% |
| Shadow Fading Margin (dB) | 3.91 | 3.91 | 3.91 | 3.91 |
| Pathloss | 149.94 | 152.92 | 149.94 | 152.92 |
| Propagation Model | Cost231-Hata(Huawei) | | Cost231-Hata(Huawei) | |
| eNodeB/UE Antenna Height (m) | 30 | 5 | 30 | 5 |
| Frequency (MHz) | 2600 | 2600 | 2600 | 2600 |
| Cell Radius (km) | 5.86 | 7.12 | 9.26 | 11.25 |

➢ Result of Link Budget

| Morphology | Dense-Urban | Urban | Sub-urban | Rural |
|---|---|---|---|---|
| Cell Radius (km) | 1.4 | 2.8 | 5.86 | 9.26 |
| Site Coverage($km^2$) | 3.82 | 15.28 | 66.93 | 167.12 |

7. Capacity Planning

➢ Site number calculation process

Considering of the Uplink capacity requirements is 1.5Mbps per camera , we could make the calculation of site number based on capacity . Considering 15% sector throughput backup for topography and camera distribution redundancy . The calculation result of camera numbers per sector is as following:

| Scenario | Frequency Plan per Sector | Average throughput per Sector UL (Mbps) | Camera Number per Sector | Camera Number per Sector (15% Backup) |
|---|---|---|---|---|
| DenseUrban/Urban | 20MHz+20MHz | 14.1+14.1 | 18 | 16 |
| SubUrban/Rural | 20MHz+20MHz | 14.1+14.1 | 18 | 16 |

➢ The calculation result of camera numbers per site is as following:

| Scenario | Site Mode | Camera Number per Site | Camera Number per Site (15% Backup) |
|---|---|---|---|
| DenseUrban/Urban | S222 | 54 | 48 |
| SubUrban/Rural | S222 | 54 | 48 |

➢ The required Site number based on capacity is below :

| Phase | Camera number | Site number |
|---|---|---|
| Phase1 | 3,268 | 68 |
| Phase2 | 2,828 | 59 |
| Phase3 | 5,871 | 123 |
| Phase4 | 1,149 | 24 |
| Total | 13,116 | 274 |

According to the prediction area and site number, the distance between two sites is as follow:

| Phase | Scenario | Total Area ($Km^2$) | Area per Site($km^2$) | Site Radius (km) | Distance between Sites |
|---|---|---|---|---|---|
| Phase1 | Dense Urban | 85.6 | 1.26 | 0.80 | 1.21 |
| Phase2 | Urban | 112.5 | 1.91 | 0.99 | 1.48 |
| Phase3 | Urban | 293.1 | 2.38 | 1.11 | 1.66 |

| | | | | | |
|---|---|---|---|---|---|
| Phase4 | Sub Urban | 383.1 | 15.96 | 2.86 | 4.29 |

Based on the sites distance from capacity dimensioning , we can totally meet the coverage requirement at the same time.

8. Dimensioning Result

We locate 274 sites in four phases of this project , The final result of the Site number is below:

| Phase | Phase1 | Phase2 | Phase3 | Phase4 | TOTAL |
|---|---|---|---|---|---|
| Site Number | 68 | 59 | 123 | 24 | 274 |

### 6.2.4 Site Evaluation and Selection

Ensure that each cameras could get sufficient throughput is a big challenge for network planning. The allocation of the BTS and cameras must be reasonable, so it's necessary to make out several principles to guide the sites survey.

- Principle1: Overlap

  The coverage area of each site should be cleared and minimize the cell's overlap.

  Avoid deploying the cameras in the overlap area of several cells. The CPE in the overlap area will suffer serious interference from the adjacent sites and can't achieve the common performance.

- Principle2: Distance

  The capacity dimension result is made out from the assumption that the cameras are evenly distributed in the surveillance area. If there are too many cameras distributed on the edge of sites, the capacity of the site will decline.

  So we suggest that the maximum distance between cameras and site should not exceed the link budget cell radius on different scenarios and the average distance between the cameras and site should not exceed the half of site coverage radius.

  Cameras should be deployed as close as possible to the site.

  Based on this principle, the average distance between the cameras and site is as following:

| Scenarios | Radius(km) | Average Distance(km) |
|---|---|---|
| Dense Urban | 1.4 | 0.7 |
| Urban | 2.8 | 1.4 |
| Sub Urban | 5.86 | 3.0 |
| Rural | 9.26 | 4.7 |

- Principle3: Density

  Cameras with high density means that there must be some cameras cannot get the service. On the contrary, cameras with low density means that wireless resource will be wasted.

  The number of cameras belong to one cell should not exceed 10.

### 6.2.5 Cell Planning

- Tracing Area Planning

Tracing area code is a important property of cells. A clutter of cells must be given a specific TA code which is unique in the whole network. The terminal will update/report the new TA code to CN when it has entered a new cell which belongs to a different tracing area. The purpose of TAU (Tracing Area Update) is to inform CN where I am. When the CN need to paging a terminal, it will send the paging messages only in the specific tracing area corresponding to the specific terminal.

The CN rarely paging the terminals when the service is video surveillance. The tracing area could be designed as large as possible. But in some extreme cases, large number terminals frequently dropped and registered, that would bring a lot of TAU messages which caused an instantaneous high load on the network. Therefore, we suggest that the network is divided into 4 different tracing areas.

- Neighbor Cell Planning

  The purpose of the neighbor cell planning is to ensure the handover and cell reselection for terminals.

  Although the terminal is fixed in the video surveillance service, the possibility of handover and cell reselection is still exist.

  We recommend using UNET to complete the neighbor cell planning automatically.

  Note: UNET is a system simulation and planning tool made by Huawei.

- PCI Planning

  PCI, the physical cell ID, is used to distinguish different cells. LTE has 504 PCI code and every 3 PCI codes composed of a group. The PCI code indicates the position of RS symbol, so the neighbor cells must be given different PCI code to avoid RS interference.

  We recommend using UNET to complete the cell PCI planning after the site position is determined.

- PRACH Planning

  Random access play an important role in the LTE system and it is the only method to accomplish the initial connection, handover, and connections rebuild operation.

  The purpose of PRACH planning is to allocate every cell with reasonable ZC root sequence. The preamble generated by the ZC root sequence corresponding to a clutter of neighboring cell should be different thus will decrease the interference.

  We recommend using the UNET to complete the PRACH planning after the site position is determined.

### 6.2.6 Power Control Parameters

Use the common settings for downlink power control. When the downlink antenna mode is 4T4R (2 ports) and the transmitter power is 20W, the RS power should be 15.2 dBm, Pb is 1, and Pa is -3.Channel power offset is show as blow:

| Channel | Power Offset |
|---|---|
| SCH | 0 |
| PBCH | -3 |
| DBCH | -3 |
| PCFICH | 0 |
| PHICH | 0 |
| PDCCH | -3 |

| | |
|---|---|
| PDSCH | -3 |

## 6.3 eNodeB Design

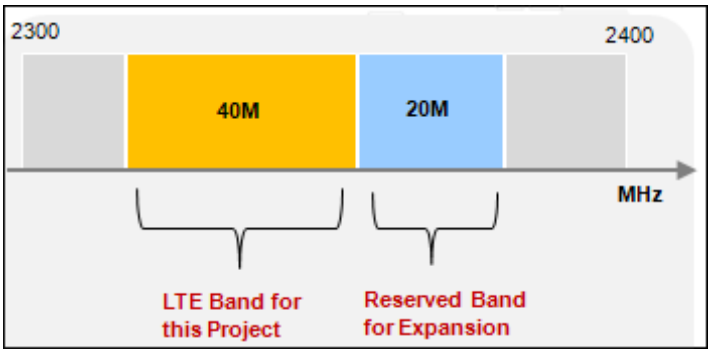
### 6.3.1 Resource Allocation Design

1. 设计概述

所有站点的 eNodeB 站型及配置相同，站型选择 DBS3900，包括 BBU3900 及 RRU3232(2.3GHz)。

- BBU3900 采用-48VDC 供电，配置 1 块风扇板及电源板（输出功率 360W），配置 2 块 LBBPd2 单板支持 6 个 20MHz 4T4R 小区，主控传输板采用 UMPTa6。BBU 与微波 IDU 共柜部署，S1 接口不涉及防雷。BBU 不支持环境监控。
- RRU3232 需要部署 3 个，支持 3 扇区 4T4R。

eNodeB 采用 TDD 制式，频段为 BAND40，总带宽 60MHz。eNodeB 扇区配置 S222，3 个扇区，每扇区部署 2 个 20MHz 频带的载波，剩下 20MHz 频带保留作为未来扩展。小区支持子帧配比 0(UL:DL 配比 3:1)，以提升上行容量。




| Frequency Planning | |
|---|---|
| Resource of frequency (MHz) | 2300~2400Mhz |
| Duplex | TDD |
| Sector Configuration | S222 |
| UL:DL Sub-frame Ratio | 3:1 |
| Bandwidth (MHz)for each Sector | 20MHz+20MHz |

2. 单板槽位配置设计

BBU3900 单板配置见下图：

| Board Type | Slot:Board Type | Slot:Board Type | Slot:Board Type |
|---|---|---|---|
| 16:FAN | 0: | 4: | 18: |
| | 1: | 5: | |

| Board Type | Slot:Board Type | Slot:Board Type | Slot:Board Type |
|---|---|---|---|
| | 2: LBBPd | 6: | 19: UPEU |
| | 3: LBBPd | 7:UMPT | |

其中，

1) 19 槽位部署电源板 UPEUc，将-48V DC 输入电源转换为 BBU3900 所需的+12V 工作电源，输出功率 360W；

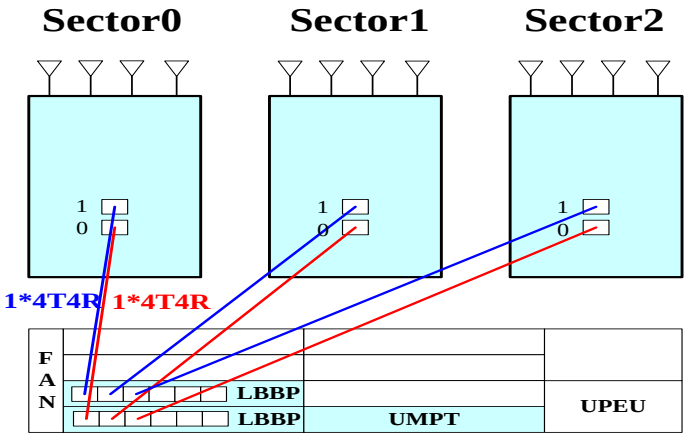
2) 7 槽位部署主控传输板 UMPTa6，为其它单板提供信令处理和资源管理等功能；

3) 2、3 槽位部署基带板 LBBPd2，实现 2 个载波的基带信号处理功能。

注意：BBU3900 与微波 IDU 共柜部署， BBU3900 的 S1 接口不涉及防雷。

3. CPRI 配线

BBU 支持 S2/2/2 (2300-2400M, 20MHz, 4T4R, DL 4*2MIMO)，同扇区双载波共享单个 RRU 的 4T4R。




每个 BBU 需要配置 2 块基带板 LBBPd2。

2 块 LBPPd2 单板部署在 2、3 槽位。

3 号槽位的基带板 CPRI 端口 0~2 依次连接 3 个 RRU 的 0 号端口（载波 1）。

2 号槽位的基带板 CPRI 端口 0~2 依次连接 3 个 RRU 的 1 号端口（载波 2）。

### 6.3.2 IP Interconnect Design

1. 与 EPC、M2000 的互联

eNodeB 以微波及 IP 承载网作为回传网络接入到 L1、L2-South 的 EPC 及 L1 的 M2000 中。两套 EPC 前部署 SeGW 与 eNodeB 建立安全联盟，为 S1 接口承载的数据提供 IPSec 服务。

eNodeB 与接入微波设备的 IDU 共柜部署。eNodeB 的 UMPT 通过千兆电口与微波 IDU 设备互连，1:1 对接。

2. IP 地址规划

eNodeB 的 IP 地址需求：

1) 1 个 IPSec IP：配置在物理接口 FE/GE0 电口，同时与两组 SeGW 建立 IPSec 隧道；

2) 2 个 S1 接口 IP：配置在逻辑接口，分别用于与 L1、L2 的 CN 建立 S1 通道。
3) 1 个 OM 通道 IP：配置在逻辑接口，用于与 M2000 建立维护通道。
4) 1 个近端维护 IP：配置在物理接口 USB 口(USB 及维护复用)，用于近端的维护。默认 192.168.0.49/24，可配置。

eNodeB 的 IP 地址规划约束：

1) eNodeB 所有 IP 地址，不能处于同一网段或存在子网包含关系；
2) eNodeB 所有 IP 地址，与网络上其它子网的 IP 地址不能处于同一网段或存在子网包含关系。

3. IP 路由规划

eNodeB 需要配置 2 条路由，路由到 L1 及 L2 监控中心的 SeGW，下一跳为 eNodeB 到 SeGW 间最近的 IP 网关。

| Service Stream | Destination NE | Route Type | Destination IP | Netmask | Nexthop IP |
|---|---|---|---|---|---|
| S1&OM | SeGW near L1 | static | SeGW Tunnel IP1 | | |
| S1&OM | SeGW near L2-South | static | SeGW Tunnel IP2 | | |

### 6.3.3 QoS Design

无线网络层：eNodeB 通过将高优先级的业务映射到高优先级的逻辑信道上，保证高优先级的业务优先得到调度。这部分由 eNodeB 内部处理，无需配置。

传输网络层：将业务优先级映射到 IP 层的 DiffServ PHB，标记不同的 DSCP，且可由网络维护工程师灵活配置，包含如下部分：

- 信令面、用户面、OM 等到 DSCP 映射；
- 用户面到 QCI 的映射，QCI 可扩展；

1. LTE 承载业务的 QOS 的分类

XX 项目中，基站主要承载一下四种业务：

| Services | Protocol | Src IP | Src Port | Dst IP | Dst Port |
|---|---|---|---|---|---|
| 摄像机管理 | TCP | CPE IP | - | 视频管理服务器 IP*5 | 5080、5081 |
| 视频业务 | TCP/UDP | CPE IP | - | 媒体处理服务器 IP*（L1:57;L2：21*4） | TCP:25000~25999 UDP:26000~29999 |
| 摄像机升级服务 | TCP | CPE IP | - | 视频管理服务器 IP*5 | 8800(HTTP+XML) |
| CPE管理 | TCP | CPE IP | - | CPE网管服务器 | 80(HTTP)、8443(HTTPS) |

- 摄像机上传的视频业务，带宽要有保障，优先级最高，配置成 GBR；
- 摄像机的设备配置及网管，优先级可适当放低；建议后续 IVS 支持设备配置、网管的流分离，便于 Qos 差异化服务。
- 摄像机的升级服务，优先级最低；
- CPE 终端的网管(含升级)，优先级不低于摄像机的 FTP 服务。

23.203 协议中对 LTE QOS 进行了定义，包括了 QCI1~8 种类型的业务，以及各业务的 QOS 参数（优先级，时延和错包率）。

根据 LTE 承载业务的 Qos 要求，同时考虑 Qos 未来扩展，相关业务的 Qos 类型定义如下。

CPE 开户的默认承载为 8。

| QCI | Resource Type | Priority | Packet Delay Budget | Packet Error Loss Rate | Services |
|---|---|---|---|---|---|
| 1 | GBR | 2 | 100 ms | $10^{-2}$ | 无 |
| 2 | | 4 | 150 ms | $10^{-3}$ | 视频业务 |
| 3 | | 3 | 50 ms | $10^{-3}$ | 无 |
| 4 | | 5 | 300 ms | $10^{-6}$ | 无 |
| 5 | Non-GBR | 1 | 100 ms | $10^{-6}$ | 无 |
| 6 | | 6 | 300 ms | $10^{-6}$ | 摄像机管理 |
| 7 | | 7 | 100 ms | $10^{-3}$ | 无 |
| 8 | | 8 | 300 ms | $10^{-6}$ | CPE管理、摄像机FTP服务 |

2. 信令面、用户面、OM 等到 DSCP 映射

DSCP 映射配置如下：

| Service Type | | DSCP | DSCP | 配置 DSCP 值的 MML |
|---|---|---|---|---|
| 视频业务 | QCI2 | 0x1A | 26 | SET DIFPRI |
| 摄像机管理 | QCI6 | 0x12 | 18 | SET DIFPRI |
| CPE管理、摄像机升级服务 | QCI8 | 0x0A | 10 | SET DIFPRI |
| SCTP | | 0x2E | 46 | SET DIFPRI |
| OM | MML | 0x2E | 46 | SET DIFPRI |
| | FTP | 0x0E | 14 | SET DIFPRI |
| IKE | | 0x30 | 46 | SET IKECFG |
| Ping报文 | | 0x3F | 63 | PING |

| Service Type | DSCP | DSCP | 配置 DSCP 值的 MML |
|---|---|---|---|
| Ping（响应报文） | 0 | 0 | 不需配置，对端 ping eNodeB 的DSCP是多少，eNodeB响应报文的DSCP就是多少。一般传输设备和核心网的ping命令DSCP Value是0 |
| ARP | 无DSCP值 | | 无需配置 |

3. 传输调度 QOS

eNodeB 与 S-GW 的用户面承载基于 Any Qos 的 IP Path。

eNodeB 传输支持基于 DSCP 的差异化队列调度，保证高优先级的业务在内部也能够得到优先的调度。推荐 DSCP 与调度队列之间的映射关系如下图表所示：

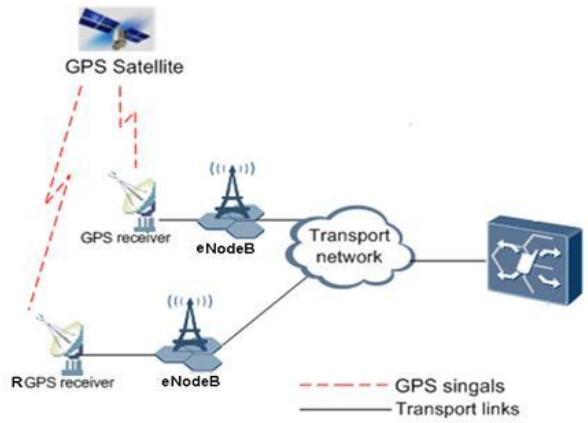
| DSCP | Queue No. |
|---|---|
| 46 | 0 |
| 34 | 1 |
| 26 | 2 |
| 18 | 3 |
| 14 | 4 |
| 10 | 5 |
| 0 | 6 |

队列对应的 DSCP 值是可以通过 MML 命令进行设置。

### 6.3.4 Clock Synchronization Design

eNodeB 采用 GPS 作为参考时钟，配置为时间同步方式。

GPS 天馈系统在 1575.42MHz 接收 GPS 信号，并将信号发送到 UMPT 单板上 GPS 模块。GPS 模块对信号进行处理后，将其发送到主时钟模块实现 eNodeB 的时钟同步。



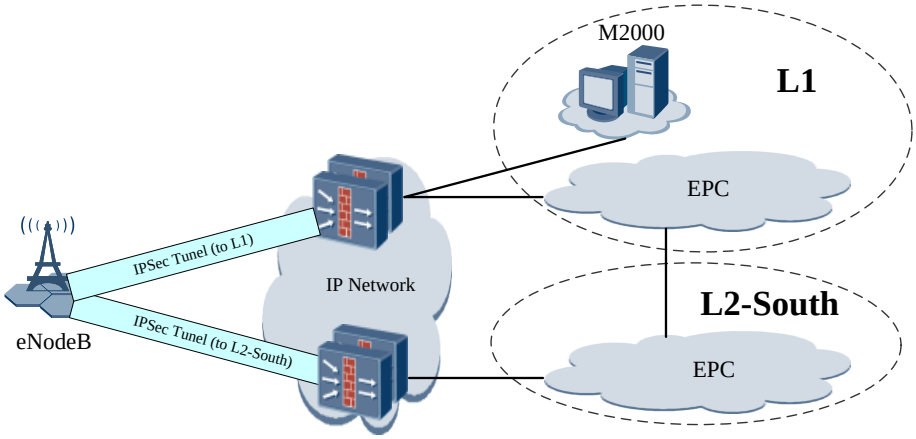
### 6.3.5 IPSec Design

1. IPSec 组网设计

本项目在 eNodeB 的 S1 接口上部署 IPsec，保护 eNodeB 与 EPC 的通信安全。

1) IPSec 版本为 V2；
2) IPSec 双方建立安全联盟过程中，采用预共享密钥 (PSK)方式进行认证；
3) IPSec 工作于隧道方式，采用 ESP 封装；

eNodeB 与 EPC 间部署两组安全网关，每组 2 套 IPSec 支持主备。具体组网如下：




IP 承载网为 eNodeB 提供不同的链路到 2 套 EPC。eNodeB 进行链路的负载分担，当 1 条链路故障时（例如 SeGW 侧的路由器故障），eNodeB 可以把所有的业务切换到另一条链路上。

eNodeB 使用 1 个物理接口 IP 地址同时与两组 SeGW 各建立 1 条 IPSec 隧道。每组 SeGW 有 2 个主备的 SeGW 组成，对 eNodeB 及 EPC 提供一条隧道 IP 地址。

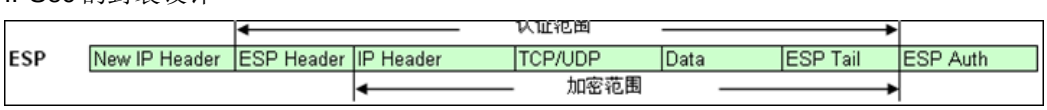
CPE 的 S1 链路信令面及用户面的路由关系如下：

1) eNodeB 使用不同的逻辑接口 IP 地址，与两个 MME 建立 S1 连接。
2) CPE 发起无线承载时，eNodeB 根据两个 MME 的负载情况均衡选择其中一个 EPC 并建立 S1 用户面承载（包括 S1-MME,S1-U）。
3) eNodeB 上传到 EPC 的数据(包括信令面、用户面)，首先关联到对应的 S1 链路，之后基于 S1 链路目的 IP 地址的 ACL 规则自动匹配到对应的 IPSec 隧道。
4) EPC 下发到 eNodeB 的数据，首先关联到对应的 S1 链路(包括信令面、用户面)，之后基于 eNodeB 的 S1 接口 IP 路由到对应的 SeGW 组。SeGW 匹配该分组到对应的 IPSec 隧道。

eNodeB 与 M2000 间的 OMCH 路由关系如下：

1) eNodeB 上传到 M2000 的分组，基于 M2000 的 OMC 通道 IP 的 ACL 规则自动匹配到对应的 IPSec 隧道。
2) M2000 下发到 eNodeB 的分组，基于 eNodeB 的 OM 通道 IP 路由到对应的 SeGW 组。SeGW 匹配该分组到对应的 IPSec 隧道。

2. IPSec 的封装设计



本项目使用 ESP 隧道模式，提供以下安全服务：

1) 访问控制：IPSec 阻止用户对资源的未授权使用，包括阻止以未授权的方式来使用资源，资源包括安全网关后面的网络及其带宽等。

2) 数据机密性保护：IPSec 发送方在通过网络传输包前对包进行加密。

3) 数据完整性验证：IPSec 接收方对发送方发送来的包进行认证，以确保数据在传输过程中没有被篡改。

4) 数据来源认证：IPSec 接收方对 IPSec 包的源地址进行认证。这项服务基于数据完整性服务。

5) 抗重放：IPSec 接收方可以检测和拒绝被重放的包。

3. IPSec 保活设计

本项目采用对等体存活检测(DPD,Dead Peer Detect)检测 IPsec 邻居状态。在 IPsec 邻居故障时，将触发 IKE 和 IPSEC SA 重协商，协商成功后，删除旧的 IKE 和 IPSEC SA。

### 6.3.6 Characteristics Design

1. S1-Flex 特性

1) S1-Flex 特性简介

S1-Flex 特性是指一个 eNodeB 与多个 MME 建立 S1-MME 连接，这多个 MME 组成了 MME 资源池。当 UE 从某个 eNodeB 接入时，eNodeB 为其选择该 UE 得 MME，并建立专用的 S1 接口连接。

引入了 S1-Flex 特性后，它的主要作用：

- UE 在同一个 MME 资源池覆盖区内移动时无需改变服务 MME，从而降低了信令开销。
- MME 资源池内实现负载均衡，提高共享增益。
- 网络便于管理，如调整网络拓扑更容易，对现有业务影响降低，增删 MME 节点更简便。
- MME 资源池内的 MME 互为备份，提高网络可靠性。

2) 特性设计

本项目在 L1 及 L2-South 各部署 1 套 EPC，实现物理容灾。

eNodeB 部署 S1-Flex 特性，分别与两个 MME 建立 S1 连接。两个 MME 构成负载分担资源池各承担 50%的负载。当其中一个 MME 故障时，另一个 MME 支持承担 100%的负载。

eNodeB 基于负载均衡原则选择 MME，选择合适的 MME。本项目两个 MME 的容量相同，eNodeB 主要以 MME 当前的专用连接数来评估 MME 的负载；

MME 发生过载或过载解除时，将发送消息（Overload Start/ Overload Stop）通知 eNodeB。MME 过载时，eNodeB 将尽量不再把新接入用户分配给该 MME。

当到某个 MME 的 S1 链路控制面故障时，eNodeB 直接释放该 S1 上的连接态用户。用户重新接入时，eNodeB 为其分配到 S1 链路正常且不过载的其它 MME。

3) 配置要求

S1-Flex 特性的引入，不仅要求每个 eNodeB 与多个 MME 相连，同时，还要求 eNodeB 能够把 UE 的信令正确地路由到不同 MME，也就是 eNodeB 需要与各个 MME 建立 S1-MME 连接，才能确保将信令路由到各个 MME。

- 部署 S1-Flex License；
- eNodeB 与两个 MME 需要进行参数协商。协商的参数包括：MCC,MNC,TAC，SCTP 端口号,IP 地址,MME 版本号(R8/R9)等；

- 需要配置 eNodeB 到 2 个 MME 的 SCTP 链路；
- eNodeB 配置 S1 接口链路将 MME 与和它相关 SCTP 链路对应起来；

2. 子帧配比 0 特性

1) 子帧配比 0 特性简介

本特性使得客户可以在上行容量为主的网络中选择配置上下行子帧配比 0（上下行子帧配比 3:1），提升用户及小区的上行吞吐量。

| Uplink-downlink configurations | Downlink-to-Uplink Switch-point periodicity | Subframe number | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 0 | 5 ms | D | S | U | U | U | D | S | U | U | U |
| 1 | 5 ms | D | S | U | U | D | D | S | U | U | D |
| 2 | 5 ms | D | S | U | D | D | D | S | U | D | D |
| 3 | 10 ms | D | S | U | U | U | D | D | D | D | D |
| 4 | 10 ms | D | S | U | U | D | D | D | D | D | D |
| 5 | 10 ms | D | S | U | D | D | D | D | D | D | D |
| 6 | 5 ms | D | S | U | U | U | D | S | U | U | D |

TDD LTE 部署子帧配比 0 特性时，小区的上行吞吐量达到最大，单用户吞吐量提升 50%。

要求 eNodeB 及 CPE 同时支持子帧配比 0 特性。

2) 特性设计

本项目以上行应用为主，单小区平均支持 8 个 IPC 的视频监控业务的上传，上行容量要求高。在网络下行带宽要求不高而上行带宽受限场景下，需要把更多的空口资源分配给上行。部署子帧配比 0 特性后，小区容量可提升到 14Mbsp。

3) 配置要求

本特性需要部署子帧配比 0 的 licence。

eNodeB 的所有小区的子帧配比需要配置成子帧配比 0。

## 6.4 Site Power Supply Design

### 6.4.1 Design Principle

This technical proposal is to present you Huawei site solution for these 274 sole eNodeB base station including equipment room, green energy and power supply system and tower system. Huawei site solution vision is to provide green, cost effective, reliable and compact solution to the customer, through this proposal, you will find Huawei's patent solutions especially on equipment room, energy and power supply system, further of this, you could also find how Huawei's site solution could provide green, cost effective, reliable and compact.

The PowerCube 1000 has considered the following factors:

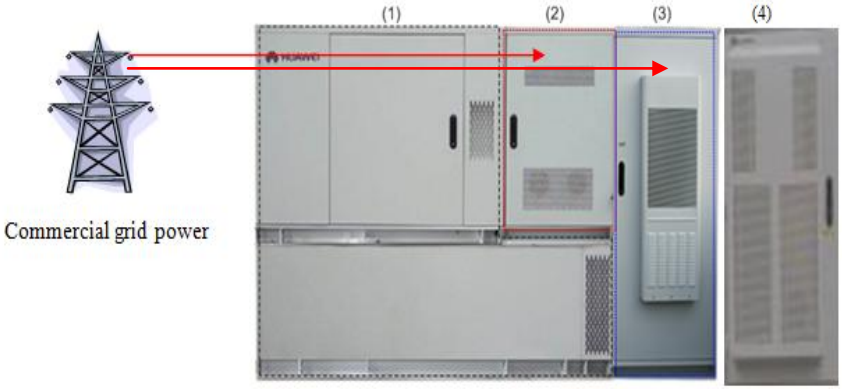
- Capacity of generator should capable to provide power for all electrical equipments including eNodeB base station, transmission equipments, battery charge, equipment room cooling system and light.
- Battery could able to support 4 hours in the event of grid power disconnection, in addition of considering depth of discharge(DOD).
- Battery should be cyclic type which guarantee long life cycle and save battery replacement cost. Battery should have 2000 cycles @ 60% DOD@25oC.
- Battery room should use DC air conditioner which could provide constant temperature for battery even when grid power absent.
- The control system should capable to detect different power resource status and send intelligent control command, control system should use battery to power equipments priority than generator if battery capacity allows, thus to reduce generator running time and save cost.
- The control system should be able to maintain the battery, for example each 1 month to initiate grid otherwise start generator to fully charge the battery. In order to avoid battery de-rating happens.

Power rectifier system of PowerCube 1000 should enough to provide power for all DC equipments such as eNodeB, transmission, battery charging, DC air conditioner, etc.

### 6.4.2 Power Supply Design

As introduced in above, these 2 site scenario will utilize mini-shelter and PowerCube 1000 solution, but the quantity of mini-shelter and PowerCube 1000 will be different, below picture will give you better idea.

Green filed site for 2000W terminal site



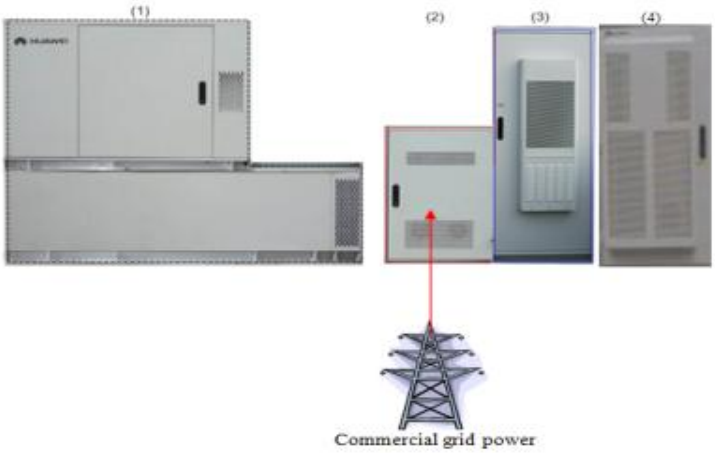

(1) Energy plant system (2) Energy control system (3) Energy storage system

(4) Mini-Shelter for equipment room

Energy plant system (Including generator and fuel tank), energy control system and energy storage system are three main parts of PowerCube 1000.

Since the green-field site, all the equipments are located on the ground, therefore, the energy plant system, energy control system and energy storage system will be integrated together as the figure shows.

Rooftop site for 2000W terminal site



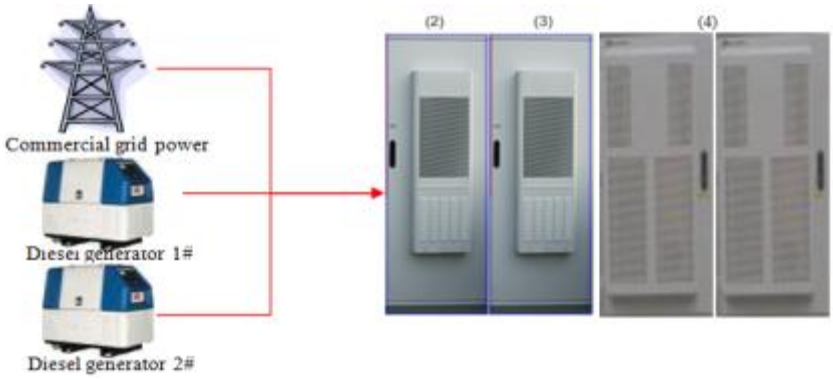

Because roof of building has limited weight afford capability, it is not possible to install energy plant system into roof as well, therefore, the energy plant system of PowerCube 1000 will be separated from energy control system and energy storage system. Energy plant system will be installed on the ground, while energy plant system and energy storage system as well as mini-shelter will be installed on the roof.

Green field site for 4300W transmission hub site

In this scenario sites, from telecommunication equipment side, fiber transmission are configured which equal to 2200W power consumption, and, a higher level microwave transmission equipment is considered whose dimension is 5U and address for 300W power consumption, in addition with eNodeB LTE base station, will totally require 2 cabinets of Mini-Shelter to contain all equipments instead of 2000W scenario 1 cabinet.

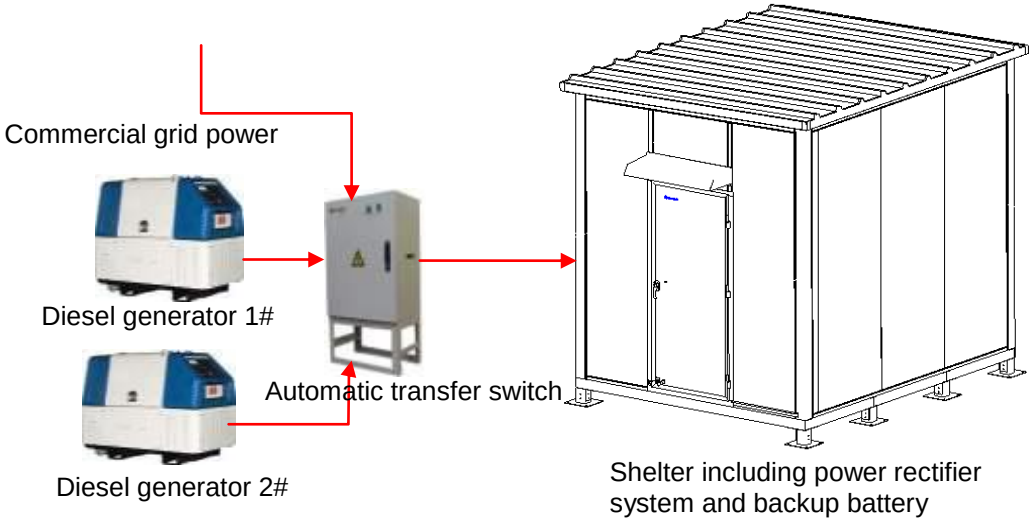
Since the power consumption is higher, the energy storage system is also required to expand to 2 cabinets in order to contain more battery.

The equipments and battery expansion will also require higher capacity diesel generator, and consider the transmission hub sites are the very important network elements which affect a cluster of network, therefore, 2 generators with 1+1 backup is proposed, below is the figure.




Green field site for 8700W super transmission hub site

For this scenario, super transmission equipments which require 6600W power consumption is configured, in addition with 300W microwave and 1800W eNodeB, the total power consumption reach to 8700W. Huawei will use 3*2.4*2.8m traditional shelter to contain above mentioned equipments and power supply system. Meanwhile, PowerCube 1000 Energy control system and Energy storage system will also move into Shelter. For energy plant system, Huawei propose 1+1 backup generator system in order to provide stable power supply once commercial grid power disconnect.




### 6.4.3 Power Supply Solution

eNodeB sites area for different scenarios (approximately)

| Scenario | PowerCube /Generator | Fuel tank | Mini-Shelter /Shelter | ATS | Total |
|---|---|---|---|---|---|
| 2000W Greenfield | 2.184 $m^2$ | Included | 1 $m^2$ | Included | 3.184 $m^2$ |
| 2000W Rooftop | 2.691 $m^2$ | Included | 1 $m^2$ | Included | 3.691 $m^2$ |
| 4300W Greenfield | 3.873 $m^2$ | 1.4 $m^2$ | 3.014 $m^2$ | Included | 8.278 $m^2$ |
| 8700W Greenfield | 3.873 $m^2$ | 1.4 $m^2$ | 7.2 $m^2$ | 0.48 $m^2$ | 12.95 $m^2$ |

The table above shows that the scenarios of using Mini-Shelter and PowerCube 1000 have much smaller footprint than the sites using traditional shelter and generator. The smaller footprint brings benefits to customer including less rent fee, easier site acquisition, and faster network rollout.

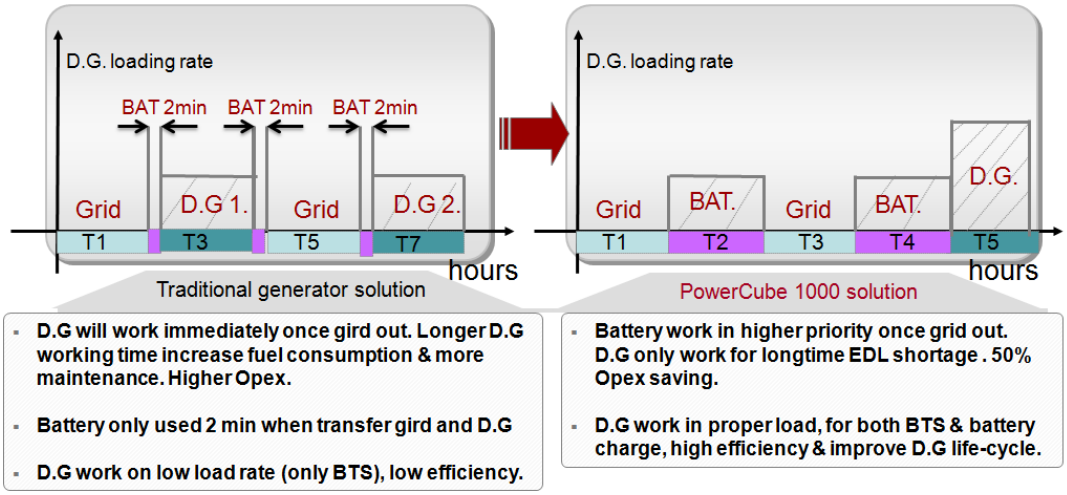
Cooling system power consumption for different scenarios (approximately)

| Scenario | Cooling system power consumption | AC A/C working time % | Final Cooling system power consumption |
|---|---|---|---|
| 2000W Greenfield | HEX: 360W<br>AC A/C: 790W<br>DC A/C:400W | 60% | 1234W |
| 2000W Rooftop | HEX: 360W<br>AC A/C: 790W<br>DC A/C:400W | 60% | 1234W |
| 4300W Greenfield | HEX: 500W<br>AC A/C:1580W<br>DC A/C:400W | 60% | 1848W |

| | | | |
|---|---|---|---|
| 8700W Greenfield | AC A/C: 3636W | 80% | 2909W |

The table above shows the cooling system power consumption data, the scenarios of using Mini-Shelter has much smaller power consumption than traditional shelter, which help customer to save power cost and make it green. Moreover, Mini-Shelter AC air conditioner working time is only 60% due to its alternative working between HEX and air conditioner, while 8700W Greenfield traditional will require 80% AC air conditioner working time, less air conditioner working time prolong the Air conditioner life cycle, and save maintenance and spare parts cost for MOI.

PowerCube 1000 work sequence bring cost saving




Compare to traditional generator solution, PowerCube 1000 solution has equipped intelligent energy control system, the control system will detect and send command in order different energy sources to working in a cost saving way, PowerCube 1000 system will always detect the battery statement of charge, and equipments working temperature, when the battery statement of charge more than 40%, the control system will command battery working firstly when Grid power disconnected in stead of generator, thus the generator working time is reduced significantly, which lead to huge fuel saving, less generator maintenance, much less air pollution and get generator life cycle prolonged. And if the temperature of equipment room goes high (more than 35 oC), the control system will send command to generator to start in order to power the AC air conditioner.

### 6.4.4 PowerCube 1000 Calculation

| Item | Formula | Remark |
|---|---|---|
| Battery Capacity Calculation | $C = \frac{P \times T_b \times 1.25 \times 1.04}{V_b \times K_b \times D}$<br>2000W terminal LTE site:<br>P=2000+$P_{DC\ aircon}$+$P_{Hex}$=2760W<br>C=2760*4*1.25*1.04/(48*0.95*0.6)=524Ah<br>So 600Ah Cyclic battery is chosen, and it can support around 8 hrs if consider 100% DOD<br>4300W transmission hub site: | $C$ : Capacity of the battery<br>$P$ : Capacity of the total DC load power<br>$T_b$ : Backup times<br>$K_b$ : Coefficient of battery capacity(=0.95)<br>$t$ : Working time per day of load(=24h)<br>$V_b$ : Voltage of the battery(=48V)<br>1.25: battery aging coefficient |

| | | |
|---|---|---|
| | P=4300+ $P_{DC\ aircon}$+$P_{Hex}$=2610W=5300W<br>C=5300*4*1.25*1.04/(48*0.95*0.6)=996Ah<br>So 1200Ah Cyclic battery is chosen, and it can support 8 hrs if consider 100% DOD<br>8700W super transmission hub site:<br>P=8700W<br>C=8700*4*1.25*1.04/(48*0.95*0.6)=1653Ah<br>So, 1800Ah cyclic battery is chosen, and it can support around 6 hrs if consider 100% DOD | 1.04:Voltage coefficient<br>D: Battery depth of discharge (=60%) |
| Power rectifier Capacity Calculation | $N = \frac{P}{V_b} + \eta \times C$<br>2000W terminal LTE site:<br>N=2760/48+0.1*600=118A<br>So 150A rectifier is required, consider for rectifier unit N+1 redundancy, 200A power rectifier system is chosen<br>4300W transmission hub site:<br>N=5300/48+0.1*1200=230A<br>So 250A rectifier is required, consider for rectifier unit N+1 redundancy, 300A power rectifier system is chosen<br>8700W super transmission hub site:<br>N=8700/48+0.1*1200=302A<br>So 300A rectifier is required, consider for rectifier unit N+1 redundancy, 350A power rectifier system is chosen | $P$ : Capacity of the total DC load power<br>$V_b$ : Voltage of the battery(=48V)<br>$C$ : Capacity of the battery<br>$\eta$ : Battery charging current co-efficient(=0.1) |
| Generator Capacity Calculation | $Pg = (\frac{P + V_b \times (\eta \times C)}{\lambda} + Pac)/0.8$<br>2000W terminal LTE site:<br>Pg=((2760+48*0.1*600)/0.94+790)/0.8=8487W<br>So, 10KW generator is proposed<br>4300W transmission hub site:<br>Pg=((4300+48*0.1*1200)/0.94+2*790)/0.8=15353W<br>So, 17.6KW generator is proposed<br>8700W super transmission hub site:<br>Pg=((8700+48*0.1*1800)/0.94+2*3636)/0.8=31248W<br>So, 50KVA generator is proposed | Pg: Capacity of generator<br>$V_b$ : Voltage of the battery(=48V)<br>$\lambda$ : Power Rectifier efficiency<br>C: Capacity of battery<br>P: Total power of DC load<br>Pac: Total power of AC load<br>0.8: Generator working load |

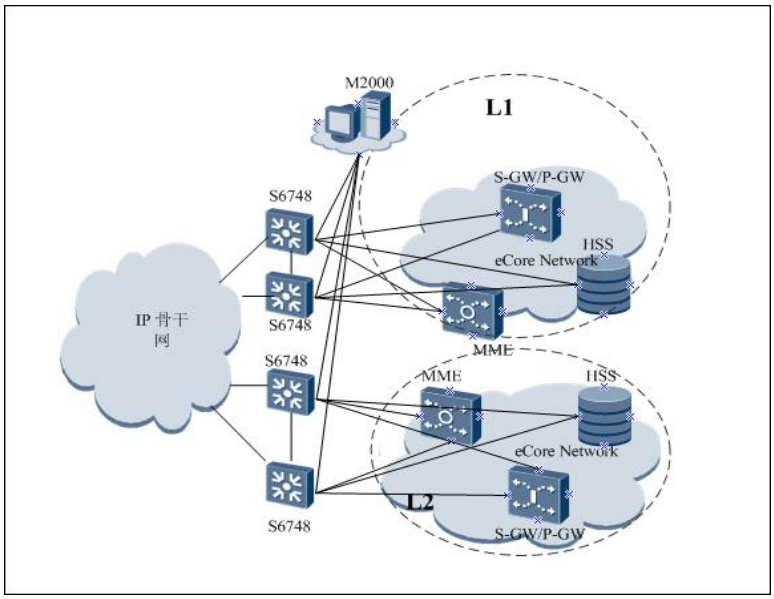
### 6.4.1 Benefit for PowerCube 1000

- Reducing Total Cost of Operation (TCO)
  - Occupies a smaller area than traditional Generator solutions.
  - Easy to transport because of high structural integrity.
  - Industry-leading generator/battery scheduling policy optimizes the generator operating status and reduces its operation duration. This cuts fuel and generator maintenance by 50%.
  - The engine is maintained every 1000 hours, compare to 250 hours of traditional generator, 75% reduce. This reduces maintenance costs.
- Fast deployment
  - Easy to install because it is smaller and lighter than traditional generators.
  - Uses the modular design and integrates storage batteries, monitoring system, surge protection devices (SPDs), temperature control system, ATS, power system, this facilitates operation, cabling, and fast site setup.
- Intelligent management
  - Reports fuel consumption and generate an alarm if the fuel capacity is below the lower threshold.
  - Reports alarms over dry contacts.
- Standard platform
  - Can be scaled smoothly in various scenarios.
  - Can schedule multiple energy sources (for future to solar power for example).

## 6.5 EPC Design

### 6.5.1 EPC Network Topology

EPC 核心网网络拓扑图：



EPC 核心网网元包括 MME、S-GW、P-GW（我司产品 S-GW 和 P-GW 合一为 UGW）和 HSS 等网元。S9303 是核心网内部交换机，工作在层三模式。MME 和 S-GW、P-GW 都通过路由器接入 IP 骨干网，与无线侧网元互通。2 个 MME 组成 MME POOL，UGW 通过一定的策略选择实现负荷分担。HSS 采用 FE/BE 主备和异地容灾增强可靠性。

### 6.5.2 Interface & Protocol Stack

下表是 EPC 核心网包含网元、对应接口名称和各接口间的顶层应用协议。

| 接口 | 对接网元 | 协议 |
|---|---|---|
| SGi | P-GW-PDN | UDP/IP |
| S1-MME | MME-eNodeB | SCTP, S1-AP |
| S1-U | eNodeB-S-GW | UDP/IP, GTP-U |
| S6a | MME-HSS | SCTP, Diameter |
| S10 | MME-MME | UDP, GTP-C |
| S11 | MME-S-GW | UDP, GTP-C |
| S5/S8 | S-GW-P-GW | UDP/IP, GTP |

### 6.5.3 IP Requirements

IP 需求见下表所示：

| 接口 | 网元 | 逻辑 IP 网段需求 | 物理 IP 网段网段 |
|---|---|---|---|
| S1-MME | MME | 2*/29 | 2*/28 |
| | S9303 | - | |
| S6a | MME | 2*/29 | 4*/29 |
| | S9303 | - | |
| S6a | HSS | - | 4*/29 |
| | S9303 | | |
| S1-U | UGW | 2*/29 | 4*/29 |
| | S9303 | - | |
| S5/S8_s | UGW | 2*/29 | 4*/29 |
| | S9303 | - | |
| S5/S8_p | UGW | 2*/29 | 4*/29 |
| | S9303 | - | |
| S11 | UGW | 2*/29 | 4*/29 |
| | S9303 | - | |
| S10/S11 | MME | 2*/29 | 4*/29 |
| | S9303 | - | |
| SGi | UGW | - | 4*/29 |
| | S9303 | - | |
| OM | MME | - | 2*/28 |
| | HSS | - | |
| | S9303 | - | |
| OM | UGW | - | 4*/29 |
| | S9303 | - | |

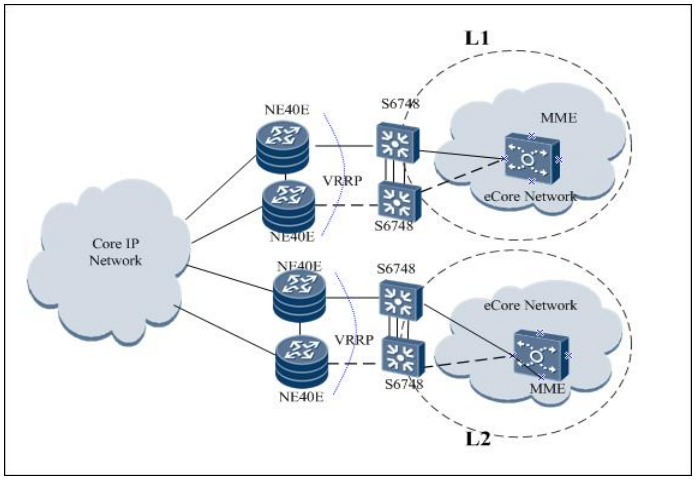
表中 IP 需求是 2 套设备需要的 IP 网段。.

### 6.5.4 Network Intercommunication Design

1. USN 组网设计

1) S1-MME 接口设计

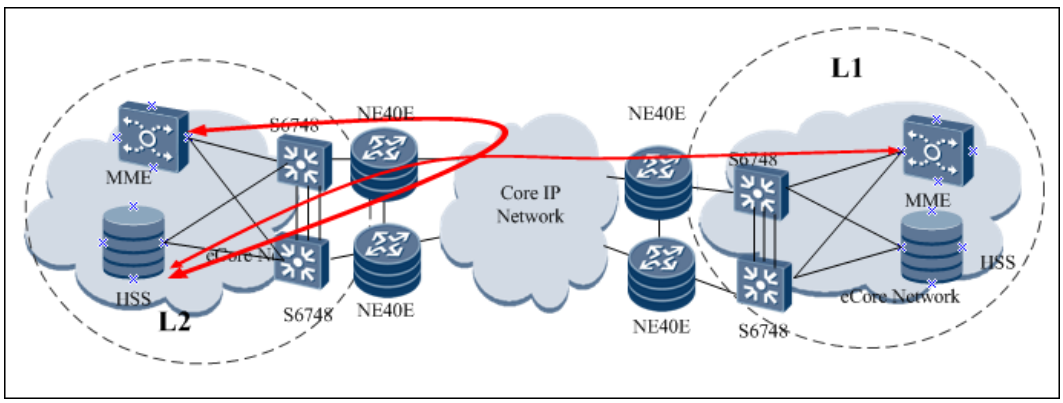
S1-MME 是 MME 和 eNodeB 之间的接口，采用了 SCTP 传输协议。S1-MME 接口组网图如下图所示：




(1) MME 提供 1 对主板 EPU 单板，每块 EPU 单板提供 1 个 GE 接口，GE 接口通过 CE（S9303）交换接与 PE 相连，同过承载网与 eNodeB 相连。
(2) GE 接口处于主备模式，组网采用主备接口+VRRP+ARP 探测组网方案。
(3) 主用 EPU 单板上需要配置 1 个 S1-MME 的逻辑地址 SIGIP1。
(4) 主用 GE 口配置物理地址 IP1.1，备用 GE 口配置 ARP 探测地址 IP1.2，S9303 需配置对应的 Vlanif（IP1.3 和 IP1.4）与之对接，需要配置 VRRP 虚拟地址 IP1.5。
(5) MME 上配置到 PCU 侧的路由，下一跳指向 CE（S9303）的 VRRP 虚 IP 地址 IP1.5。CE（S9303）上分别配置到 MME 所需的静态路由。
(6) CE（S9303）上配置 S1-MME VLAN。
(7) CE（S9303）工作在层 3 模式，之间绑 2 个 10GE 的 trunk 线做 VRRP 通道。
(8) 为避免 VRRP 心跳线中断，因此 VRRP 心跳通道均配置为两条。
(9) 配置 S1 VRF，用以隔离其他逻辑接口的路由数据。

2) S6a 接口设计

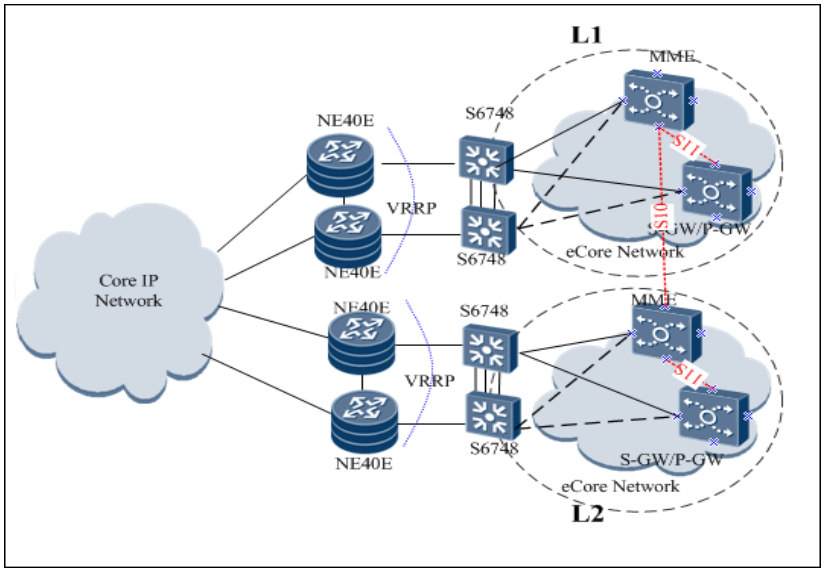
S6a 是 MME 和 HSS 之间的接口,采用了 SCTP 传输协议。S6a 接口组网图如下图所示：



(1) MME 提供一对主备 EPU 单板，每块 EPU 单板提供 1 个 GE 接口，GE 接口通过 S9303 交换接与 PE 相连，同过承载网与 HSS 相连。
(2) GE 接口处于双主模式，组网采用双主接口+SCTP 多归属方案。
(3) 主用 EPU 板上配置 2 个逻辑地址：IP1、IP2。
(4) 两个 GE 接口配置不同网段的物理地址 IP1.1 和 IP2.1，与之对接的 CE（S9303）配置对应的 Vlanif（IP1.2、IP2.2）与之对接。
(5) HSS 上配置不同网段的物理地址 IP3.1 和 IP4.1，与之对接的 CE（S9303）配置对应的 Vlanif（IP3.2、IP4.2）与之对接。
(6) MME 上配置到 HSS 的路由，下一跳为 CE（S9303）的对应 Vlanif 的地址。
(7) 配置 S1 VRF，用以隔离其他逻辑接口的路由数据。
(8) MME 和 HSS 之间建立 1 个偶联，不开启交叉路径 。
(9) Diameter 链路集配置中，选路模式选择主从模式，HSS 主备容灾。

3) S10/S11 接口设计

S11 是 S-GW 与 MME 之间的接口。S10/S11 接口组网图如下图所示：

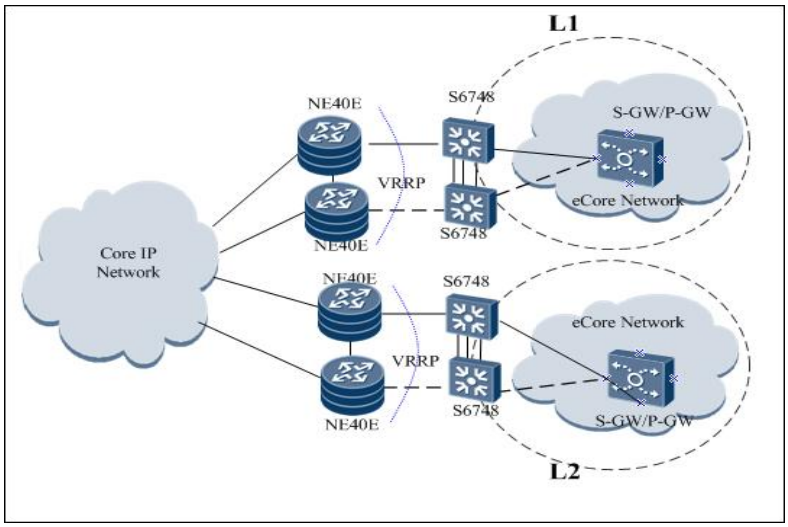



(1) EPU 提供 1 对主备 EPU 单板，一块 EPU 单板提供 2 个 GE 接口，2 个 GE 接口处于双主模式。
(2) 采用双主接口+OSPF 组网方案。
(3) 在 EPU 单板上配置 S11 的逻辑地址 IP1 和 IP2。
(4) 配置 2 个 GE 接口的物理地址并使之处于不同网段 IP1.1 和 IP2.1，S9303 上配置对应的 IP1.2 和 IP2.2 对接。
(5) MME 和 CE（S9303）、PE 之间，及 PE 之间启用 OSPF，MME 不做 DR 和 BDR。
(6) MME 和 CE、CE 与 PE 之间采用等价路由。
(7) 配置 CN VRF （与 S5/S8_s、S5/S8_p 接口 VPN 合一），用以隔离其他逻辑接口的路由数据。

2. S-GW/P-GW 组网设计

1) S1-U 接口设计

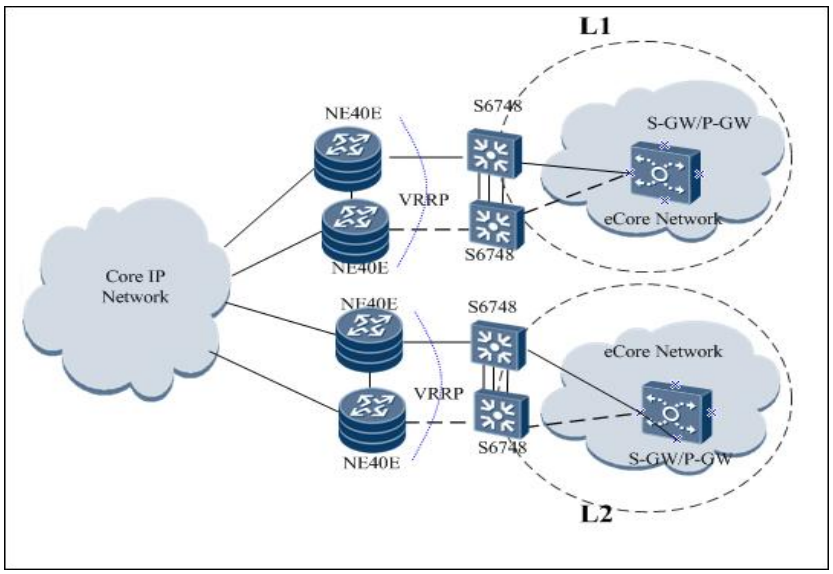
S1-U 是 S-GW 与 eNodeB 之间的用户面接口。S1-U 接口组网如下图所示：




(1) S1-U 接口与 S5/S8_s、S5/S8_p、S11、OM 接口合用物理接口。
(2) UGW 提供 3 个 LPU 单板，一块 LPU 单板提供 2 个 10GE 接口，每 3 个 10GE 接口绑一个 Trunk，UGW 上 Eth-trunk 配置时使用静态 LACP 模式链路聚合。
(3) 接口捆绑中，CE（S9303）和 UGW 都需要配置最小活动链路数，且配置的最小链路数相同。
(4) Trunk 划分 S1-U、S5/S8_s、S5/S8_p、S11 和 OM 分子接口。
(5) 采用双主接口+OSPF 组网方案。
(6) 在 SPUe 单板上配置 S1-U 的逻辑地址 S1UifIP1 和 S1UifIP2。
(7) 2 个 Trunk 上分别配置 S1-U 子接口的物理地址并处于不同网段 IP1.1 和 IP2.1，S9303 上配置对应的 IP1.2 和 IP2.2 对接。
(8) UGW 和 CE（S9303）、PE 之间，及 PE 之间启用 OSPF，UGW 不做 DR 和 BDR。
(9) UGW 和 CE（S9303）、CE（S9303）与 PE 之间采用等价路由。
(10) 配置 S1 VRF（与 S1-MME 同一 VPN），用以隔离其他逻辑接口的路由数据。

2) S5/S8 S11 接口设计

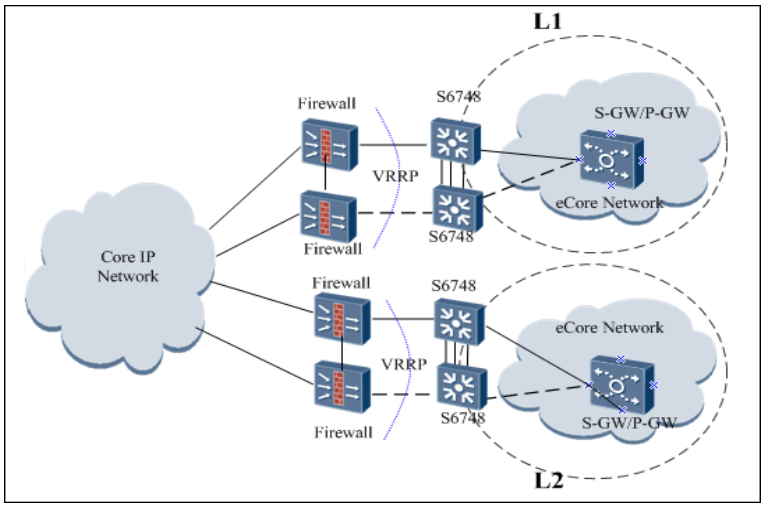
S5/S8 是 S-GW 与 P-GW 之间的接口。S5/S8 物理接口无法分开，VPN 也必须合一。S5/S8 在 S-GW 和 P-GW 侧分别为 S5/S8_s 和 S5/S8_p。S11 是 S-GW 与 MME 之间的接口。



(1) S5/S8_s、S5/S8_p、S11 接口与 S1-U、OM 接口合用物理接口。
(2) UGW 提供 3 个 LPU 单板，一块 LPU 单板提供 2 个 10GE 接口，每 3 个 10GE 接口绑一个 Trunk，UGW 上 Eth-trunk 配置时使用静态 LACP 模式链路聚合。
(3) 接口捆绑中，CE（S9303）和 UGW 都需要配置最小活动链路数，且配置的最小链路数相同。
(4) Trunk 划分 S1-U、S5/S8_s、S5/S8_p、S11 和 OM 分子接口。
(5) 采用双主接口+OSPF 组网方案。
(6) 在 SPUe 单板采用 1+1 模式，配置 S5/S8_s、S5/S8_p、S11 的逻辑地址 S5sifIP1、S5sifIP2、S5pifIP1、S5pifIP2、S11ifIP1、S11ifIP2。
(7) 2 个 Trunk 上分别配置 S1-U 子接口的物理地址并处于不同网段 IP1.1 和 IP2.1，S9303 上配置对应的 IP1.2 和 IP2.2 对接。
(8) UGW 和 CE（S9303）、PE 之间，及 PE 之间启用 OSPF，UGW 不做 DR 和 BDR。
(9) UGW 和 CE（S9303）、CE（S9303）与 PE 之间采用等价路由。
(10) 配置 CN VRF（S5/S8_s、S5/S8_p、S11 接口 VPN 合一），用以隔离其他逻辑接口的路由数据。

3) SGi 接口设计

SGi 是 P-GW 与 PDN 之间的接口。SGi 接口组网如下下图所示：

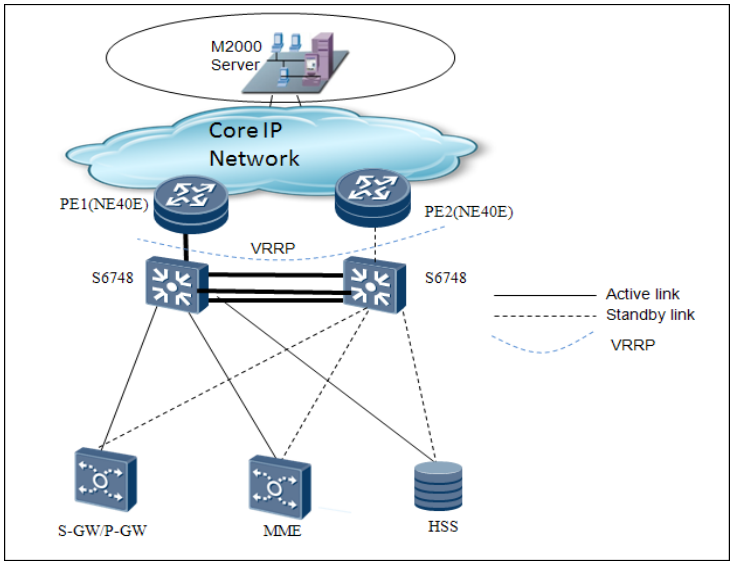



(1) UGW 提供 3 个 LPU 单板，一块 LPU 单板提供 2 个 10GE 接口，每 3 个 10GE 接口绑一个 Trunk，UGW 上 Eth-trunk 配置时使用静态 LACP 模式链路聚合。
(2) 接口捆绑中，CE（S9303）和 UGW 都需要配置最小活动链路数，且配置的最小链路数相同。
(3) 采用双主接口+OSPF 组网方案。
(4) SGi 不需要配置逻辑地址。
(5) 2 个 Trunk 上分别配置 SGi 子接口的物理地址并使之处于不同网段 IP1.1 和 IP2.1，CE（S9303）上配置对应的 IP1.2 和 IP2.2 对接。
(6) UGW 和 CE（S9303）、防火墙、PE 之间启用 OSPF，UGW 不做 DR 和 BDR。
(7) 由于采用主备防护墙，所以 UGW 和 CE（S9303）、CE（S9303）与防火墙、防火墙与 PE 之间采用不等价路由，正常情况下使流量都通过主用防火墙。
(8) 配置 SGi VRF，用以隔离其他逻辑接口的路由数据。

3. 网管系统接口互通设计

1) OM 接口设计

OM 组网如下图所示：




(1) MME/HSS 各提供 2 块 OMU 板，每块 OMU 板出 1 个 GE 接口连接 PE，两个 GE 接口工作在主备模式；都采用主备接口+VRRP+ARP 探测组网方案。
(2) 由于 S-GW/P-GW 接口只有 10GE 接口，且没有多余接口，所以 S-GW/P-GW 上的 OM 接口与 S1-U 合用接口，在 S1-U 的接口的一个 Trunk 划分子接口，采用主备接口+VRRP+ARP 探测组网方案。
(3) CE（S6748）到 MME/HSS/S-GW/P-GW 的接口上起 vlan（vlan13）。
(4) CE（S6748）工作在层二模式，之间绑 3 个 10GE 的 trunk，允许 vlan13 通过。
(5) MME/HSS/S-GW/P-GW 上不需要配置 OM 的逻辑地址。
(6) MME 主用 GE 口配置物理地址 IP1.1，备用 GE 口配置 ARP 探测地址 IP1.2，在主 OMU 板上配置一个浮动 IP：IP1.3，PE（NE40E）需配置对应的地址（IP1. 4 和 IP1.5）与之对接，需要配置 VRRP 虚拟地址 IP1.6。
(7) HSS 主用 GE 口配置物理地址 IP1.7，备用 GE 口配置 ARP 探测地址 IP1.8，在主 OMU 板上配置一个浮动 IP：IP1.9，PE（NE40E）需配置对应的地址（IP1. 10 和 IP1.11）与之对接，需要配置 VRRP 虚拟地址 IP1.12。
(8) 配置 S-GW/P-GW 子接口的物理地址 IP1.13。PE(NE40E)上需配置对应的地址(IP1.14 和 IP1.15)与之对接，需要配置 VRRP 虚拟地址 IP1.16。
(9) MME/HSS/上配置到 eNodeB 侧的路由，下一跳指向 PE(NE40E)的 VRRP 虚拟 IP 地址。PE(NE40E)上分别配置到 MME 所需的静态路由。
(10) 交换机配置时注意避免发生二层环路问题。
(11) 配置 OM VRF，用以隔离其他逻辑接口的路由数据。

### 6.5.5 Reliability Design

1. HSS 可靠性设计

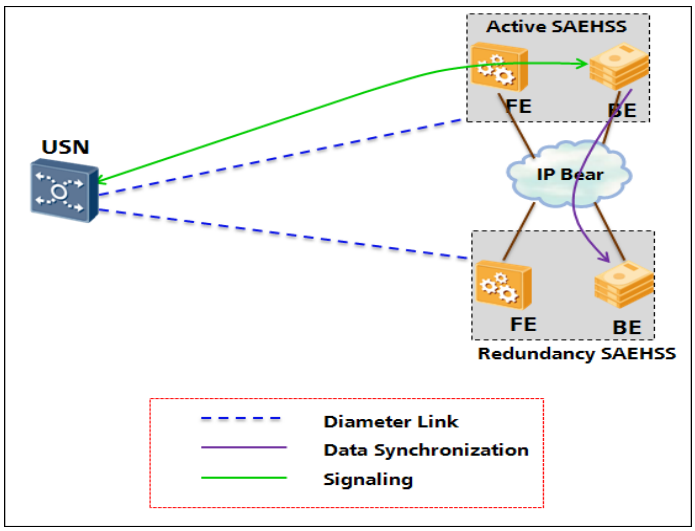
无缝地理容灾组网设计，组网中部署不同站点的 FE/BE 之间通过 IP 承载网络相连，实现数据层实时同步，保持容灾 BE 与主用 BE 数据的一致性。当主用局发生故障，容灾局能自动接管信令业务处理。

1) 1+1 FE 主备、BE 主备无缝地理容灾组网

两个 HSS 异地部署，并且为主备关系，主用局和容灾局都连接 IP 网络，两个 HSS 之间的数据同步通过 IP 承载网完成。正常情况下，只有主用局处理信令业务，容灾局不处理信令业务。

- 正常情况下的容灾信令路由：

在正常情况下，主备无缝地理容灾信令路由下图所示：




正常情况下，只有主用 HSS 才处理 Diameter 消息业务。

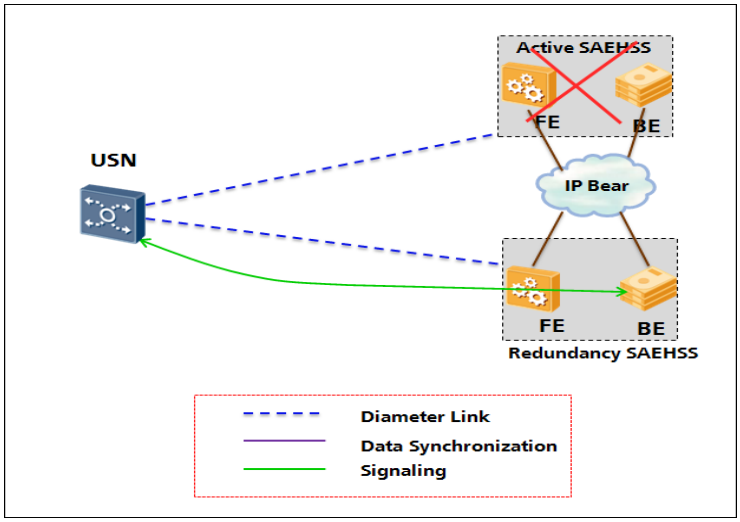
2) HSS 可靠性分析

从面（HSS 整体）和点（FE 和 BE）两个方面考虑 S6a 组网可靠性。

- 从面的角度考虑

主用 HSS 和容灾 HSS 构成双平面容灾组网结构，当该主用 HSS 故障时，也即双平面中主用平面故障时，信令路由可靠性分析下图所示：

主用 HSS 故障的冗余路由




容灾信令路由概述如下：

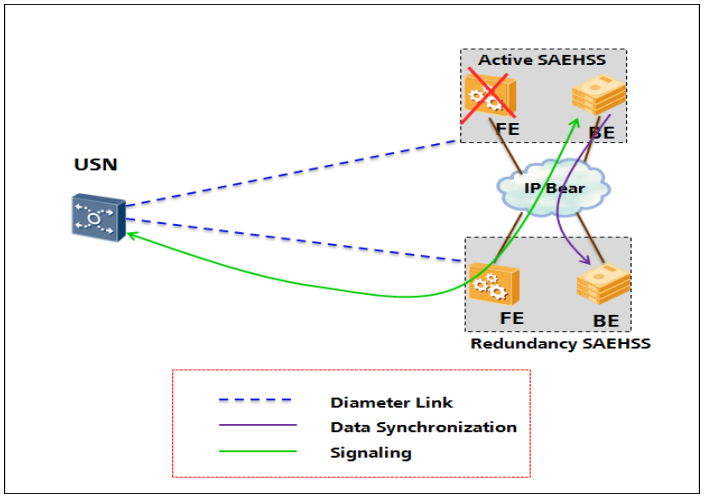
– 容灾 HSS 实现对故障 HSS 的备份，接管业务。

– 如上图表示主用 HSS 故障后，其它网元发送的消息将会发送到备用平面。

- 从点的层次考虑

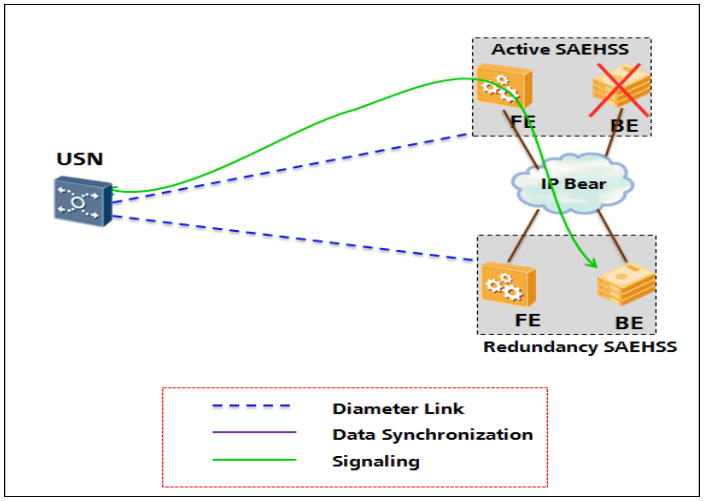
该容灾场景下，主用 HSS 和容灾 HSS 均连接到 IP 承载网，通过 IP 承载网完成数据同步。HSS 由 FE 和 BE 两个模块组成，两个模块可以看做一个点，当其中任意一个模块故障时，SAE-HSS 的信令容灾路由如下图所示：

主用 HSS FE 模块故障




正常情况下，所有的消息都发往主用 HSS 的 FE 模块进行处理，并在主用 BE 完成数据查询和修改操作，当主用 HSS 的 FE 故障以后，MME 的消息发往备用 SAE-HSS 的 FE，容灾 SAE-HSS 的 FE 向主用 SAE-HSS 的 BE 发出数据请求，从而实现业务接管。

主用 HSS BE 模块故障场景




当主用 SAE-HSS 的 BE 故障以后，FE 对外的信令链路仍然正常，MME 发送的消息仍然发送到主用 SAE-HSS 的 FE，FE 检测到本 SAE-HSS 的 BE 故障，因此将消息发送到容灾 SAE-HSS BE，从而实现业务接管。

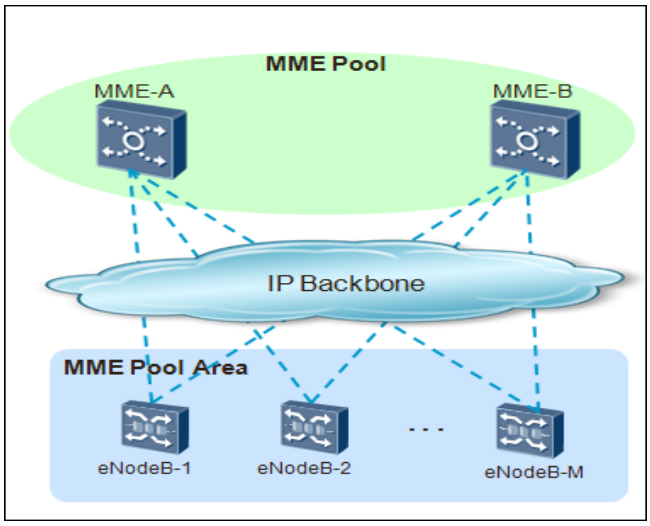
- 倒回原则

当原主用模块（HSS 或 FE/BE）故障恢复后，业务处理从原容灾模块倒回至原主用模块。

2. MME POOL

1) MME POOL 组网

组成 MME Pool 后，Pool 内所有 eNodeB 与 Pool 内 2 个 MME 互联，以保证 POOL 内 MME 可靠性。




2) MME POOL 参数

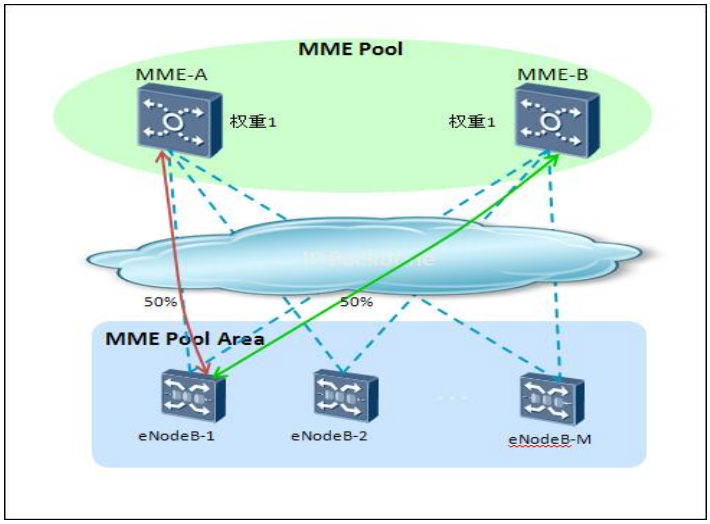
MME POOL 中的关键参数如下表所示：（MME Group ID、MME Code 需客户提供）

| 类别 | MMEA | MMEB | 说明 |
|---|---|---|---|
| MME Group ID | | | PLMN 内唯一 |
| MME Code | | | MME 不能属于多个 MMEGI |
| MMEC 长度（bits） | 8 | 8 | MMEC 固定长度为 8 |
| MME 相同容量 | 15000 | 15000 | 新建场景建议容量一致 |
| MME 权重 | 1 | 1 | 与容量比例保持匹配，保证负荷均衡 |

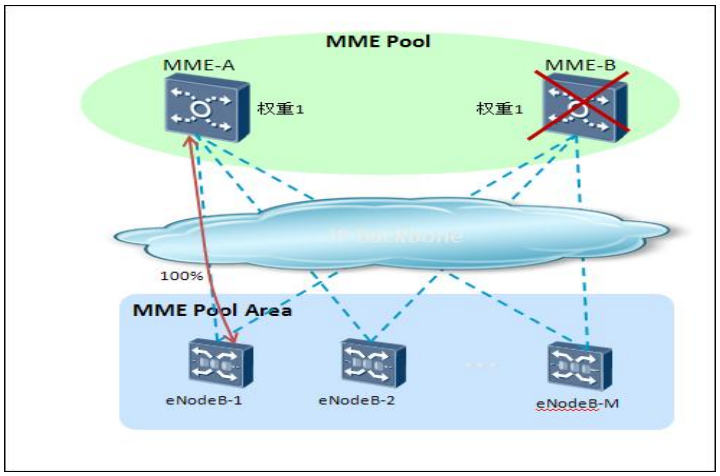
3) MME POOL 可靠性分析

为了利于容灾，建议 2 个 MME 分开放置在异地机房。在 POOL 内 MME 负荷分担，一个 MME 出现故障后另一个 MME 将接替它的工作。故障 MME 恢复后，Pool 内的 MME 仍是负荷分担。如果 Pool 内一个 MME 过载，此时可以通过手动指令进行用户迁移。

- 正常情况下 eNodeB 与 MME POOL 之间的数据流量是 POOL 内 MME 负荷分担，如下图所示：




- 当 POOL 内一个 MME 发生故障后，eNodeB 将消息全部发往 POOL 内另一个 MME，直至故障 MME 恢复正常。




4) POOL 维护

- 演进

当 Pool Area 内增加 eNodeB 时，新建 eNodeB 与 Pool 内 2 个 MME 相连，2 个 MME 按照权重比例对新建 eNodeB 的数据进行负荷分担。

当 Pool 内增加 MME 时，eNodeB 侧增加到新建 MME 的信令链路和路由，Pool 内 MME 按照权重比例对 Pool Area 内 eNodeB 进行负荷分担。

- 用户迁移

MME Pool 用户迁移特性是指根据 MME Pool 内各 MME 的负载情况，操作人员通过 EMS（Element Management System）下发启动迁移命令，将负载过高或需要升级的 MME 上的用户迁移到 MME Pool 中的其他 MME 上，从而实现实时、动态地调整 MME Pool 内的负荷分布。

为降低迁移对业务的影响，需要将用户迁移分为两个阶段：

EMS 控制迁移用户第一阶段：用户主动发起接入时，由 MME 通过终止当前流程将用户置为空闲态的方式进行用户迁移。

EMS 控制迁移用户第二阶段：第一阶段的定时器超时后，MME 对仍然在线的用户主动发起连接释放，进行用户迁移。

用户迁移类型主要包括：迁移全部用户（ALL）、迁移指定数量用户（PART）、迁移指定百分比用户（RATE）。

3. UGW POOL

1) 网关选择原则

- Inter-Attach 或者 Intra-Attach 流程中，在建立连接之前，MME 要获取 S-GW 和 P-GW 的地址。MME 首先根据 APN 构建 FQDN，向 DNS 发起 P-GW 地址解析，同时根据 TAI 信息构建 FQDN 向 DNS 发起解析请求。DNS 返回 S-GW 和 P-GW 地址列表，MME 根据选择策略选择一个 P-GW 和 S-GW。
- TAU 流程中，新侧 MME 从旧侧 MME 获取了源 S-GW 域名等信息，新侧 MME 用新 TAI 构建 FQDN 向 DNS 发起请求，获取 S-GW 地址信息，MME 进行比较判断 S-GW 是否需要切换，如需切换，则向新 S-GW 发起会话请求。

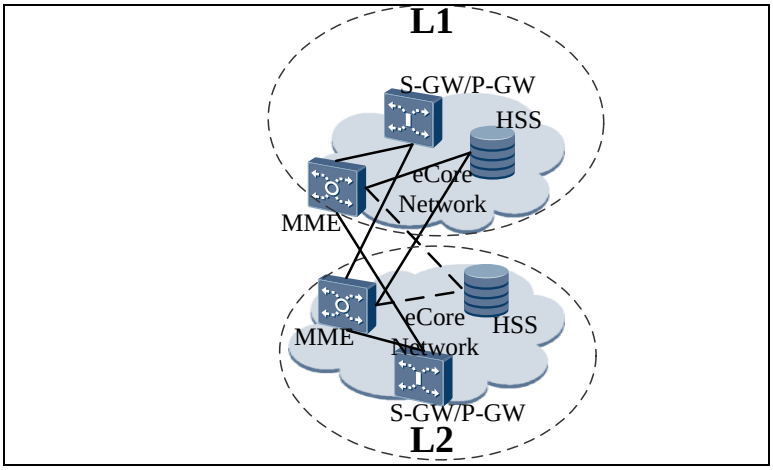
此场景下 P-GW 不变，只涉及 S-GW 选择。

- Handover 流程中，由于目标 eNodeB 的 TAI 发生改变，其相应的 S-GW 可能发生改变。MME 根据 TAI 构建 FQDN 向 DNS 发起解析请求，DNS 返回 S-GW 地址列表。MME 根据源上下文信息中旧 S-GW 信息进行比较，判断是否需进行切换，如需切换，则向新侧 S-GW 发起会话建立请求。

此场景下 P-GW 不变，只涉及 S-GW 选择。

- PDN 连接请求流程，在向 S-GW 发起承载上下文建立之前，需获取 P-GW 的地址，MME 根据 APN 构建 FQDN 向 DNS 发起解析请求，获取 P-GW 地址信息。

2) 网关选择




在正常情况下，MME 通过网关选择原则来选取通信网关，当一个网关发生故障后 MME 将只能与另一个正常工作的网关通信。

### 6.5.6 Tracking Area Divided

跟踪区（TA）为 EPC 网络 MME 网元所管辖的区域，一个跟踪区可由一个或多个小区构成。移动用户在检测跟踪区更新或切换的时候，需要使用跟踪区标识符 TAI。TAI 由 MCC+MNC+TAC 三部分组成。

MCC-移动国家码，由 3 位数组成，唯一地识别移动用户所属的国家。与 IMSI 中的 MCC 相同。

MNC-移动网号，一般由 2 位数组成，识别移动用户所归属的移动通信网。与 IMSI 中的 MNC 相同。

TAC-跟踪区码，用于标识一个跟踪区。TAC 由各省市自行分配。

网络设计时 TAI 不需要规划，通常由客户直接提供。

由于 TA 覆盖面积比较小，所以引入 TA list 来减少 TAU 流程，用户在 TA list 中移动不发生 TAU。

跟踪区划分原则如下：

- 跟踪区的划分不能过大或过小，TAC 的最大值由 MME 的最大寻呼容量来决定；
- 跟踪区规划应在地理上为一块连续的区域，避免和减少各跟踪区基站插花组网；
- 寻呼区域不跨 MME。

## 6.6 M2000 Design

### 6.6.1 Software Configration

1. 软件服务类型

| 服务器 | 提供服务 | 软件版本 |
|---|---|---|
| Master Server | iManager M2000 Server Software | V200R012C00 |

2. 软件配置

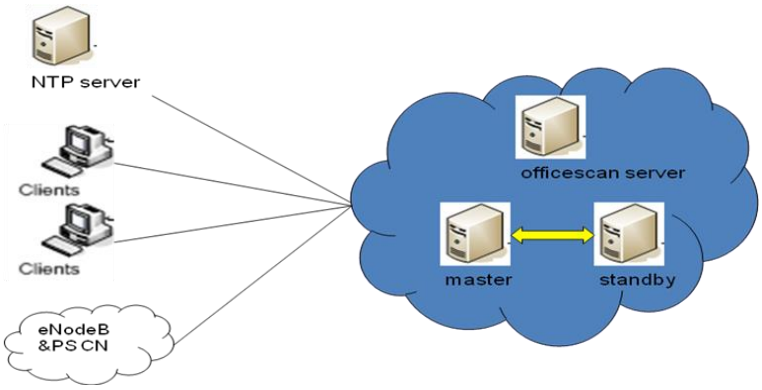
XX 项目所使用的 Sun servers 基于操作系统 Solaris10 以及数据库系统 Sybase15 进行配置.

| 网元功能 | 网元类型 | 第三方软件类型 | 软件名 | 版本 |
|---|---|---|---|---|
| M2000 服务器 | | 操作系统 | Solaris | Solaris 10 SPARC |
| | | 数据库 | Sybase | Sybase 15.0.2 |
| | | 终端仿真软件 | WinaXe | WinaXe 7.1 |
| | | 中间件 | WebSphere ILOG Rules | 包含在 M2000 软件组件中 |
| | | 中间件 | Rogue Wave Source Pro C++ | 包含在 M2000 软件组件中 |
| | | 数据储存管理软件 | Veritas Volume Manager | 5.0 |
| | | 集群管理软件 | Sun Cluster | Sun Cluster 3.2 |
| 防病毒服务器 Server | HP DL360G7 | 操作系统 | Windows | Windows Server 2003 R2 |
| | | 防病毒软件 | Trend Micro OfficeScan | Trend Micro OfficeScan Client/Server |

| | | | | |
|---|---|---|---|---|
| | | | | Version, English, V10.0 |

### 6.6.2 Hardware Configuration

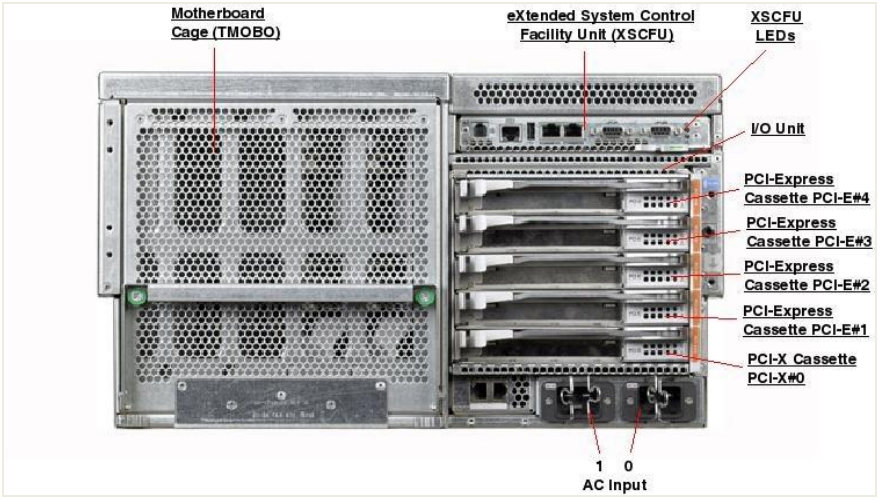
1. 硬件概览




XX 项目中所使用的主要硬件如下表所述：：

| 组件 | 数量 | 配置描述 |
|---|---|---|
| Sun M4000 | 2 | 2CPU*2.66GHz(4core),16G(8*2G),2*300G |
| M2000 磁阵 S2600 | 2 | 12x450G (15K SAS Disk, 8*4-Gbps FC) |
| HP DL360G7 | 1 | 1CPU*2.4G(4Core),1*4G,146G |

2. 主服务器: SUN M4000 服务器接口




可参考的 华为硬件安装指南：

M2000 的硬件服务器安装请参考《M2000 Hardware Installation Guide (M4000&M5000).pdf》.

3. M2000 硬件约束

系统支持的同时最大连接数是指系统在满负荷运行情况下，服务器所能支持的客户端连接数；从客户使用的典型场景来看，这些客户端并不是同时做相同的操作，我们假定客户端的操作模型如下，客户端上的应用可以按场景如下细分：

- 最多 1/2 的客户端：查询和浏览告警（不同客户端关注的网元是不同的）；对告警做一些处理（确认、分析）。
- 最多 1/3 的客户端：生成报表,包括性能报表/配置报表/告警报表,并进行分析。
- 最多 1/3 的客户端：面板和状态监控、跟踪；会穿插进行：查询配置数据、查询性能结果、启动 MML 客户端和脚本进行维护命令下发和结果分析。
- 最多 1/6 个客户端：做安全管理：用户和权限信息维护、日志分析等。
- 最多 1/3 的客户端：软件升级、License 管理等。
- 最多 1/3 的客户端：做配置数据分析、配置下发等。
- 最多 1/6 的客户端：进行 CME 的相关操作（与 CME 共部署时）。

### 6.6.3 M2000 Bandwidth Design

➢ 带宽要求

M2000 涉及的业务有性能管理、告警管理、配置管理、软件管理、操作维护。而带宽的需求取决于这些业务数据在个部分的网络流量。

- 核心网带宽需求

| | USN-SGSN | USN-MME | UGW | HSS | 合计 |
|---|---|---|---|---|---|
| 带宽需求 (kbit/s) | 256 | 256 | 256 | 256 | 1536 |

- M2000 客户端及 IP 网络带宽需求

| | M2000 客户端 | IP 网络设备 | 合计 |
|---|---|---|---|
| 带宽需求(kbit/s) | 512 | 16 | 528 |

- LTE 基站带宽需求

| LTE基站总数 | 100 | 200 | 400 |
|---|---|---|---|
| 带宽需求(kbit/s) | 4096 | 4480 | 5120 |

- XX 项目带宽整体需求

| | 核心网 | 客户端及IP设备 | 基站 | 合计 |
|---|---|---|---|---|
| 带宽需求(kbit/s) | 1536 | 528 | 5120 | 7184 |

## 6.7 ACS Design

### 6.7.1 ACS Overview

ACS：Automatic Configuration Server，CPE 网管服务器。

ACS 基于 TR-069 协议族，对 CPE 进行设备管理。功能包括，

1) 设备认证
2) 设备配置，包括自动预配置
3) 设备固件升级
4) 设备诊断
5) 设备监控及报告
6) 设备日志、设备告警
7) 基于设备事件的处理
8) 设备的任务计划管理
9) 用户认证
10) 用户、角色管理
11) 基于角色查看、操作设备
12) 系统日志、系统告警
13) 北向接口订单/事件处理

### 6.7.2 ACS Netwroking

ACS 与 M2000 一起，部署在 L1 监控中心的机房。

ACS 通过千兆以太网交换机连接 EPC 的 SGi 接口，与 EPC 确认。

ACS 与 CPE 在 IP 层双向可达。

### 6.7.3 External Interface

1. 南向接口

   ACS 通过南向接口管理 CPE。对外呈现 1 个千兆以太网口，1 个 IP 地址。

   CPE 通过南向接口对应的 URL 连接 ACS。

2. 北向接口

   ACS 接收终端管理指令的方式有两种：订单方式、ACS 客户端方式。

   1) 订单方式：用户在订单工具的辅助下，编制XML描述的、包含CPE配置/管理指令的订单。通过FTP传输到ACS的指定路径。ACS接收到订单后，执行指令。

   2) ACS客户端方式：用户通过web浏览器登录ACS，然后在ACS界面下，下达设备配置/管理指令。

   ACS 通过北向接口接收订单、以及 ACS 客户端连接。对外呈现 1 个千兆以太网口，1 个 IP 地址。用户通过 web 浏览器连接 ACS 时，浏览器地址栏输入 http://ACS 北向接口 IP 地址，或者 https://ACS 北向接口 IP 地址。

3. 端口

| 端口 | 协议 | 服务 | 位置 | 备注 |
|---|---|---|---|---|
| 80 | tcp | http | 南向接口 | CWMP(CPE Wan Management Protocol)，双向 |
| 443 | tcp | https | 南向接口 | CWMP(CPE Wan Management Protocol)，双向 |
| 514 | udp | syslog | 南向接口 | CPE通过syslog上报设备告警 |
| 3478 | udp | stun | 南向接口 | ACS通过stun管理NAT后面的CPE |
| 3479 | udp | stun | 南向接口 | ACS通过stun管理NAT后面的CPE |
| 7547 | tcp | http/https | 南向接口 | CWMP（IANA为CWMP预分配的端口），双向 |
| 8080 | tcp | http | 南向接口 | 上传、下载文件，例如下载固件、上传CPE故障日志。双向 |
| 80 | tcp | http | 北向接口 | ACS客户端连接 |
| 443 | tcp | https | 北向接口 | ACS客户端连接 |
| 21 | tcp | ftp | 北向接口 | 订单通过ftp传输到ACS |
| 22 | tcp | ssh | 北向接口 | 远程终端连接 |
| 123 | udp | ntp | 北向接口 | 时间同步 |

### 6.7.4 CPE Connect ACS

1. CPE 发现 ACS

CPE 出厂时，预置 ACS 南向接口对应的 URL。ACS URL 的主机名部分，采用 DNS 主机名形式。CPE 上电后，通过 DNS 服务器，解析取得 ACS 的 IP 地址。

2. 设备认证

CPE 通过 ACS URL 连接 ACS 时，ACS 将对 CPE 执行设备认证。

CPE 出厂时，预置设备认证账号。ACS 出厂时，预置相应的设备认证账号。

为简化操作，CPE 出厂时，统一预置设备认证账号/密码 hgw/hgw，ACS 上做相应预置。

### 6.7.5 User Connect ACS

1. 用户认证

用户是 ACS 的实际管理者、使用者。

用户账号在 ACS 上维护。每个用户对应一个角色，从而具有一定权限。

角色在 ACS 上维护。

用户通过 web 浏览器登录 ACS 时，需输入用户名、密码，通过用户认证。

ACS 出厂时，预置用户账号 root/root，具有最高权限。ACS 开通时，应尽快更改 root 账号的密码，然后添加其他用户账号。

### 6.7.6 Time synchronization

时间信息对于联合分析 CPE 本地日志、CPE 对 ACS 实时传输的告警信息、ACS 日志/告警有重要意义。CPE、ACS 将分别同 NTP 服务器做时间同步。

CPE 出厂时，预置 NTP URL 和时间同步策略。NTP URL 的主机名部分，采用 DNS 主机名形式。

CPE 上电后，通过 DNS 服务器，解析取得 NTP 服务器的 IP 地址。

ACS 出厂时，预置 NTP URL 和时间同步策略。NTP URL 的主机名部分，采用 DNS 主机名形式。

ACS 上电后，通过 DNS 服务器，解析取得 NTP 服务器的 IP 地址。

NTP 服务器须同时支持 SNTP、NTP 协议。

## 6.8 Equipment Configuration

| Item | Equipment | Description | Amount |
|---|---|---|---|
| eNodeB | DBS3900 | S222 @20Mhz 3:1 | 274 |
| EPC | HSS9820 | 14K subs | 2 |
| | USN9810 | 14K subs | 2 |
| | UGW9811 | 28K PDP 22G TP | 2 |
| Terminal | Outdoor CPE | 2.3Ghz, outdoor CPE | 13116 |
| NMS(network management system) | M2000 | Management of eNodeB and EPC | 1 |
| CPE Management System | CPE Mgt Server | Management of CPE | 1 |

## 6.9 General Features

LTE TDD is the natural evolution of Wimax and ideal wireless technology for video surveillance:

- Higher performance and capacity: more than 50Mbps in peak uplink with advanced UL technology.
- Low transport latency: transport latency is similar with fix line access, around10ms
- Scalable frequency bandwidth : supports frequency bandwidth from 1.4MHz to 20MHz
- Flexible UL and DL bandwidth control: support 3:1,2:2,1:3,1:8 and software configuration

# 7 Microwave Network Design

## 7.1 Transmission Technology Introduction

Huawei fully analyzes the importance of transmission's requirement to bear LTE data service of camera surveillance. Regarding the LTE wireless data backhaul requirements, Microwave transmission technology would be designed to access the LTE data and transmit the data to the MW aggregation sites in this project.

Huawei designs to adopt the modular structure of the microwave product, which can provide various services interfaces, support flexible network topologies and software-programmable capacity design. With regard to its advantages, the MW links for this project would be widely applicable to the backhaul transmission system. MW is also applicable at the access layer of transmission networks and on networks supplementary to optical networks.

In this project, Huawei provides latest MW solution IP radio transmission for backhaul transmission network and for fast deployment and high UL throughput for surveillance service, the whole microwave network can be easily upgrade to satisfy future expansion requirement.

The MW network provides the following functions:

- Convergence and grooming of radio services in multiple directions
- Construction of various SDH/PDH/Hybrid ring networks or more complex network topologies
- Quick provisioning and flexible grooming of services

Enhanced Radio Networking and Service Protection Capability

The MW supports HSB/FD/SD protection for the Hybrid ring, SDH ring, PDH ring, and radio links, as well as the N+1 protection. Thus, the Microwave links provide diversified methods and powerful capability to construct and protect radio networks.

AM-Based Hybrid Radio

The adaptive modulation (AM) is a technology that automatically adjusts the modulation scheme depending on the channel quality. When the channel quality is favorable (such as on days when the weather is fine), the equipment adopts a high-efficiency modulation scheme to transmit more user services. In this manner, the transmission efficiency and the spectrum utilization of the system are improved. When the channel quality is degraded (such as on days when the weather is stormy and foggy), the equipment adopts a low-efficiency modulation scheme and high-gain coding mode. In this manner, the anti-interference capability of the radio link is improved and the link availability of the services with a higher priority is ensured.

High Bandwidth Efficiency

Microwave transmission links access the Native TDM service and Native Ethernet service at the air interface. Unlike the service transmission through the EoS or PWE3 technology, this method increases the bandwidth efficiency.

Integration of the Radio Device and Optical Device

The MW links provide integrates the functions of the radio transmission system and the optical transmission system. Therefore it supports PDH, SDH, and IP services, which helps to reduce the investment.

## 7.2 MW Network Design Principle

The designed principle is strictly in accordance with transmission requirements and relevant ITU-T recommendations and standards. It fully meets the requirements of backhaul transmission network for system capacity, upgrade ability, quality of service and network protection. Both the economical and developmental factors have been considered during the network design and system configuration.

The main MW network design priciple is as below:

Microwave Transmission KPI

The key performance indexes (KPIs) are considered in radio link design. The KPIs vary according to the adopted digital radio technologies. Huawei considers the Network performance related to IP radio links to support relevant access networks.

We recommend that all digital mobile radio (DMR) transmission systems KPI can reach 99.999％

Assumptions Related to Radio Planning and Description

In the preceding design, we make the following assumptions:

Within the 26GHz & 32 GHz frequency band, a large number of channels are planned and the channel spacing is 28MHz. On this frequency band, Huawei recommends at least 12 channels 28MHz frequency band. Thus, Huawei can submit detailed frequency planning information and sub-channel planning information only after performing an intensive site survey.

At the radio planning stage, digital radio transmission planning should be based on the analysis of the digital topographic map. After an intensive line of sight (LOS) survey, the nominal planning needs to be further modified. The bill of quotation (BoQ) of the digital radio system also needs to be modified so that it can agree with the actual radio network planning scheme, LOS survey, and local geographical conditions. In addition, the price and the delivery schedule need to be modified accordingly.

In LOS availability planning, man-made buildings or natural structures between two sites can be ignored. If an obstacle is found on a transmission link during the LOS survey and there is no way of redirecting the signals on this link to surrounding base stations, needs to consider using repeaters or other substitutable transmission media.

Repeaters are not recommended

If the AM function is enabled, the network planning steps are as follows:

Configure the transmission parameters and determine the reference mode according to service capacity, frequency, bandwidth, LOS, distance, rain region, and other factors.

Determine the availability under the reference mode according to the link capacity.

Instruct the user to determine the lowest availability according to the maximum transmission capacity.

Upgrade the modulation scheme based on the reference mode, and reduce the fade margin according to the AM different adjustment table until the lowest availability of extra services is met.

Follow the common radio network planning steps.

Capacity and Channel Allocation

Huawei reasonably allocates the radio capacity according to the service requirements of wireless base stations.

In addition, Huawei reserves a sufficient margin during the planning and design of the radio link capacity. The margin will meet the future service requirements, the requirements resulting from system expansion, and the rerouting requirements brought due to the following reasons can be met:

- The LOS is interrupted, especially when the relief in the area is uneven or many high-rising buildings stand in the area.
- The land owner does not agree to the setup of transmission lines in the area of the land or requires a higher rental.
- Frequency interference exists in the surrounding environment, and thus rerouting to another wireless station is required.

The number of base stations that are cascaded on each link is limited so that the unexpected cases, as well as the preceding problems, during the project implementation can be handled. Thus, MOI can easily upgrade the capacities of base stations, without concerning about an insufficient transmission capacity.

Frequency, Channel, and Polarity Configuration

The rain fading greatly affects the transmission performance of radio links, especially the radio links that operate on the frequency band of 18 GHz or higher. To protect the radio links against the impacts of rain fading, a sufficient flat fading margin (FFM) needs to be set for the IP Radio system.

To guarantee the annual link availability of 99.999% and the minimum FFM in the area with strong annual precipitation intensity, all radio antennas should transmit electromagnetic waves in the vertical polarization direction. The annual precipitation intensity is calculated according to the data provided in ITU-R 530.

In the actual project implementation, the ODUs that operate on the correct frequency band and the accurate sub-bands need to be selected according to the frequencies obtained by the customer.

Antenna and Other Passive Components

Antenna gain helps to increase effective transmit power. Similarly, gain of an receive antenna helps to increase transmission effectiveness. Actually, all the features of the receive antenna and transmit antenna are the same.

Single-polarized and high-performance (UHP) antennas are recommended. The UHP antennas have the following advantages over the standard-performance (SP) antennas:

- Narrower 3 dB beam width
- Smaller side lobes
- Better front-to-back ratio
- Higher cross-polarization discrimination capability

The ODU can be directly mounted to a single-polarized UHP antenna with a radius of 0.3 m, 0.6 m, 0.9 m. In this case, the short and flexible waveguide, which may cause a great signal loss, is not required.

An ODU bracket is a passive component connecting the ODU to the flexible waveguide. The adapter has one major function.

## 7.3 MW Network Architecture

### 7.3.1 Logical Network Diagram

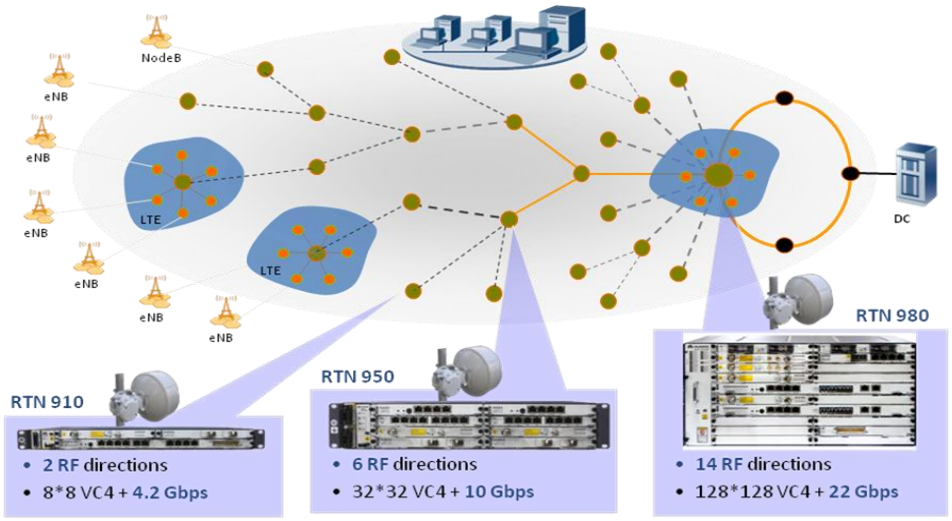



Figure 10 MW Logical Network Diagram

末端链路 eNodeN 侧使用 RTN910，中间汇聚节点使用 RTN950，光传输节点使用 RTN980。微波空口形态为 hybrid。会聚节点 RTN950 和 RTN980 上面配置 E-LAN 业务。RTN980 和路由器如果容量超过 GE，需要配置负荷分担形式的 LAG（IEEE 802.3ad）。

### 7.3.2 Physical Network Topology

- Phase1 MW Network DesignedTopology

There are 66 hops of digital microwave radio for Phase 1 project. The digital microwave radio capacities of the links are 100M, 200M, 400M and 800M (2*400M, XPIC). After detailed site survey, we can adjust the frequency planning based on the actual link condition. The final frequency scheme will be determined after getting the confirmation from the frequency authority. Please refer to Table below for detail information.

| Hop | Main Ant.Size | Frequency | Protection | Transmission Capacity | ODU Type | Band |
|---|---|---|---|---|---|---|
| 37 | 0.3m | 38GHz | 1+0 | 100 | SP | 28MHz |
| 4 | 0.6m | 38GHz | 1+0 | 100 | SP | 28MHz |
| 12 | 0.6m | 38GHz | 1+0 | 200 | HP | 28MHz |
| 3 | 0.6m | 23GHz | 1+0 | 200 | HP | 28MHz |
| 7 | 0.6m | 38GHz | 1+0 XPIC | 400 | HP | 28MHz 256QAM 1+0 XPIC |
| 1 | 0.6m | 23GHz | 1+0 XPIC | 400 | HP | 28MHz 256QAM 1+0 XPIC |
| 1 | 0.6m | 38GHz | 1+0 XPIC | 800 | HP | 56MHz 256QAM 1+0 XPIC |
| 66 Hops | | | | | | |

- Phase 2 MW Network DesignedTopology

There are 55 hops of digital microwave radio for Phase 2 project. The digital microwave radio capacities of the links are 100M, 200M, 400M and 800M (2*400M, XPIC). After detailed site survey, we can adjust the frequency planning based on the actual link condition. The final frequency scheme will be determined after getting the confirmation from the frequency authority. Please refer to Table below for detail information.

| Hop | Main Ant.Size | Frequency | Protection | Transmission Capacity | ODU Type | Band |
|---|---|---|---|---|---|---|
| 11 | 0.3m | 38GHz | 1+0 | 100 | SP | 28MHz |
| 19 | 0.6m | 38GHz | 1+0 | 100 | SP | 28MHz |
| 7 | 0.6m | 23GHz | 1+0 | 100 | HP | 28MHz |
| 8 | 0.6m | 38GHz | 1+0 | 200 | HP | 28MHz |
| 1 | 0.6m | 23GHz | 1+0 | 200 | HP | 28MHz |
| 5 | 0.6m | 23GHz | 1+0 XPIC | 400 | HP | 28MHz 256QAM 1+0 XPIC |
| 3 | 0.6m | 18GHz | 1+0 XPIC | 400 | HP | 28MHz 256QAM 1+0 XPIC |
| 1 | 0.6m | 38GHz | 1+0 XPIC | 800 | HP | 56MHz 256QAM 1+0 XPIC |
| 55 Hops | | | | | | |

- Phase 3 MW Network Designed Topology

There are 111 hops of digital microwave radio for Phase 3 project. The digital microwave radio capacities of the links are 100M, 200M, 400M and 800M (2*400M, XPIC). After detailed site survey, we can adjust the frequency planning based on the actual link condition. The final frequency scheme will be determined after getting the confirmation from the frequency authority. Please refer to Table below for detail information.

| Hop | Main Ant.Size | Frequency | Protection | Transmission Capacity | ODU Type | Band |
|---|---|---|---|---|---|---|
| 5 | 0.3m | 38GHz | 1+0 | 100 | SP | 28MHz |
| 60 | 0.6m | 38GHz | 1+0 | 100 | SP | 28MHz |
| 5 | 0.6m | 23GHz | 1+0 | 100 | HP | 28MHz |
| 1 | 0.6m | 18GHz | 1+0 | 100 | HP | 28MHz |
| 21 | 0.6m | 38GHz | 1+0 | 200 | HP | 28MHz |
| 1 | 0.6 | 23GHz | 1+0 | 200 | HP | 28MHz |
| 13 | 0.6m | 23GHz | 1+0 XPIC | 400 | HP | 28MHz 256QAM 1+0 XPIC |
| 1 | 0.6m | 18GHz | 1+0 XPIC | 400 | HP | 28MHz 256QAM 1+0 XPIC |
| 1 | 0.9m | 18GHz | 1+0 XPIC | 400 | HP | 28MHz 256QAM 1+0 XPIC |
| 3 | 0.6m | 23GHz | 1+0 XPIC | 800 | HP | 56MHz 256QAM 1+0 XPIC |
| 111 Hops | | | | | | |

- Phase 4 MW Network Designed Topology

There are 24 hops of digital microwave radio for Phase 4 project. The digital microwave radio capacities of the links are 100M, 200M, 400M (2*200M, XPIC). After detailed site survey, we can adjust the frequency planning based on the actual link condition. The final frequency scheme will be determined after getting the confirmation from the frequency authority. Please refer to Table below for detail information.

| Hop | Main Ant.Size | Frequency | Protection | Transmission Capacity | ODU Type | Band |
|---|---|---|---|---|---|---|
| 13 | 0.6m | 23GHz | 1+0 | 100 | HP | 28MHz |
| 5 | 0.6m | 18GHz | 1+0 | 100 | HP | 28MHz |
| 2 | 0.6m | 23GHz | 1+0 | 200 | HP | 28MHz |
| 1 | 0.9m | 18GHz | 1+0 | 200 | HP | 28MHz |
| 2 | 0.6m | 18GHz | 1+0 XPIC | 400 | HP | 28MHz 256QAM 1+0 XPIC |
| 1 | 0.9m | 18GHz | 1+0 XPIC | 800 | HP | 56MHz 256QAM 1+0 XPIC |
| 24 Hops | | | | | | |

## 7.4 Network Capacity Planning

根据单站容量需求 100M 且不可收敛来计算，链路容量，所需频点带宽以及调制模式做如下考虑：

Table 5 MW Bandwidth and Modulation Mode

| 累计后挂站点数量 | 容量需求 | 链路规划容量 | 频点带宽 | 调制模式 | XPIC |
|---|---|---|---|---|---|
| 1 | 100M | 108M | 28M | 32QAM | NO |
| 2 | 200M | 208M | 56M | 32QAM | NO |
| 3 | 300M | 314M | 28M | 128QAM | YES |
| 4 | 400M | 530M | 56M | 64QAM | YES |
| 5 | 500M | 624M | 56M | 128QAM | YES |
| 6 | 600M | 624M | 56M | 128QAM | YES |

根据具体拓扑和以上原则，针对每跳链路的链路容量规划如下：

| Site 1 Name | Site 2 Name | Bandwidth | Site 1 Name | Site 2 Name | Bandwidth |
|---|---|---|---|---|---|
| P1-6 | L2-CC-03 | 108M | P3-32 | P3-43 | 530M |
| P4-15 | P3-11 | 208M | P3-33 | P3-43 | 314M |
| P4-1 | P3-100 | 530M | P3-4 | P3-56 | 530M |
| P1-37 | L1-East | 108M | P3-44 | P3-43 | 530M |
| P1-64 | P1-52 | 108M | P3-50 | P3-43 | 314M |
| P1-24 | L2-South | 108M | P3-64 | P3-66 | 314M |
| P1-62 | P1-42 | 108M | P3-92 | P3-85 | 314M |
| P1-16 | P1-13 | 108M | P3-93 | P3-85 | 530M |
| P1-67 | P1-22 | 108M | P3-30 | P3-29 | 624M |
| P2-9 | P2-8 | 108M | P3-31 | P3-30 | 624M |
| P1-40 | P1-68 | 108M | P3-83 | P3-82 | 624M |
| P1-55 | P1-54 | 108M | P3-117 | P3-110 | 108M |
| P3-68 | P3-18 | 314M | P2-41 | P2-43 | 208M |
| P1-12 | P1-34 | 108M | P3-118 | P3-113 | 108M |
| P4-22 | P3-7 | 530M | P2-27 | P2-29 | 314M |
| P3-10 | P3-7 | 208M | P2-34 | P2-29 | 530M |
| P1-27 | P1-29 | 108M | P3-15 | P3-22 | 108M |
| P1-14 | P1-13 | 108M | P3-20 | P3-29 | 108M |
| P1-57 | P1-56 | 108M | P3-24 | P3-33 | 108M |
| P1-10 | P1-13 | 108M | P3-28 | P3-29 | 108M |

| Site 1 Name | Site 2 Name | Bandwidth | Site 1 Name | Site 2 Name | Bandwidth |
|---|---|---|---|---|---|
| P1-15 | P1-17 | 108M | P2-44 | P2-43 | 624M |
| P1-28 | P1-29 | 108M | P2-23 | P2-19 | 314M |
| P1-30 | P1-39 | 108M | P3-3 | P3-4 | 108M |
| P1-31 | P1-26 | 108M | P3-88 | P3-82 | 314M |
| P1-32 | P1-36 | 108M | P3-34 | P3-33 | 108M |
| P2-55 | P2-23 | 314M | P3-36 | P3-26 | 108M |
| P1-33 | P1-36 | 108M | P2-58 | P2-23 | 208M |
| P1-45 | P1-29 | 108M | P3-37 | P3-27 | 108M |
| P4-23 | P4-22 | 208M | P3-40 | P3-31 | 108M |
| P1-46 | P1-48 | 108M | P3-41 | P3-42 | 108M |
| P3-11 | P3-100 | 624M | P3-19 | P3-18 | 530M |
| P1-49 | P1-50 | 108M | P3-45 | P3-44 | 108M |
| P1-61 | P1-38 | 108M | P3-48 | P3-53 | 108M |
| P2-16 | P2-40 | 208M | P3-49 | P3-43 | 108M |
| P1-19 | P1-18 | 108M | P3-54 | P3-50 | 108M |
| P1-44 | P1-65 | 108M | P3-55 | P3-50 | 108M |
| P4-12 | P3-11 | 208M | P1-20 | P1-18 | 208M |
| P1-58 | P1-59 | 108M | P3-100 | P3-121 | 208M |
| P1-35 | P1-34 | 108M | P3-67 | P3-31 | 208M |
| P2-13 | P2-8 | 314M | P3-58 | P3-59 | 108M |
| P1-11 | P1-7 | 108M | P3-60 | P3-56 | 108M |
| P4-6 | P3-66 | 314M | P2-47 | P2-44 | 208M |
| P1-41 | P1-39 | 108M | P3-78 | P3-83 | 208M |
| P1-54 | P1-2 | 208M | P3-66 | P3-63 | 108M |
| P1-47 | L2-South | 314M | P3-72 | P3-77 | 108M |
| P1-38 | L1-East | 208M | P3-75 | P3-80 | 108M |
| P1-26 | L2-West | 208M | P1-56 | L2-South | 530M |
| P1-60 | P1-34 | 108M | P2-30 | P2-29 | 530M |
| P1-18 | L2-West | 530M | P3-76 | P3-82 | 108M |

| Site 1 Name | Site 2 Name | Bandwidth | Site 1 Name | Site 2 Name | Bandwidth |
|---|---|---|---|---|---|
| P1-17 | L2-West | 208M | P3-81 | P3-82 | 108M |
| P2-5 | P2-3 | 108M | P3-86 | P3-85 | 108M |
| P1-22 | P1-56 | 208M | P3-87 | P3-82 | 108M |
| P1-52 | L2-CC-03 | 208M | P3-90 | P3-83 | 108M |
| P1-48 | L2-South | 208M | P3-92 | P3-91 | 108M |
| P1-7 | L2-CC-03 | 530M | P3-94 | P3-93 | 108M |
| P1-63 | P1-7 | 208M | P3-98 | P3-92 | 108M |
| P1-3 | L2-CC-03 | 108M | P3-99 | P3-93 | 108M |
| P1-21 | P1-20 | 108M | P3-108 | P3-112 | 108M |
| P1-36 | L1-East | 314M | P2-14 | P2-30 | 108M |
| P1-50 | P1-47 | 208M | P2-21 | P2-19 | 108M |
| P1-66 | P1-63 | 108M | P2-40 | P2-43 | 530M |
| P2-51 | P2-3 | 314M | P3-1 | P3-19 | 108M |
| P1-9 | P1-5 | 108M | P1-23 | L2-South | 108M |
| P2-2 | P2-51 | 108M | P3-95 | P3-88 | 108M |
| P1-53 | P1-51 | 108M | P3-57 | P3-56 | 108M |
| P1-25 | L2-West | 108M | P3-97 | P3-103 | 108M |
| P2-49 | P2-13 | 108M | P1-1 | P1-5 | 108M |
| P2-50 | P2-53 | 108M | P3-30 | P3-39 | 108M |
| P2-17 | P2-55 | 108M | P3-17 | P3-18 | 108M |
| P3-16 | P3-22 | 108M | P3-61 | P3-64 | 108M |
| P2-22 | P2-46 | 108M | P2-30 | P2-35 | 108M |
| P1-59 | P1-34 | 208M | P3-8 | P3-7 | 108M |
| P3-119 | P3-89 | 108M | P2-26 | P2-27 | 108M |
| P3-96 | P3-88 | 108M | P1-43 | L1-East | 108M |
| P3-73 | P3-121 | 108M | P2-15 | P2-33 | 108M |
| P3-71 | P3-100 | 108M | P3-102 | P3-7 | 108M |
| P2-1 | P2-3 | 108M | P3-12 | P3-84 | 108M |
| P2-10 | P2-8 | 108M | P2-56 | P2-55 | 108M |

| Site 1 Name | Site 2 Name | Bandwidth | Site 1 Name | Site 2 Name | Bandwidth |
|---|---|---|---|---|---|
| P2-45 | P2-41 | 108M | P3-107 | P3-7 | 108M |
| P2-7 | P2-8 | 108M | P4-4 | P3-2 | 108M |
| P2-4 | P2-3 | 108M | P2-25 | P2-27 | 108M |
| P2-32 | P2-29 | 108M | P2-20 | P2-23 | 108M |
| P1-39 | P1-29 | 530M | P2-57 | P2-58 | 108M |
| P2-6 | P2-8 | 108M | P4-2 | P3-120 | 108M |
| P1-40 | P1-39 | 208M | P2-54 | P2-47 | 108M |
| P2-31 | P2-30 | 108M | P4-3 | P3-18 | 108M |
| P3-79 | P3-78 | 108M | P4-19 | P3-32 | 108M |
| P1-8 | L2-CC-03 | 108M | P2-24 | P2-28 | 108M |
| P1-51 | P1-2 | 208M | P4-5 | P3-66 | 108M |
| P1-13 | P1-34 | 530M | P2-28 | P2-29 | 208M |
| P1-2 | P1-4 | 624M | P2-33 | P2-29 | 208M |
| P2-39 | P2-19 | 108M | P3-109 | P3-110 | 208M |
| P3-47 | P3-6 | 108M | P3-112 | P3-113 | 208M |
| P3-74 | P3-122 | 108M | P3-116 | P3-110 | 208M |
| P1-5 | P1-4 | 314M | P3-2 | P3-32 | 208M |
| P2-48 | P2-51 | 108M | P3-21 | P3-30 | 208M |
| P3-23 | P3-31 | 108M | P3-27 | P3-19 | 208M |
| P3-46 | P3-38 | 108M | P3-38 | P3-29 | 208M |
| P2-18 | P2-16 | 108M | P3-42 | P3-43 | 208M |
| P3-13 | P3-7 | 108M | P3-51 | P3-44 | 208M |
| P2-42 | P2-43 | 108M | P3-53 | P3-56 | 208M |
| P2-59 | P2-40 | 108M | P3-59 | P3-56 | 208M |
| P3-25 | P3-18 | 108M | P3-6 | P3-4 | 208M |
| P3-52 | P3-51 | 108M | P3-80 | P3-85 | 208M |
| P3-65 | P3-64 | 108M | P3-82 | P3-77 | 208M |
| P2-12 | P2-11 | 108M | P3-84 | P3-83 | 208M |
| P1-44 | L1-East | 208M | P4-8 | P3-10 | 108M |

| Site 1 Name | Site 2 Name | Bandwidth | Site 1 Name | Site 2 Name | Bandwidth |
|---|---|---|---|---|---|
| P3-122 | P3-100 | 208M | P3-5 | P3-21 | 108M |
| P2-38 | P2-34 | 108M | P2-52 | P2-13 | 108M |
| P3-9 | P3-120 | 108M | P4-11 | P4-23 | 108M |
| P3-89 | P3-100 | 208M | P4-14 | P4-15 | 108M |
| P1-42 | P1-39 | 208M | P4-18 | P3-67 | 108M |
| P2-11 | P2-8 | 208M | P3-35 | P3-18 | 108M |
| P2-36 | P2-34 | 108M | P3-14 | P3-22 | 108M |
| P2-37 | P2-34 | 108M | P4-13 | P4-12 | 108M |
| P3-101 | P3-93 | 108M | P4-10 | P3-120 | 108M |
| P3-104 | P3-103 | 108M | P3-62 | P3-66 | 108M |
| P3-105 | P3-113 | 108M | P3-70 | P3-68 | 108M |
| P3-106 | P3-113 | 108M | P3-123 | P3-109 | 108M |
| P3-26 | P3-18 | 208M | P4-9 | P4-22 | 108M |
| P2-53 | P2-8 | 208M | P4-24 | P4-6 | 108M |
| P3-111 | P3-110 | 108M | P4-17 | P4-1 | 108M |
| P3-114 | P3-113 | 108M | P4-20 | P3-66 | 108M |
| P3-115 | P3-116 | 108M | P4-7 | P4-6 | 108M |
| P2-46 | P2-44 | 208M | P4-21 | P4-1 | 108M |
| P3-103 | P3-110 | 314M | P3-69 | P3-68 | 108M |
| P3-120 | P3-113 | 530M | P4-16 | P4-1 | 108M |
| P3-22 | P3-30 | 530M | | | |

*注意：链路容量与拓扑有关系，在低阶规划LLD 阶段，如果拓扑由于LOS 问题发生变化，容量需要做相应的调整。*

## 7.5 Frequency Planning

微波作为移动回传常用的频段为 6G，7G，8G，11G，15G，18G，23G 和 38G。A 国 W 市运营商较多且大多数运营商的传输资源都使用微波，微波频点资源非常紧张。以上所提到的频段均无足够的频点满足 XX 项目，经过和 XX 项目客户和 CMC 商议，确定使用 26G 和 32G 作为此次项目的微波传输频段。

频段具体原则如下：

| 链路容量 | 距离范围 KM（32G） | 距离范围 KM（26G） |
|---|---|---|
| 108M | 0～2 | >2 |

| | | |
|---|---|---|
| 208M | 0~1.8 | >1.8 |
| 314M | 0~1.5 | >1.5 |
| 530M | 0~1.5 | >1.5 |
| 624M | 0～1.3 | >1.3 |

综合考虑微波传输距离以及容量和天线大小后，对各链路的频段分配如下，其中 26G 主要用在 314M，530M 和 624M，而 32G 主要用在 108M 和 208M 链路上：

| Site 1 Name | Site 2 Name | Band(GHz) | Site 1 Name | Site 2 Name | Band(GHz) |
|---|---|---|---|---|---|
| P1-6 | L2-CC-03 | 32 | P3-22 | P3-30 | 26 |
| P1-38 | L1-East | 32 | P3-32 | P3-43 | 26 |
| P1-47 | L2-South | 32 | P3-33 | P3-43 | 26 |
| P1-37 | L1-East | 32 | P3-4 | P3-56 | 26 |
| P1-64 | P1-52 | 32 | P3-44 | P3-43 | 26 |
| P1-24 | L2-South | 32 | P3-50 | P3-43 | 26 |
| P1-62 | P1-42 | 32 | P3-64 | P3-66 | 26 |
| P1-16 | P1-13 | 32 | P3-92 | P3-85 | 26 |
| P1-67 | P1-22 | 32 | P3-30 | P3-29 | 26 |
| P2-9 | P2-8 | 32 | P3-31 | P3-30 | 26 |
| P1-40 | P1-68 | 32 | P3-83 | P3-82 | 26 |
| P1-55 | P1-54 | 32 | P3-117 | P3-110 | 32 |
| P1-18 | L2-West | 32 | P2-33 | P2-29 | 32 |
| P1-12 | P1-34 | 32 | P3-118 | P3-113 | 32 |
| P1-7 | L2-CC-03 | 32 | P3-93 | P3-85 | 26 |
| P1-26 | L2-West | 32 | P2-51 | P2-3 | 26 |
| P1-27 | P1-29 | 32 | P3-15 | P3-22 | 32 |
| P1-14 | P1-13 | 32 | P3-20 | P3-29 | 32 |
| P1-57 | P1-56 | 32 | P3-24 | P3-33 | 32 |
| P1-10 | P1-13 | 32 | P3-28 | P3-29 | 32 |
| P1-15 | P1-17 | 32 | P4-6 | P3-66 | 26 |
| P1-28 | P1-29 | 32 | P2-13 | P2-8 | 26 |
| P1-30 | P1-39 | 32 | P3-3 | P3-4 | 32 |
| P1-31 | P1-26 | 32 | P3-11 | P3-100 | 26 |

| | | | | | |
|---|---|---|---|---|---|
| P1-32 | P1-36 | 32 | P3-34 | P3-33 | 32 |
| P1-36 | L1-East | 32 | P3-36 | P3-26 | 32 |
| P1-33 | P1-36 | 32 | P3-109 | P3-110 | 32 |
| P1-45 | P1-29 | 32 | P3-37 | P3-27 | 32 |
| P1-17 | L2-West | 32 | P3-40 | P3-31 | 32 |
| P1-46 | P1-48 | 32 | P3-41 | P3-42 | 32 |
| P1-39 | P1-29 | 32 | P2-55 | P2-23 | 26 |
| P1-49 | P1-50 | 32 | P3-45 | P3-44 | 32 |
| P1-61 | P1-38 | 32 | P3-48 | P3-53 | 32 |
| P1-48 | L2-South | 32 | P3-49 | P3-43 | 32 |
| P1-19 | P1-18 | 32 | P3-54 | P3-50 | 32 |
| P1-44 | P1-65 | 32 | P3-55 | P3-50 | 32 |
| P1-63 | P1-7 | 32 | P3-112 | P3-113 | 32 |
| P1-58 | P1-59 | 32 | P3-116 | P3-110 | 32 |
| P1-35 | P1-34 | 32 | P3-2 | P3-32 | 32 |
| P1-2 | P1-4 | 32 | P3-58 | P3-59 | 32 |
| P1-11 | P1-7 | 32 | P3-60 | P3-56 | 32 |
| P1-13 | P1-34 | 32 | P3-21 | P3-30 | 32 |
| P1-41 | P1-39 | 32 | P3-27 | P3-19 | 32 |
| P1-50 | P1-47 | 32 | P3-66 | P3-63 | 32 |
| P1-5 | P1-4 | 32 | P3-72 | P3-77 | 32 |
| P1-59 | P1-34 | 32 | P3-75 | P3-80 | 32 |
| P1-40 | P1-39 | 32 | P4-22 | P3-7 | 26 |
| P1-60 | P1-34 | 32 | P3-68 | P3-18 | 26 |
| P2-40 | P2-43 | 32 | P3-76 | P3-82 | 32 |
| P1-51 | P1-2 | 32 | P3-81 | P3-82 | 32 |
| P2-5 | P2-3 | 32 | P3-86 | P3-85 | 32 |
| P1-44 | L1-East | 32 | P3-87 | P3-82 | 32 |
| P3-122 | P3-100 | 32 | P3-90 | P3-83 | 32 |
| P3-89 | P3-100 | 32 | P3-92 | P3-91 | 32 |

| | | | | | |
|---|---|---|---|---|---|
| P1-56 | L2-South | 26 | P3-94 | P3-93 | 32 |
| P1-42 | P1-39 | 32 | P3-98 | P3-92 | 32 |
| P1-3 | L2-CC-03 | 32 | P3-99 | P3-93 | 32 |
| P1-21 | P1-20 | 32 | P3-108 | P3-112 | 32 |
| P2-30 | P2-29 | 26 | P2-14 | P2-30 | 32 |
| P2-11 | P2-8 | 32 | P2-21 | P2-19 | 32 |
| P1-66 | P1-63 | 32 | P4-1 | P3-100 | 26 |
| P2-44 | P2-43 | 26 | P3-1 | P3-19 | 32 |
| P1-9 | P1-5 | 32 | P1-23 | L2-South | 32 |
| P2-2 | P2-51 | 32 | P3-95 | P3-88 | 32 |
| P1-53 | P1-51 | 32 | P3-57 | P3-56 | 32 |
| P1-25 | L2-West | 32 | P3-97 | P3-103 | 32 |
| P2-49 | P2-13 | 32 | P1-1 | P1-5 | 32 |
| P2-50 | P2-53 | 32 | P3-30 | P3-39 | 32 |
| P2-17 | P2-55 | 32 | P3-17 | P3-18 | 32 |
| P3-16 | P3-22 | 32 | P3-61 | P3-64 | 32 |
| P2-22 | P2-46 | 32 | P2-30 | P2-35 | 32 |
| P3-26 | P3-18 | 32 | P3-8 | P3-7 | 32 |
| P3-119 | P3-89 | 32 | P2-26 | P2-27 | 32 |
| P3-96 | P3-88 | 32 | P1-43 | L1-East | 32 |
| P3-73 | P3-121 | 32 | P2-15 | P2-33 | 32 |
| P3-71 | P3-100 | 32 | P3-102 | P3-7 | 32 |
| P2-1 | P2-3 | 32 | P3-12 | P3-84 | 32 |
| P2-10 | P2-8 | 32 | P2-56 | P2-55 | 32 |
| P2-45 | P2-41 | 32 | P3-107 | P3-7 | 32 |
| P2-7 | P2-8 | 32 | P4-4 | P3-2 | 26 |
| P2-4 | P2-3 | 32 | P2-25 | P2-27 | 26 |
| P2-32 | P2-29 | 32 | P2-20 | P2-23 | 26 |
| P3-19 | P3-18 | 26 | P2-57 | P2-58 | 26 |
| P2-6 | P2-8 | 32 | P4-2 | P3-120 | 26 |

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|---|---|---|---|---|---|
| P2-53 | P2-8 | 32 | P2-54 | P2-47 | 26 |
| P2-31 | P2-30 | 32 | P4-3 | P3-18 | 26 |
| P3-79 | P3-78 | 32 | P4-19 | P3-32 | 26 |
| P1-8 | L2-CC-03 | 32 | P2-24 | P2-28 | 26 |
| P2-46 | P2-44 | 32 | P4-5 | P3-66 | 26 |
| P3-88 | P3-82 | 26 | P3-38 | P3-29 | 32 |
| P2-23 | P2-19 | 26 | P3-42 | P3-43 | 32 |
| P2-39 | P2-19 | 32 | P3-51 | P3-44 | 32 |
| P3-47 | P3-6 | 32 | P3-53 | P3-56 | 32 |
| P3-74 | P3-122 | 32 | P3-59 | P3-56 | 32 |
| P2-27 | P2-29 | 26 | P3-6 | P3-4 | 32 |
| P2-48 | P2-51 | 32 | P3-80 | P3-85 | 32 |
| P3-23 | P3-31 | 32 | P3-82 | P3-77 | 32 |
| P3-46 | P3-38 | 32 | P3-84 | P3-83 | 32 |
| P2-18 | P2-16 | 32 | P1-22 | P1-56 | 26 |
| P3-13 | P3-7 | 32 | P1-52 | L2-CC-03 | 26 |
| P2-42 | P2-43 | 32 | P1-54 | P1-2 | 26 |
| P2-59 | P2-40 | 32 | P4-12 | P3-11 | 26 |
| P3-25 | P3-18 | 32 | P2-16 | P2-40 | 26 |
| P3-52 | P3-51 | 32 | P4-23 | P4-22 | 26 |
| P3-65 | P3-64 | 32 | P3-10 | P3-7 | 26 |
| P2-12 | P2-11 | 32 | P4-15 | P3-11 | 26 |
| P2-41 | P2-43 | 32 | P4-8 | P3-10 | 26 |
| P2-58 | P2-23 | 32 | P3-5 | P3-21 | 26 |
| P2-38 | P2-34 | 32 | P2-52 | P2-13 | 26 |
| P3-9 | P3-120 | 32 | P4-11 | P4-23 | 26 |
| P1-20 | P1-18 | 32 | P4-14 | P4-15 | 26 |
| P3-100 | P3-121 | 32 | P4-18 | P3-67 | 26 |
| P3-67 | P3-31 | 32 | P3-35 | P3-18 | 26 |
| P2-36 | P2-34 | 32 | P3-14 | P3-22 | 26 |

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|---|---|---|---|---|---|
| P2-37 | P2-34 | 32 | P4-13 | P4-12 | 26 |
| P3-101 | P3-93 | 32 | P4-10 | P3-120 | 26 |
| P3-104 | P3-103 | 32 | P3-62 | P3-66 | 26 |
| P3-105 | P3-113 | 32 | P3-70 | P3-68 | 26 |
| P3-106 | P3-113 | 32 | P3-123 | P3-109 | 26 |
| P2-47 | P2-44 | 32 | P4-9 | P4-22 | 26 |
| P3-78 | P3-83 | 32 | P4-24 | P4-6 | 26 |
| P3-111 | P3-110 | 32 | P4-17 | P4-1 | 26 |
| P3-114 | P3-113 | 32 | P4-20 | P3-66 | 26 |
| P3-115 | P3-116 | 32 | P4-7 | P4-6 | 26 |
| P2-28 | P2-29 | 32 | P4-21 | P4-1 | 26 |
| P2-34 | P2-29 | 26 | P3-69 | P3-68 | 26 |
| P3-103 | P3-110 | 26 | P4-16 | P4-1 | 26 |
| P3-120 | P3-113 | 26 | | | |

*注意：具体每链路的频点以及极化方式规划需要在低阶规划LLD 中完成。如果在低阶规划LLD 中其他诸如链路容量，路由等发上变化，频段也需要做相应的调整。*

## 7.6 Availability Planning

本项目由于客户对可用度方面没有具体要求，所以按照华为推荐的 99.995%来规划。根据 99.995%的可用度要求，综合考虑本项目的频段，链路距离等，我们使用以下原则来选用天线：

| 链路容量 | 距离范围 KM（32G） | | 距离范围 KM（26G） | |
|---|---|---|---|---|
| | 0.3M | 0.6M | 0.6M | 0.9M |
| 108M | 0～1.4 | 1.4～2 | 2～2.35 | 2.35~5 |
| 208M | / | 0～1.8 | 1.8～2.3 | 2.3~4.69 |
| 314M | / | 0～1.5 | 1.5~1.6 | 1.6~2.93 |
| 530M | / | 0~1.5 | 1.5~1.6 | 1.6~4.61 |
| 624M | / | 0～1.3 | 1.3~1.55 | 1.55~2.37 |

根据以上天线选取原则，我们对每跳链路的天线分配如下：

| Site 1 Name | Site 2 Name | Path length (KM) | Anntena D(M) | Frequency (GHz) | Bandwidth |
|---|---|---|---|---|---|
| P1-6 | L2-CC-03 | 0.59 | 0.3 | 32 | 108M |
| P1-38 | L1-East | 0.41 | 0.6 | 32 | 208M |
| P1-47 | L2-South | 0.37 | 0.6 | 32 | 314M |
| P1-37 | L1-East | 0.79 | 0.3 | 32 | 108M |

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| P1-64 | P1-52 | 0.96 | 0.3 | 32 | 108M |
| P1-24 | L2-South | 0.97 | 0.3 | 32 | 108M |
| P1-62 | P1-42 | 1.05 | 0.3 | 32 | 108M |
| P1-16 | P1-13 | 1.07 | 0.3 | 32 | 108M |
| P1-67 | P1-22 | 1.14 | 0.3 | 32 | 108M |
| P2-9 | P2-8 | 1.14 | 0.3 | 32 | 108M |
| P1-40 | P1-68 | 1.15 | 0.3 | 32 | 108M |
| P1-55 | P1-54 | 1.15 | 0.3 | 32 | 108M |
| P1-18 | L2-West | 0.76 | 0.6 | 32 | 530M |
| P1-12 | P1-34 | 1.16 | 0.3 | 32 | 108M |
| P1-7 | L2-CC-03 | 0.84 | 0.6 | 32 | 530M |
| P1-26 | L2-West | 0.57 | 0.6 | 32 | 208M |
| P1-27 | P1-29 | 1.16 | 0.3 | 32 | 108M |
| P1-14 | P1-13 | 1.18 | 0.3 | 32 | 108M |
| P1-57 | P1-56 | 1.18 | 0.3 | 32 | 108M |
| P1-10 | P1-13 | 1.2 | 0.3 | 32 | 108M |
| P1-15 | P1-17 | 1.2 | 0.3 | 32 | 108M |
| P1-28 | P1-29 | 1.2 | 0.3 | 32 | 108M |
| P1-30 | P1-39 | 1.2 | 0.3 | 32 | 108M |
| P1-31 | P1-26 | 1.2 | 0.3 | 32 | 108M |
| P1-32 | P1-36 | 1.2 | 0.3 | 32 | 108M |
| P1-36 | L1-East | 1 | 0.6 | 32 | 314M |
| P1-33 | P1-36 | 1.2 | 0.3 | 32 | 108M |
| P1-45 | P1-29 | 1.2 | 0.3 | 32 | 108M |
| P1-17 | L2-West | 0.78 | 0.6 | 32 | 208M |
| P1-46 | P1-48 | 1.2 | 0.3 | 32 | 108M |
| P1-39 | P1-29 | 1.2 | 0.6 | 32 | 530M |
| P1-49 | P1-50 | 1.2 | 0.3 | 32 | 108M |
| P1-61 | P1-38 | 1.21 | 0.3 | 32 | 108M |
| P1-48 | L2-South | 0.82 | 0.6 | 32 | 208M |

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|---|---|---|---|---|---|
| P1-19 | P1-18 | 1.22 | 0.3 | 32 | 108M |
| P1-44 | P1-65 | 1.22 | 0.3 | 32 | 108M |
| P1-63 | P1-7 | 0.88 | 0.6 | 32 | 208M |
| P1-58 | P1-59 | 1.22 | 0.3 | 32 | 108M |
| P1-35 | P1-34 | 1.23 | 0.3 | 32 | 108M |
| P1-2 | P1-4 | 1.22 | 0.6 | 32 | 624M |
| P1-11 | P1-7 | 1.24 | 0.3 | 32 | 108M |
| P1-13 | P1-34 | 1.22 | 0.6 | 32 | 530M |
| P1-41 | P1-39 | 1.24 | 0.3 | 32 | 108M |
| P1-50 | P1-47 | 1.02 | 0.6 | 32 | 208M |
| P1-5 | P1-4 | 1.24 | 0.6 | 32 | 314M |
| P1-59 | P1-34 | 1.19 | 0.6 | 32 | 208M |
| P1-40 | P1-39 | 1.21 | 0.6 | 32 | 208M |
| P1-60 | P1-34 | 1.25 | 0.3 | 32 | 108M |
| P2-40 | P2-43 | 1.42 | 0.6 | 32 | 530M |
| P1-51 | P1-2 | 1.22 | 0.6 | 32 | 208M |
| P2-5 | P2-3 | 1.26 | 0.3 | 32 | 108M |
| P1-44 | L1-East | 1.32 | 0.6 | 32 | 208M |
| P3-122 | P3-100 | 1.33 | 0.6 | 32 | 208M |
| P3-89 | P3-100 | 1.39 | 0.6 | 32 | 208M |
| P1-56 | L2-South | 1.51 | 0.6 | 26 | 530M |
| P1-42 | P1-39 | 1.4 | 0.6 | 32 | 208M |
| P1-3 | L2-CC-03 | 1.27 | 0.3 | 32 | 108M |
| P1-21 | P1-20 | 1.28 | 0.3 | 32 | 108M |
| P2-30 | P2-29 | 1.51 | 0.6 | 26 | 530M |
| P2-11 | P2-8 | 1.4 | 0.6 | 32 | 208M |
| P1-66 | P1-63 | 1.28 | 0.3 | 32 | 108M |
| P2-44 | P2-43 | 1.54 | 0.6 | 26 | 624M |
| P1-9 | P1-5 | 1.28 | 0.3 | 32 | 108M |
| P2-2 | P2-51 | 1.28 | 0.3 | 32 | 108M |

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| P1-53 | P1-51 | 1.29 | 0.3 | 32 | 108M |
| P1-25 | L2-West | 1.32 | 0.3 | 32 | 108M |
| P2-49 | P2-13 | 1.32 | 0.3 | 32 | 108M |
| P2-50 | P2-53 | 1.32 | 0.3 | 32 | 108M |
| P2-17 | P2-55 | 1.38 | 0.3 | 32 | 108M |
| P3-16 | P3-22 | 1.38 | 0.3 | 32 | 108M |
| P2-22 | P2-46 | 1.42 | 0.6 | 32 | 108M |
| P3-26 | P3-18 | 1.46 | 0.6 | 32 | 208M |
| P3-119 | P3-89 | 1.42 | 0.6 | 32 | 108M |
| P3-96 | P3-88 | 1.42 | 0.6 | 32 | 108M |
| P3-73 | P3-121 | 1.44 | 0.6 | 32 | 108M |
| P3-71 | P3-100 | 1.45 | 0.6 | 32 | 108M |
| P2-1 | P2-3 | 1.46 | 0.6 | 32 | 108M |
| P2-10 | P2-8 | 1.49 | 0.6 | 32 | 108M |
| P2-45 | P2-41 | 1.49 | 0.6 | 32 | 108M |
| P2-7 | P2-8 | 1.49 | 0.6 | 32 | 108M |
| P2-4 | P2-3 | 1.51 | 0.6 | 32 | 108M |
| P2-32 | P2-29 | 1.52 | 0.6 | 32 | 108M |
| P3-19 | P3-18 | 1.57 | 0.6 | 26 | 530M |
| P2-6 | P2-8 | 1.52 | 0.6 | 32 | 108M |
| P2-53 | P2-8 | 1.48 | 0.6 | 32 | 208M |
| P2-31 | P2-30 | 1.53 | 0.6 | 32 | 108M |
| P3-79 | P3-78 | 1.53 | 0.6 | 32 | 108M |
| P1-8 | L2-CC-03 | 1.54 | 0.6 | 32 | 108M |
| P2-46 | P2-44 | 1.49 | 0.6 | 32 | 208M |
| P3-88 | P3-82 | 1.59 | 0.6 | 26 | 314M |
| P2-23 | P2-19 | 1.6 | 0.6 | 26 | 314M |
| P2-39 | P2-19 | 1.55 | 0.6 | 32 | 108M |
| P3-47 | P3-6 | 1.55 | 0.6 | 32 | 108M |
| P3-74 | P3-122 | 1.55 | 0.6 | 32 | 108M |

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| P2-27 | P2-29 | 1.66 | 0.9 | 26 | 314M |
| P2-48 | P2-51 | 1.56 | 0.6 | 32 | 108M |
| P3-23 | P3-31 | 1.56 | 0.6 | 32 | 108M |
| P3-46 | P3-38 | 1.56 | 0.6 | 32 | 108M |
| P2-18 | P2-16 | 1.57 | 0.6 | 32 | 108M |
| P3-13 | P3-7 | 1.57 | 0.6 | 32 | 108M |
| P2-42 | P2-43 | 1.58 | 0.6 | 32 | 108M |
| P2-59 | P2-40 | 1.58 | 0.6 | 32 | 108M |
| P3-25 | P3-18 | 1.58 | 0.6 | 32 | 108M |
| P3-52 | P3-51 | 1.64 | 0.6 | 32 | 108M |
| P3-65 | P3-64 | 1.64 | 0.6 | 32 | 108M |
| P2-12 | P2-11 | 1.66 | 0.6 | 32 | 108M |
| P2-41 | P2-43 | 1.51 | 0.6 | 32 | 208M |
| P2-58 | P2-23 | 1.55 | 0.6 | 32 | 208M |
| P2-38 | P2-34 | 1.66 | 0.6 | 32 | 108M |
| P3-9 | P3-120 | 1.66 | 0.6 | 32 | 108M |
| P1-20 | P1-18 | 1.58 | 0.6 | 32 | 208M |
| P3-100 | P3-121 | 1.59 | 0.6 | 32 | 208M |
| P3-67 | P3-31 | 1.62 | 0.6 | 32 | 208M |
| P2-36 | P2-34 | 1.67 | 0.6 | 32 | 108M |
| P2-37 | P2-34 | 1.67 | 0.6 | 32 | 108M |
| P3-101 | P3-93 | 1.67 | 0.6 | 32 | 108M |
| P3-104 | P3-103 | 1.67 | 0.6 | 32 | 108M |
| P3-105 | P3-113 | 1.67 | 0.6 | 32 | 108M |
| P3-106 | P3-113 | 1.67 | 0.6 | 32 | 108M |
| P2-47 | P2-44 | 1.64 | 0.6 | 32 | 208M |
| P3-78 | P3-83 | 1.64 | 0.6 | 32 | 208M |
| P3-111 | P3-110 | 1.67 | 0.6 | 32 | 108M |
| P3-114 | P3-113 | 1.67 | 0.6 | 32 | 108M |
| P3-115 | P3-116 | 1.67 | 0.6 | 32 | 108M |

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| P2-28 | P2-29 | 1.67 | 0.6 | 32 | 208M |
| P2-34 | P2-29 | 1.66 | 0.9 | 26 | 530M |
| P3-103 | P3-110 | 1.67 | 0.9 | 26 | 314M |
| P3-120 | P3-113 | 1.67 | 0.9 | 26 | 530M |
| P3-22 | P3-30 | 1.67 | 0.9 | 26 | 530M |
| P3-32 | P3-43 | 1.67 | 0.9 | 26 | 530M |
| P3-33 | P3-43 | 1.67 | 0.9 | 26 | 314M |
| P3-4 | P3-56 | 1.67 | 0.9 | 26 | 530M |
| P3-44 | P3-43 | 1.67 | 0.9 | 26 | 530M |
| P3-50 | P3-43 | 1.67 | 0.9 | 26 | 314M |
| P3-64 | P3-66 | 1.67 | 0.9 | 26 | 314M |
| P3-92 | P3-85 | 1.67 | 0.9 | 26 | 314M |
| P3-30 | P3-29 | 1.67 | 0.9 | 26 | 624M |
| P3-31 | P3-30 | 1.67 | 0.9 | 26 | 624M |
| P3-83 | P3-82 | 1.67 | 0.9 | 26 | 624M |
| P3-117 | P3-110 | 1.67 | 0.6 | 32 | 108M |
| P2-33 | P2-29 | 1.67 | 0.6 | 32 | 208M |
| P3-118 | P3-113 | 1.67 | 0.6 | 32 | 108M |
| P3-93 | P3-85 | 1.67 | 0.9 | 26 | 530M |
| P2-51 | P2-3 | 1.71 | 0.9 | 26 | 314M |
| P3-15 | P3-22 | 1.67 | 0.6 | 32 | 108M |
| P3-20 | P3-29 | 1.67 | 0.6 | 32 | 108M |
| P3-24 | P3-33 | 1.67 | 0.6 | 32 | 108M |
| P3-28 | P3-29 | 1.67 | 0.6 | 32 | 108M |
| P4-6 | P3-66 | 2.09 | 0.9 | 26 | 314M |
| P2-13 | P2-8 | 2.13 | 0.9 | 26 | 314M |
| P3-3 | P3-4 | 1.67 | 0.6 | 32 | 108M |
| P3-11 | P3-100 | 2.37 | 0.9 | 26 | 624M |
| P3-34 | P3-33 | 1.67 | 0.6 | 32 | 108M |
| P3-36 | P3-26 | 1.67 | 0.6 | 32 | 108M |

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| P3-109 | P3-110 | 1.67 | 0.6 | 32 | 208M |
| P3-37 | P3-27 | 1.67 | 0.6 | 32 | 108M |
| P3-40 | P3-31 | 1.67 | 0.6 | 32 | 108M |
| P3-41 | P3-42 | 1.67 | 0.6 | 32 | 108M |
| P2-55 | P2-23 | 2.59 | 0.9 | 26 | 314M |
| P3-45 | P3-44 | 1.67 | 0.6 | 32 | 108M |
| P3-48 | P3-53 | 1.67 | 0.6 | 32 | 108M |
| P3-49 | P3-43 | 1.67 | 0.6 | 32 | 108M |
| P3-54 | P3-50 | 1.67 | 0.6 | 32 | 108M |
| P3-55 | P3-50 | 1.67 | 0.6 | 32 | 108M |
| P3-112 | P3-113 | 1.67 | 0.6 | 32 | 208M |
| P3-116 | P3-110 | 1.67 | 0.6 | 32 | 208M |
| P3-2 | P3-32 | 1.67 | 0.6 | 32 | 208M |
| P3-58 | P3-59 | 1.67 | 0.6 | 32 | 108M |
| P3-60 | P3-56 | 1.67 | 0.6 | 32 | 108M |
| P3-21 | P3-30 | 1.67 | 0.6 | 32 | 208M |
| P3-27 | P3-19 | 1.67 | 0.6 | 32 | 208M |
| P3-66 | P3-63 | 1.67 | 0.6 | 32 | 108M |
| P3-72 | P3-77 | 1.67 | 0.6 | 32 | 108M |
| P3-75 | P3-80 | 1.67 | 0.6 | 32 | 108M |
| P4-22 | P3-7 | 2.88 | 0.9 | 26 | 530M |
| P3-68 | P3-18 | 2.93 | 0.9 | 26 | 314M |
| P3-76 | P3-82 | 1.67 | 0.6 | 32 | 108M |
| P3-81 | P3-82 | 1.67 | 0.6 | 32 | 108M |
| P3-86 | P3-85 | 1.67 | 0.6 | 32 | 108M |
| P3-87 | P3-82 | 1.67 | 0.6 | 32 | 108M |
| P3-90 | P3-83 | 1.67 | 0.6 | 32 | 108M |
| P3-92 | P3-91 | 1.67 | 0.6 | 32 | 108M |
| P3-94 | P3-93 | 1.67 | 0.6 | 32 | 108M |
| P3-98 | P3-92 | 1.67 | 0.6 | 32 | 108M |

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| P3-99 | P3-93 | 1.67 | 0.6 | 32 | 108M |
| P3-108 | P3-112 | 1.68 | 0.6 | 32 | 108M |
| P2-14 | P2-30 | 1.69 | 0.6 | 32 | 108M |
| P2-21 | P2-19 | 1.69 | 0.6 | 32 | 108M |
| P4-1 | P3-100 | 4.61 | 0.9 | 26 | 530M |
| P3-1 | P3-19 | 1.69 | 0.6 | 32 | 108M |
| P1-23 | L2-South | 1.7 | 0.6 | 32 | 108M |
| P3-95 | P3-88 | 1.7 | 0.6 | 32 | 108M |
| P3-57 | P3-56 | 1.71 | 0.6 | 32 | 108M |
| P3-97 | P3-103 | 1.71 | 0.6 | 32 | 108M |
| P1-1 | P1-5 | 1.73 | 0.6 | 32 | 108M |
| P3-30 | P3-39 | 1.75 | 0.6 | 32 | 108M |
| P3-17 | P3-18 | 1.78 | 0.6 | 32 | 108M |
| P3-61 | P3-64 | 1.81 | 0.6 | 32 | 108M |
| P2-30 | P2-35 | 1.82 | 0.6 | 32 | 108M |
| P3-8 | P3-7 | 1.82 | 0.6 | 32 | 108M |
| P2-26 | P2-27 | 1.83 | 0.6 | 32 | 108M |
| P1-43 | L1-East | 1.85 | 0.6 | 32 | 108M |
| P2-15 | P2-33 | 1.87 | 0.6 | 32 | 108M |
| P3-102 | P3-7 | 1.89 | 0.6 | 32 | 108M |
| P3-12 | P3-84 | 1.89 | 0.6 | 32 | 108M |
| P2-56 | P2-55 | 1.93 | 0.6 | 32 | 108M |
| P3-107 | P3-7 | 2 | 0.6 | 32 | 108M |
| P4-4 | P3-2 | 2.03 | 0.6 | 26 | 108M |
| P2-25 | P2-27 | 2.1 | 0.6 | 26 | 108M |
| P2-20 | P2-23 | 2.15 | 0.6 | 26 | 108M |
| P2-57 | P2-58 | 2.19 | 0.6 | 26 | 108M |
| P4-2 | P3-120 | 2.23 | 0.6 | 26 | 108M |
| P2-54 | P2-47 | 2.25 | 0.6 | 26 | 108M |
| P4-3 | P3-18 | 2.3 | 0.6 | 26 | 108M |

| | | | | | |
|---|---|---|---|---|---|
| P4-19 | P3-32 | 2.31 | 0.6 | 26 | 108M |
| P2-24 | P2-28 | 2.37 | 0.9 | 26 | 108M |
| P4-5 | P3-66 | 2.45 | 0.9 | 26 | 108M |
| P3-38 | P3-29 | 1.67 | 0.6 | 32 | 208M |
| P3-42 | P3-43 | 1.67 | 0.6 | 32 | 208M |
| P3-51 | P3-44 | 1.67 | 0.6 | 32 | 208M |
| P3-53 | P3-56 | 1.67 | 0.6 | 32 | 208M |
| P3-59 | P3-56 | 1.67 | 0.6 | 32 | 208M |
| P3-6 | P3-4 | 1.67 | 0.6 | 32 | 208M |
| P3-80 | P3-85 | 1.67 | 0.6 | 32 | 208M |
| P3-82 | P3-77 | 1.67 | 0.6 | 32 | 208M |
| P3-84 | P3-83 | 1.67 | 0.6 | 32 | 208M |
| P1-22 | P1-56 | 1.83 | 0.6 | 26 | 208M |
| P1-52 | L2-CC-03 | 1.83 | 0.6 | 26 | 208M |
| P1-54 | P1-2 | 2.02 | 0.6 | 26 | 208M |
| P4-12 | P3-11 | 2.21 | 0.6 | 26 | 208M |
| P2-16 | P2-40 | 2.3 | 0.6 | 26 | 208M |
| P4-23 | P4-22 | 2.42 | 0.9 | 26 | 208M |
| P3-10 | P3-7 | 2.86 | 0.9 | 26 | 208M |
| P4-15 | P3-11 | 4.69 | 0.9 | 26 | 208M |
| P4-8 | P3-10 | 2.56 | 0.9 | 26 | 108M |
| P3-5 | P3-21 | 2.61 | 0.9 | 26 | 108M |
| P2-52 | P2-13 | 2.62 | 0.9 | 26 | 108M |
| P4-11 | P4-23 | 2.66 | 0.9 | 26 | 108M |
| P4-14 | P4-15 | 2.67 | 0.9 | 26 | 108M |
| P4-18 | P3-67 | 2.68 | 0.9 | 26 | 108M |
| P3-35 | P3-18 | 2.72 | 0.9 | 26 | 108M |
| P3-14 | P3-22 | 2.79 | 0.9 | 26 | 108M |
| P4-13 | P4-12 | 2.81 | 0.9 | 26 | 108M |
| P4-10 | P3-120 | 2.85 | 0.9 | 26 | 108M |

| | | | | | |
|---|---|---|---|---|---|
| P3-62 | P3-66 | 2.88 | 0.9 | 26 | 108M |
| P3-70 | P3-68 | 3 | 0.9 | 26 | 108M |
| P3-123 | P3-109 | 3.1 | 0.9 | 26 | 108M |
| P4-9 | P4-22 | 3.28 | 0.9 | 26 | 108M |
| P4-24 | P4-6 | 3.55 | 0.9 | 26 | 108M |
| P4-17 | P4-1 | 3.7 | 0.9 | 26 | 108M |
| P4-20 | P3-66 | 3.83 | 0.9 | 26 | 108M |
| P4-7 | P4-6 | 3.86 | 0.9 | 26 | 108M |
| P4-21 | P4-1 | 4.35 | 0.9 | 26 | 108M |
| P3-69 | P3-68 | 4.53 | 0.9 | 26 | 108M |
| P4-16 | P4-1 | 5 | 0.9 | 26 | 108M |

*注意：如果在低阶规划 LLD 中其他诸如链路容量，路由等发上变化，天线大小也需要做相应的调整以满足 KPI*

## 7.7 QoS Planning

OptiX RTN 980 具有完善的 QoS 能力，实现了标准的 BE、AF1、AF2、AF3、AF4、EF、CS6、CS7 八组 PHB，使网络运营商可为用户提供具有不同服务质量等级的服务保证，实现同时承载数据、语音和视频业务的综合网络。

QoS 特性说明 项目：

DiffServ,，对以太网业务，支持根据 C-VLAN 优先级、S-VLAN 优先级、IP 报文的 DSCP 值或 MPLS 报文的 EXP 值映射到 PHB 服务等级。

对 ATM 业务，支持 ATM 业务类型（CBR、UBR、UBR+、rtVBR 和 nrtVBR）与 PHB 服务等级间的灵活映射。

对 CES 业务，每条 CES 业务对应的 PHB 服务等级可设置，默认为 EF。

复杂流分类，支持根据 PORT、CVLAN ID、SVLAN ID 以及 CVLAN/SVLAN 报文的 802.1p 优先级和 DSCP 进行流分类。

流量监管， 支持基于流的流量监管。支持设置 PIR 和 CIR，步进为 64kbit/s。

队列调度 ，每个以太网端口和一体化 IP 微波端口支持八级优先级队列调度。

可以对每个以太网端口和一体化 IP 微波端口灵活设置队列调度方式，队列调度方式有 SP、SP+WRR 和 WRR。

流量整形，支持对指定的 PORT、优先级队列或业务流进行 shaping，PIR 和 CIR 的设置步进为 64kbit/s。

XX 项目 QoS 规划：

1. 采用 DiffServ 简单流分类，根据 LTE 侧报文内 DSCP 进行默认调度，PHB 采用默认映射，具体映射关系如下。

   默认的 DS 域入方向映射关系：

| CVLAN Pri | SVLAN Pri | MPLS EXP | DSCP 值（十进制） | PHB |
|---|---|---|---|---|
| 0 | 0 | 0 | 0 | BE |
| 1 | 1 | 1 | 8，10，12，14 | AF1 |
| 2 | 2 | 2 | 16，18，20，22 | AF2 |
| 3 | 3 | 3 | 24，26，28，30 | AF3 |
| 4 | 4 | 4 | 32，34，36，38 | AF4 |
| 5 | 5 | 5 | 40，46 | EF |
| 6 | 6 | 6 | 48 | CS6 |
| 7 | 7 | 7 | 56 | CS7 |

默认的 DS 域出方向映射关系：

| PHB | CVLAN Pri | MPLS EXP | SVLAN Pri | DSCP 值（十进制） |
|---|---|---|---|---|
| BE | 0 | 0 | 0 | 0 |
| AF1 | 1 | 1 | 1 | 8，12，14 |
| AF2 | 2 | 2 | 2 | 16，20，22 |
| AF3 | 3 | 3 | 3 | 24，28，30 |
| AF4 | 4 | 4 | 4 | 32，36，38 |
| EF | 5 | 5 | 5 | 40 |
| CS6 | 6 | 6 | 6 | 48 |
| CS7 | 7 | 7 | 7 | 56 |

2. 流量监管 CAR 不使能。
3. 调度机制如下：

| PHB | Scheduling |
|---|---|
| CS7 | SP |
| CS6 | SP |
| EF | SP |
| AF4 | WRR |
| AF3 | WRR |
| AF2 | WRR |

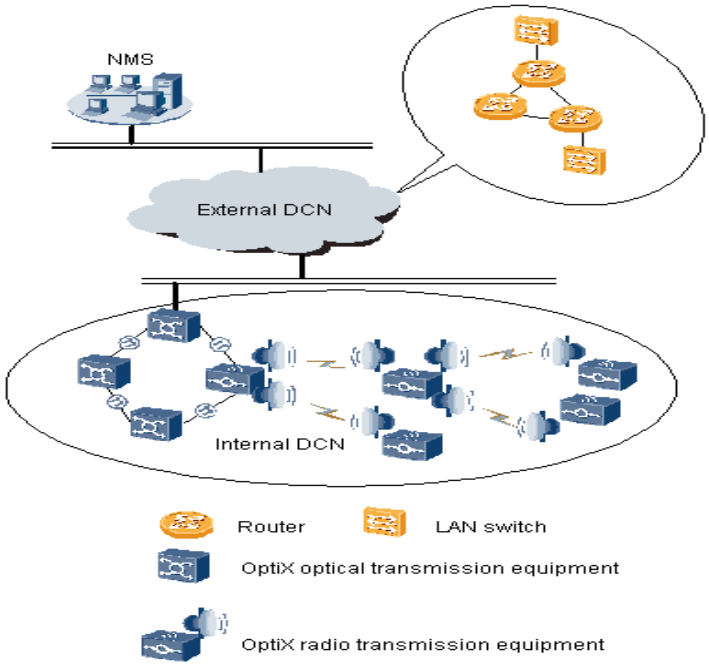
| | |
|---|---|
| AF1 | WRR |
| BE | SP |

4. 流量整形不使能。

## 7.8 DCN Planning for U2000

- DCN 的组成

在 DCN 中，网管和网元都是 DCN 的节点。网管和网元之间的 DCN 被称为外部 DCN，网元和网元之间的 DCN 被称为内部 DCN。




- 外部 DCN

XX 项目组网中，网管与网元可能位于不同的建筑，因此网管与网元之间需要由以太网交换机、路由器等数据通信设备组成的外部 DCN 网络相连接。

网管与每个网关网元间的外部 DCN 带宽不应低于网管网元的内部 DCN 带宽，为保证网管性能，不低于 2Mbit/s。

本项目要求数通侧在每个光节点提供 1 个 FE 电口，承载微波网管信息，带宽不能低于 2M。

- 内部 DCN

在内部 DCN 中，OptiX RTN 950 支持的网络管理信息的方式有：

容量小于 16×E1 的 PDH 微波通过微波帧自定义的 1 个 DCC 字节传输网络管理信息。

容量不小于 16×E1 的 PDH 微波通过微波帧自定义的 3 个 DCC 字节传输网络管理信息。

通过 SDH 微波帧和 SDH 帧中 D1～D3、D4～D12 字节或 D1～D12 字节传输网络管理信息。

通过 Hybrid 微波帧自定义的 3 个字节传输网络管理信息。

通过以太网网管接口或网元级联接口传输网络管理信息。

通过外时钟接口传输 DCC 功能，使网络管理消息通过 SDH/PDH 网络传输。

采用带内 DCN 功能，使用以太网业务的带宽，通过 Hybrid 微波端口、FE/GE 端口传输网络管理信息。

本项目通过 Hybrid 微波帧自定义的 3 个字节传输网络管理信息。

内部 DCN 采用 Huawei ECC 组网，当两个或多个网元之间没有 DCC 通道互通时，通过互联各网元的以太网网管接口或网元级联接口来实现扩展 ECC 通信。

内部 DCN 网元 ID 规划规则：

| 扩展 ID | ID |
|---|---|
| 9 | 1-65534 各个 NE 保持唯一 |

内部 DCN 网 IP 规划：

0x81000000+网元 ID

举例：如果 ID 为 0x090001，则“IP”设置为 129.9.0.1。“子网掩码”设置为 255.255.0.0

光节点网管网元 IP 地址规划根据按照数通规划结果来。

## 7.9 Key Performance

华为微波标准 KPI 参数如下表（单跳）

| Category | KPIs | KPI Definition |
|---|---|---|
| RTN Hybrid | ▪ BER<br>▪ Annual Availability(年度可用性)<br>▪ Flat Fade Margin (平坦衰落余量)<br>▪ Receive Signal Level (RSL)<br>▪ System Configuration | ▪ 10 E-6<br>▪ 99.999%<br>▪ 30dB (min)<br>▪ -45dBm (min)<br>▪ 1+0 or XPIC |

## 7.10 Equipment Configuration

根据路由，频段，容量和天线大小的规划结果，可以得出以下设备配置：

| Band | Capacity | 0.3M Ant | 0.6M Ant | 0.9M Ant |
|---|---|---|---|---|
| 26G | 108M | | 8 | 23 |
| 26G | 208M | | 5 | 3 |
| 26G | 314M | | 2 | 11 |
| 26G | 530M | | 3 | 9 |
| 26G | 624M | | 1 | 4 |
| 32G | 108M | 44 | 92 | |
| 32G | 208M | | 41 | |
| 32G | 314M | | 3 | |

| | | | | |
|---|---|---|---|---|
| 32G | 530M | | 5 | |
| 32G | 624M | | 1 | |

IDU 选取原则，光节点使用 RTN980，其他汇聚节点使用 RTN950，末端节点使用 RTN910。

ODU 全部采用 XMC-2。

天线采用 UHP 类型。

产品版本采用 RTN900V1R3C03SPC201。

# 8 Fiber IP Network Design

## 8.1 Design Principle

In order to build a solid IP core infrastructure to meet the huge surveillance traffic, the following principles shall has been applied in the designing of IP backbone network.

- High Capacity & Ultra Scalability: Due to the fast growing traffic needs, the proposed platform should have high capacity & ultra scalability. High speed interfaces, high density port cards & multi-chassis platform may be required depending on the capacity requirements.
- High Reliability & Resiliency: Any failure in the IP backbone network may affect large amount of internet subscribers and may be a disaster for mission-critical services. Therefore reliable equipments and reliable network design must be offered to ensure non-stop operation.
- Strict QoS Guarantee: The next generation IP backbone shall be able to classify and prioritize different services so as to guarantee end-to-end QoS. IP DiffServ shall be deployed.
- Security: Malicious attacks may be initiated from customer side or from external networks, therefore series measures shall be taken to ensure IP backbone network security & robustness, as well as the traffic privacy & integrity.

As the microwave hub nodes traffic already reached more than 2 Giga, Huawei proposed optical fiber to connect all the Microwave Hub Nodes and Commander Centers .With deep analysis the traffic modle, Huawei designed 3 layer in fiber transmission backbone, Layer 1 with 40GE and Layer 2 and Layer 3 with 10GE capacity, this structure can meet the traffic growth within 5 years and high network resilience also take into the consideration.

## 8.2 Implementation Procedure

The transmission project will implemented in 3 phase in line with the Surveillance camera deployments. As this is a pure IP network, all the fiber nodes is positioned by Router only providing flexible routing and multi QOS mechanism guarantee. In phase I, transmission will cover 3 command center nodes and 4 fiber nodes, so totally 7 fiber nodes there. For phase 2, there are totally 5 fiber nodes,2 combined within the Command center and the other 3 is independent fiber nodes. In phase III, there are totally 11 fiber nodes collecting the Microwave site traffics.

This is just an brief overview of the 3 phases, the details description is coming in the following chapter.

- Phase 1 Construction

In phase 1, the fiber routes only cover the density camera area. The fiber route design already take the future coming network deployment into consideration .There are 3 command center ,each with one NE40E-X16 and two S9312 switch which is works in CSS mode providing connectivity for the IP

devices in command center. Two unit E1000E firewall to secure the out access of the network. For the non commander center fiber nodes, each fiber nodes two unites NE40E-X8 or NE40E-X3, NE40E-X8 placed in cross connection nodes and hands more traffic and NE40E-X3 serves in less density area.

- Phase 2 Construction

In phase 2, there are 3 fiber nodes placed on the Phase 1 fiber route, the new fiber routes mainly cover the South east area. There are 2 command center ,each with one NE40E-X16 and two S9312 switch which is works in CSS mode providing connectivity for the IP devices in command center. For the non commander center fiber nodes, each fiber nodes two unites NE40E-X8 or NE40E-X3, NE40E-X8 placed in cross connection nodes and hands more traffic and NE40E-X3 serves in less density area.

- Phase 3 Construction

In phase 3, the fiber routes will extend to W City edge area and with the largest fiber nodes among the 3 phases. As command already set up so there only NE40E-X8 or NE40E-X3 Router in the fiber nodes. each fiber nodes two unites NE40E-X8 or NE40E-X3, NE40E-X8 placed in cross connection nodes and hands more traffic and NE40E-X3 serves in less density area.

## 8.3 Bandwidth Requirement

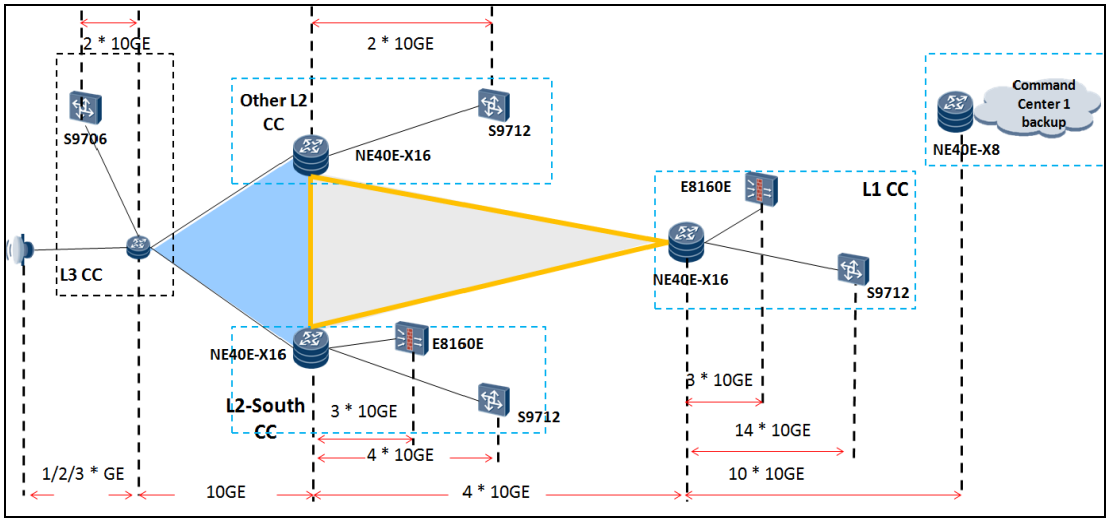
The fiber IP network is used to bear IVS service traffic, Telepresence traffic, CSS backup traffic, etc. The following table depicts bandwidth requirement for each application system, the IVS traffic model is divided into 2 parts, scenario 1 when only L1 EPC core network is working (short for L1 EPC in the figure below), and scenario 2 when only L2 EPC core network is working (short for L2 EPC in the figure below). The bandwidth of other scenarios of IVS is within the range of scenario 1 and 2.

| Application | Scenario | Location | Connection (including direction) | Load (Gbps) |
|---|---|---|---|---|
| IVS | L1 EPC | L1 CC | NE40E -> S9712 | 40 |
| | | | NE40E <- S9712 | 21 |
| | | | NE40E <-> E8160E | 20 |
| | | L2-South CC | NE40E -> S9712 | 5.3 |
| | | | NE40E <- S9712 | 6 |
| | | | NE40E <-> E8160E | N/A |
| | | Other L2 CC | NE40E -> S9712 | 5.3 |
| | | | NE40E <- S9712 | 6 |
| | | L3 CC | NE40E <-> S9706 | 1 |
| | L2 EPC | L1 CC | NE40E -> S9712 | 20 |
| | | | NE40E <- S9712 | 1 |
| | | | NE40E <-> E8160E | N/A |
| | | L2-South CC | NE40E -> S9712 | 20.3 |
| | | | NE40E <- S9712 | 21 |

| | | | | |
|---|---|---|---|---|
| | | | NE40E <-> E8160E | 20 |
| | | Other L2 CC | NE40E -> S9712 | 5.3 |
| | | | NE40E <- S9712 | 6 |
| | | L3 CC | NE40E <-> S9706 | 1 |
| IVS (signaling) | | L1 CC | NE40E <-> S9712 | 5 |
| IVS (signaling) | | L2 CC | NE40E <-> S9712 | 5 |
| EPC | | L1 CC | NE40E <-> S9712 | 1 |
| | | L2-South CC | NE40E <-> S9712 | 1 |
| CSS backup | | L1 CC | NE40E -> S9712 | 87 |
| | | L1 CC backup | NE40E -> L1 CC | 87 |
| IP phone | | L1 CC | NE40E <-> S9712 | <1 |
| Telepresence | | L1 CC | NE40E <-> S9712 | <1 |

Please note, the overhead of media encapsulation, which cost 2% of each network inter-connection, should be taken into account in the bandwidth reservation. And the normal bandwidth usage should not beyond 70% of calculated bandwidth.

As the calculation above, the bandwidth of core network is shown below:




## 8.4 Fiber IP Network Architecture

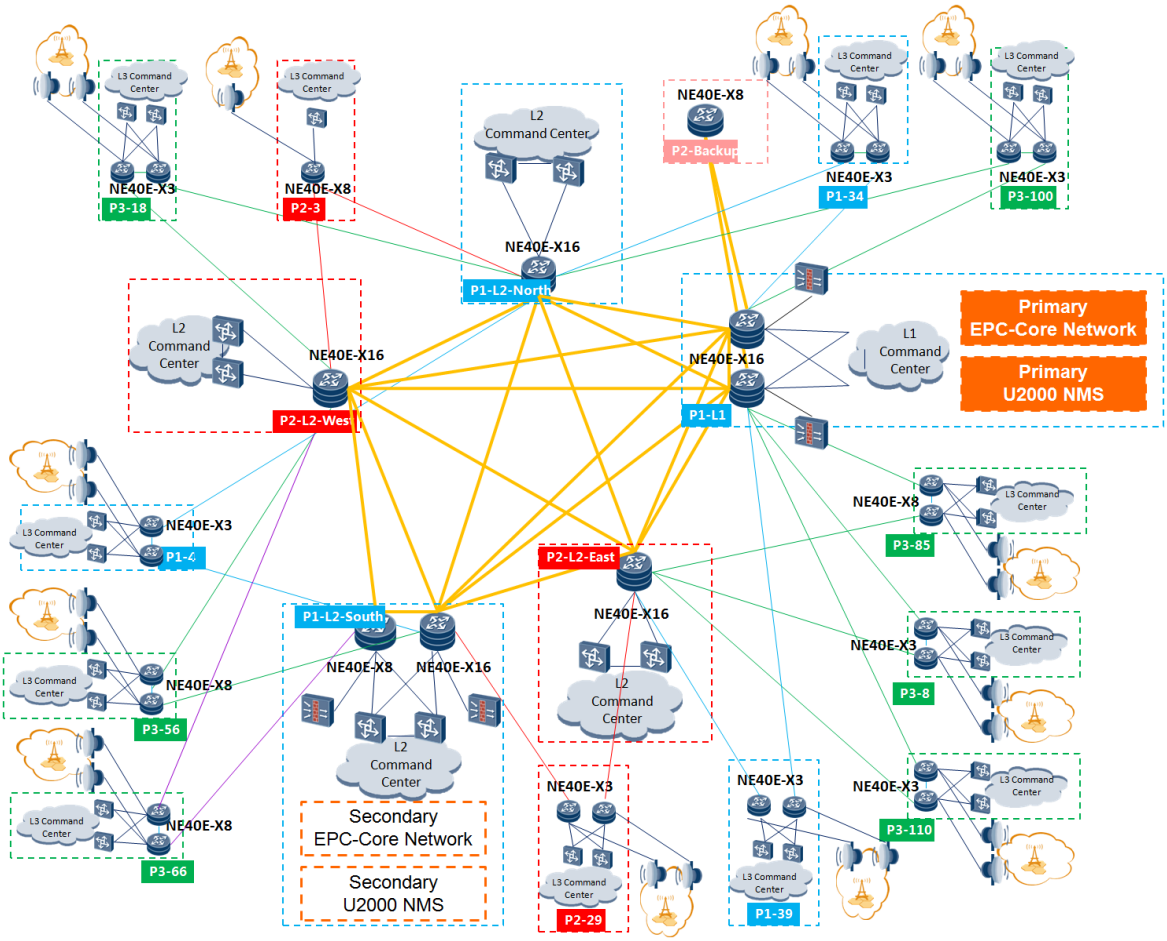
### 8.4.1 Overview

The fiber route design already take the future coming network deployment into consideration Each command center is equipped with a Huawei NE40E-X16 router to provide outer access of the network. For the non commander center fiber nodes, each fiber nodes two unites NE40E-X8 or NE40E-X3, NE40E-X8 placed in cross connection nodes and hands more traffic and NE40E-X3 serves in less density area.

Connections between Command Centers are designed with 50Gbps partial mesh network to provide high speed inter-connection and fail-over protection. 10Gbps connections are deployed between fiber nodes and command center with dual home technique to balance the network stability and cost by different physical router.

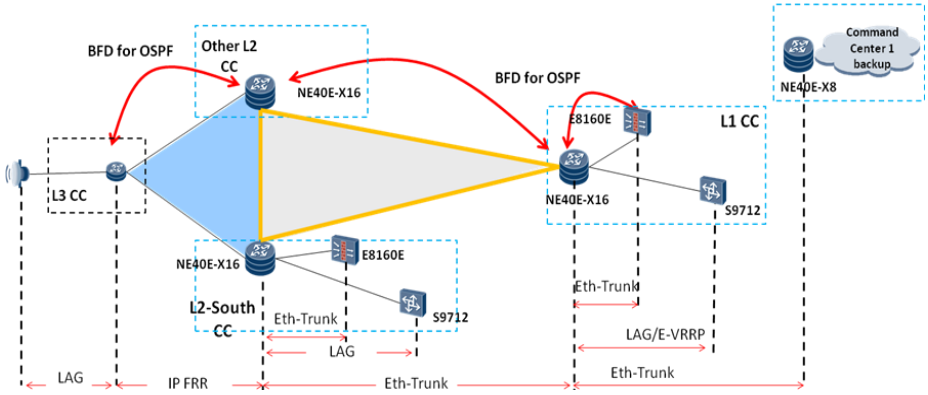
As this is a pure IP network, all the fiber nodes is positioned by Router only providing flexible routing and multi QOS mechanism guarantee.

The general topology of the fiber IP network is designed as below:




### 8.4.2 Key Technology

Fiber IP network of A 国 W City Security Surveillance Project bears traffic from L3 fiber node to Command Centers. Besides, fiber IP network provides transmission of multi-media services between Command Centers, e.g. video conference, IP phone, network browsing, etc.



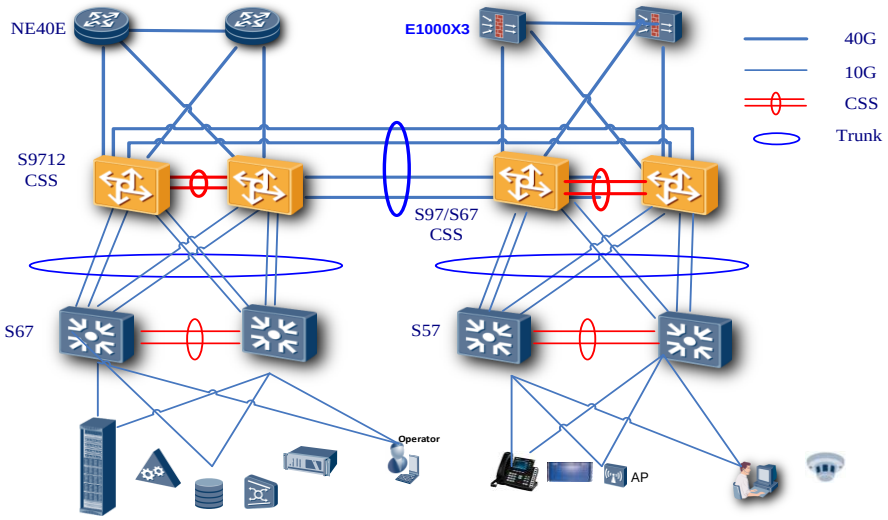

- IGP design: OSPF
  The fiber IP network is deployed with OSPF (Open Shortest Path First) as the network routing protocol. Hierarchical multi-area is designed to optimize network convergence.
- Optimization for IGP: BFD for OSPF
  Default OSPF convergence occurs several seconds after a network failure due to software limitation. With BFD, time to discover a network failure may decrease to sub-second. OSPF can converge faster using BFD to detect network failure.
- Network protection: IP FRR
  IP FRR saves traffic forwarding with a backup link that always stays in the forwarding database. When there is a fault on the primary path, IP FRR provides the backup link before the control plane of OSPF recalculation. IP FRR is deployed between L3 fiber node and Command Center to guarantee non-stop traffic forwarding.
- Network protection: Eth-trunk
  Eth-trunk aggregates several physical links to form a logical link for data transmission at a higher rate, and also provide link redundancy. Eth-trunk is deployed between two points that require bandwidth more than 10Gbps. For detailed deployment, please refer to the diagram above.

## 8.5 Switching Network Design

### 8.5.1 Network Architecture

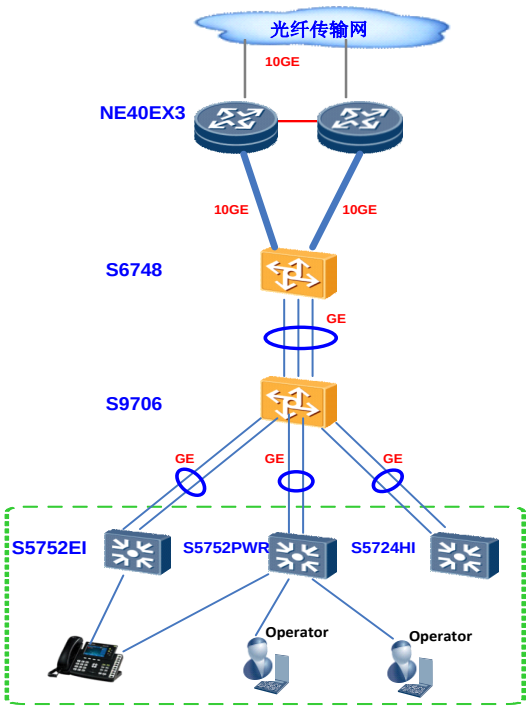
本系统分为三级监控中心，其中一级和二级监控中心交换网络相同，使用一个组网场景；三级监控中心交换网络组网对应一个组网场景。

- L1/L2 监控中心组网图：




如图 S97 建立 CSS 系统，S67 与 S57 同样建立堆叠系统，S97CSS 系统通过双链路连接两台防火墙设备 E8160E, S97CSS 与 S67 或者 S57 堆叠之间通过跨框方式,两套 S97 CSS 系统之间通过跨框链路建立 40G 的 Eth-Trunk。S57 连接 PC 或者 AP，S67 连接服务器等。

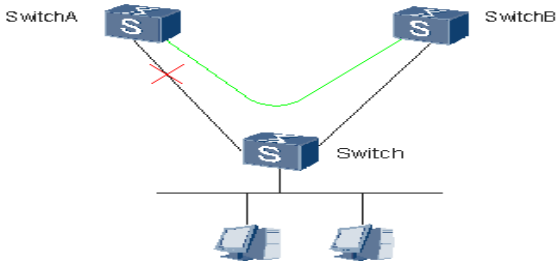
♦ L3 监控中心组网图：




S67 双上行 10GE 连接 NE，与 S97 之间通过 Eth-Trunk 相连，S97 与下挂的 S57 分别通过 Eth-Trunk 相连。

### 8.5.2 VRRP & CSS Design

VRRP：VRRP（Virtual Router Redundancy Protocol）虚拟路由冗余协议，是一种容错协议。该协议通过把几台路由设备联合组成一台虚拟的路由设备，使用一定的机制保证当主机的下一跳交换机出现故障时，及时将业务切换到其它交换机，从而保持通讯的连续性和可靠性。

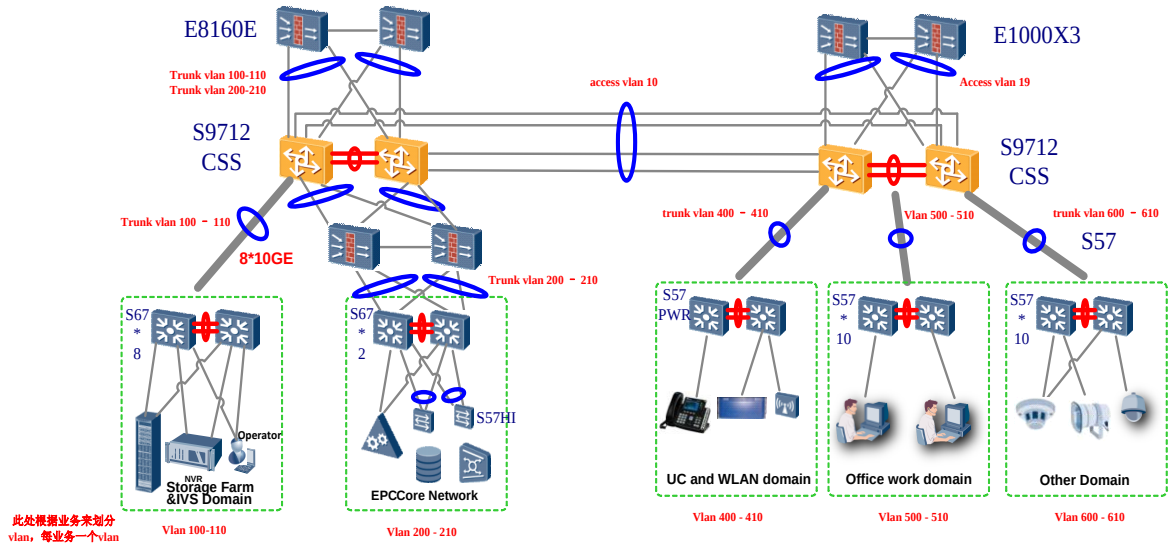



CSS：CSS 是 Cluster Switch System 的简称，又被称为集群交换机系统（简称为 CSS 或堆叠），是将 2 台交换链接起来，对外呈现为一台逻辑交换机。

S97 支持 VRRP 与 CSS 特性；S57 与 S67 同样支持堆叠。
根据两个特性的特点，我们选择 CSS 与堆叠，当 CSS 系统建立后，网络更简单更可靠。此处 CSS 做为下游网络的网关。
97 设备通过 X12SA 业务堆叠板部署堆叠，通过 X12SA 单板 12 个 10GE 端口，可以提供 120G 的堆叠线带宽；
67 设备采用业务口堆叠，从 48 个 10GE 业务口划分出 4 个业务口用作堆叠使用，堆叠带宽为 40G。
57 设备通过堆叠子卡堆叠，堆叠子卡提供两个 10GE 端口可供互连，堆叠带宽为 20G。

### 8.5.3 VLAN Design

L1/L2 Command Center：

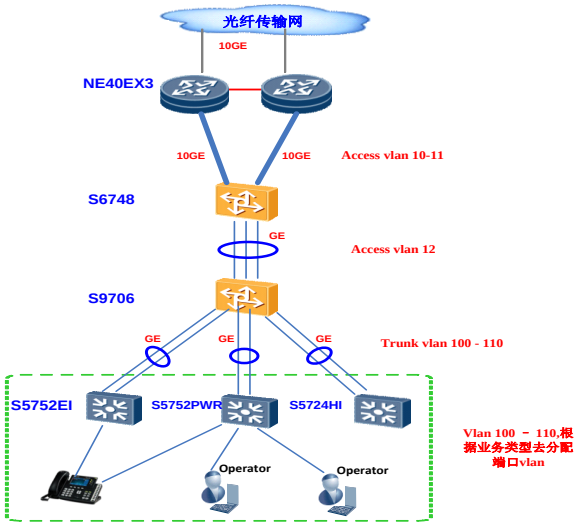



| | |
|---|---|
| 左侧 S97 堆叠与 NE40E 设备之间 | 允许所有涉及私网业务的 vlan 通过如 100-210； |
| 右侧 S97 与防火墙之间 | 配置公网业务为 vlan 19 |
| 右侧 S97 堆叠与 NE 之间 | 通过接入 vlan10 三层通信； |
| S97 下挂的每个绿色域根据业务划分 vlan | 允许所有下挂区域的所有私网业务 vlan |
| S67 或者 S57 下连的端口 | 根据业务类型分配 vlan，每区域不同 |

业务划分：
存储：　业务 VLAN，管理 VLAN 和内部 VLAN 三个 vlan
核心网：　预留 10 个 vla n 足够使用

IVS： VRRP（如果用堆叠则不需要）、媒体 vlan、信令 vlan、互联 vlan、存储 vlan、Trunk
右侧办公区：智真，办公数据，WLAN 的数据，上网，管理 vlan

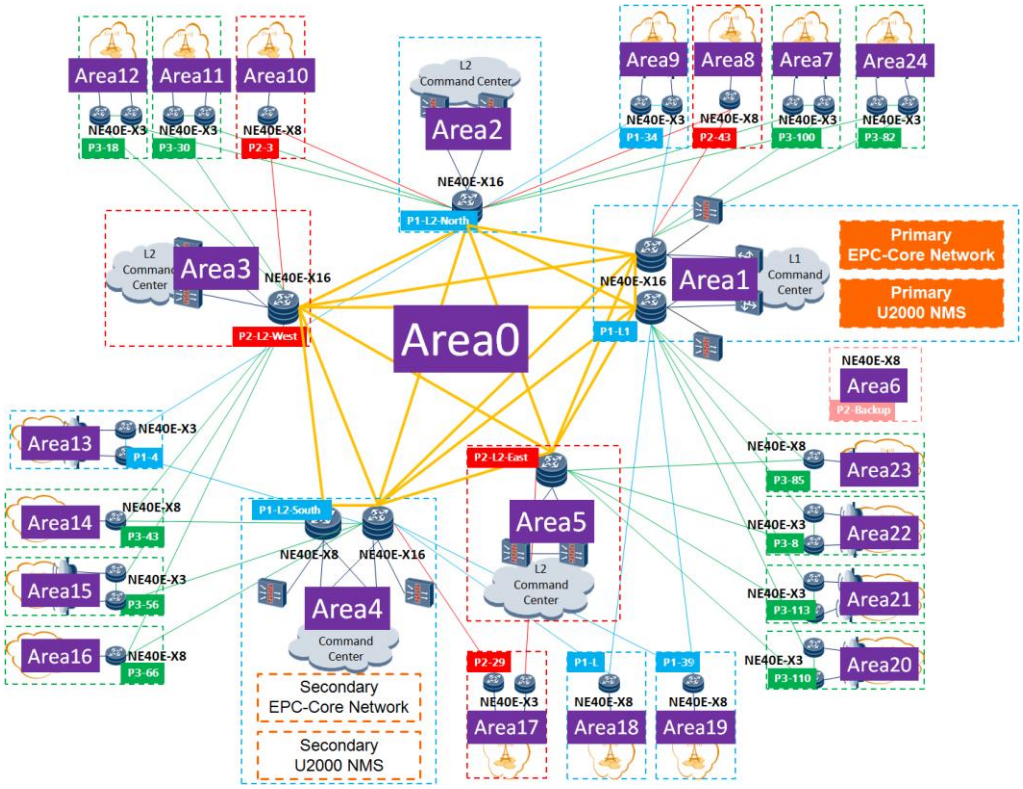
L3 Command Center：




S67 连接防火墙时以 access vlan，且双链路使用不同的 vlan 10 – 11；

S67 与 S97 之间通过 access vlan 方式加入 vlan 12；
S97 与 S57 之间以 Trunk 方式加入 vlan 100 - 110；
S57 下接用户则根据业务类型再划分 vlan；

## 8.6 IGP Design




The fiber IP network is deployed with hierarchical OSPF, in order to provide the network with sustainability, high availability and hierarchy.

- All the inter-connections between commend center are in backbone area 0.
- Each area except area 0 consists of connections from L3 fiber nodes to command centers.
- Command center acts as Area Border Router (ABR).

### 8.6.1 Router ID

Router ID is defined with Loopback0 address of each router.

### 8.6.2 OSPF Area Planning

Area 0: Area of connections between Command Center routers

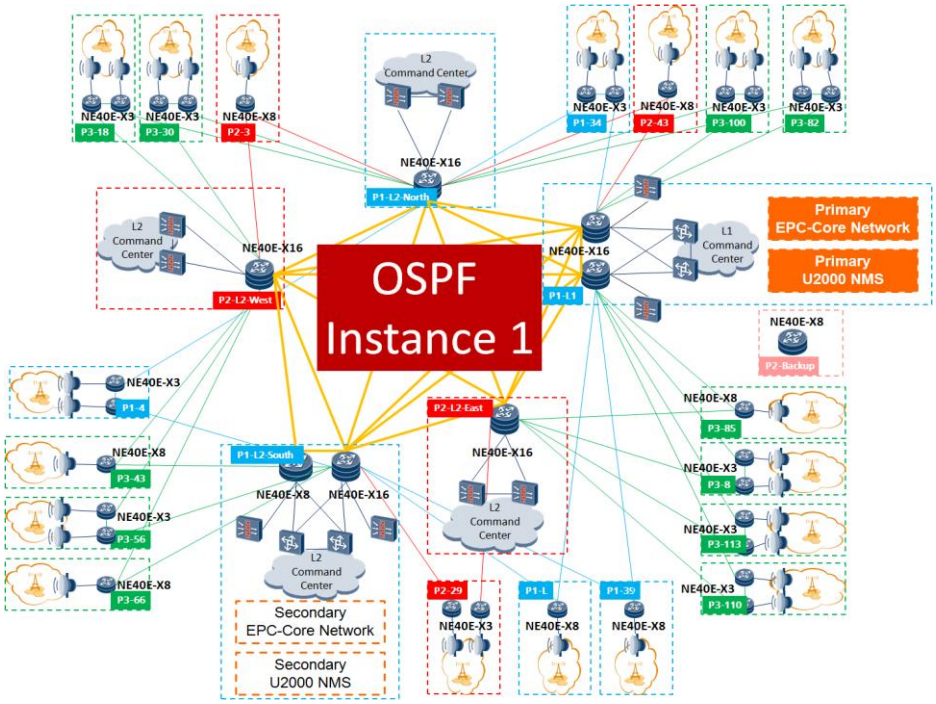
Area 1-24: Area of connections from Command Center to L3 fiber node or intranet of Command Center

| Network | OSPF Area |
|---|---|
| Command Center Inter-connection | 0 |
| P1-L1 Intranet | 1 |
| P1-L2-North | 2 |
| P2-L2-West | 3 |
| P1-L2-South | 4 |

| | |
|---|---|
| P2-L2-East | 5 |
| P2-Backup | 6 |
| P3-100 | 7 |
| P2-43 | 8 |
| P1-34 | 9 |
| P2-3 | 10 |
| P3-30 | 11 |
| P3-18 | 12 |
| P1-4 | 13 |
| P3-43 | 14 |
| P3-56 | 15 |
| P3-66 | 16 |
| P2-29 | 17 |
| P1-L | 18 |
| P1-39 | 19 |
| P3-100 | 20 |
| P3-113 | 21 |
| P3-8 | 22 |
| P3-85 | 23 |
| P3-82 | 24 |

### 8.6.3 OSPF Instance planning

Use OSPF instance 1 as Fiber IP Network IGP instance.




### 8.6.4 Authentication Design

OSPF enables security authentication, and the MD5 password is *W City-Huawei*.

## 8.7 High Reliability Design

Huawei has been concentrating on the development & implementation of mobile/ bearer networks for years. We have developed series of patented high reliability features such as VPN FRR, IP/LDP FRR, Enhanced-VRRP, OAM tunnel protection group, RPR, Flexible VPN to TE mapping. These features enable Huawei to provide real deployable end-to-end sub-200ms reliability solution. The solution can protect against any link or node failure, and it can be deployed in any type of networks, including small scale networks, large scale network, pure IP forwarding networks, forwarding networks.

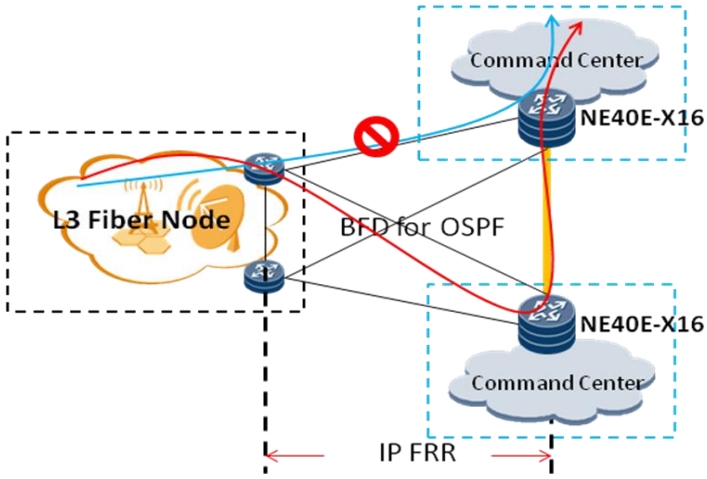
### 8.7.1 Equipment Reliability

The hardware/software design will greatly affect the reliability of the equipment. The Huawei proposed router adopt carrier class design and the availability of the system can reach 99.999%. It has a passive backplane. All of the key parts such as main control board, switching fabric, power supply and fan, have redundant design and are all hot swappable. There is no single point of failure in the system. Besides, Huawei has implemented a large number of reliability software features on the routers, including Non-Stop Forwarding, Graceful Restart, Hot Patching and etc.

### 8.7.2 Network Reliability

To ensure non-stop operation, only equipment reliability is not enough, the high-reliable characteristics of equipment should be effectively considered and applied in the network layout to organize a high-reliable network with full redundancy capability.

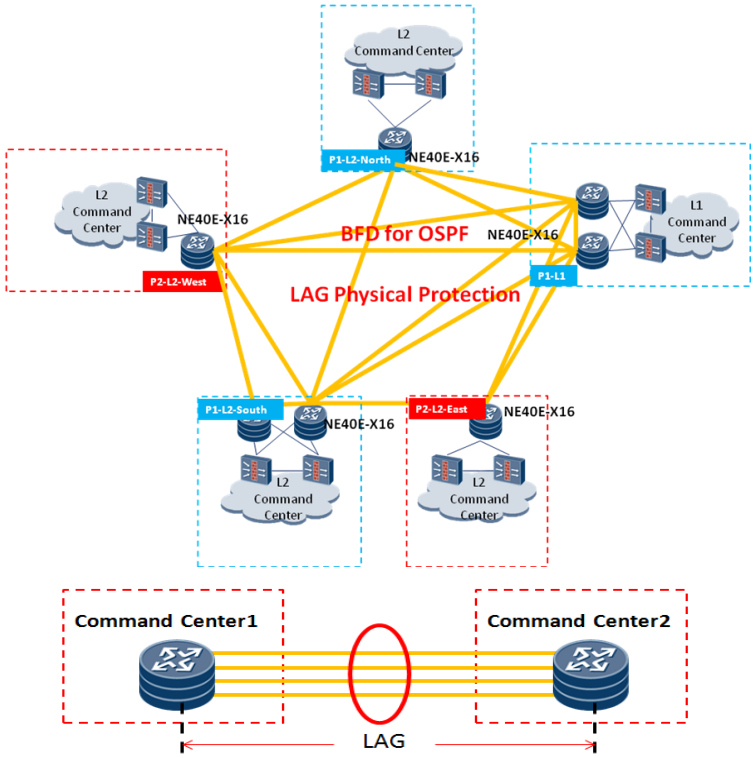
1. Protection between L3 fiber node and Command Center




Considering disaster redundancy, each L3 fiber node router connects to 2 Command Center via 2 physical links. Each L3 fiber node router will be connected to the closest Command Center physically to minimize delay and cost, and the second link to another Command Center will be used.

In order to optimize OSPF, all OSPF areas are deployed with BFD fast fault detection to provide millisecond convergence. Besides, BFD for interface is configured for IP FRR on fiber node routers to ensure instant traffic forwarding to Command Centers.

2. Protection between Command Centers

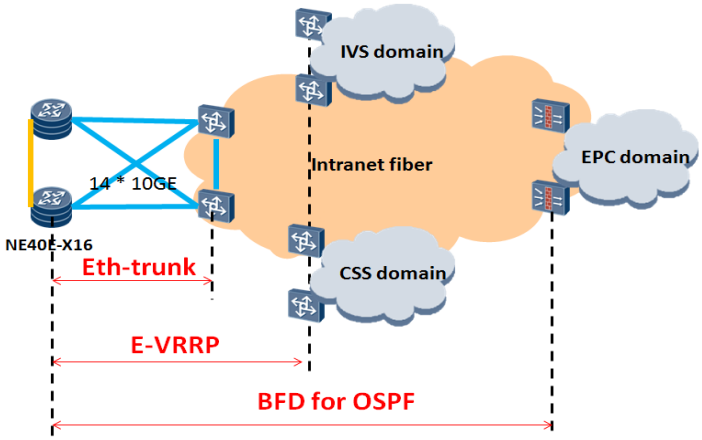



The following protection is deployed between Command Centers:

- BFD for OSPF in the network provides fast faults detection to enable OSPF to converge within second after a failure occurs.

- LAG is configured with 4 fiber links to provide redundant physical connection, and also increase bandwidth with load-balance feature.

3. Protection for egress traffic at L1/L2-south command center



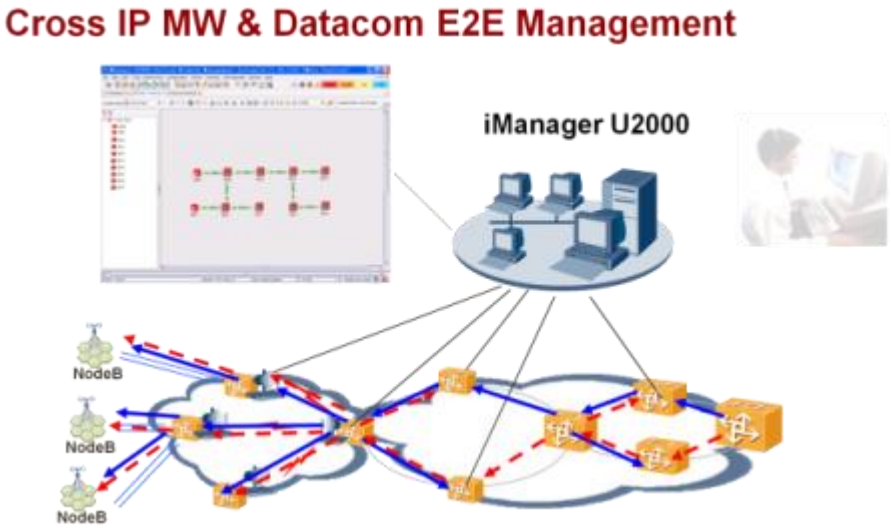

The following protection is deployed between egress router and intranet devices:

- Enhanced VRRP is deployed to provide redundancy for egress traffic of IVS and CSS domain
- Eth-trunk technology is deployed to provide redundant physical connection between egress router and core switch, and also increase bandwidth.
- BFD for OSPF is deployed between egress router and EPC firewall to provide fast detection for OSPF convergence.

## 8.8 Operation & Maintenance

U2000 NMS Solution

Huawei unified network management platform can Provide E2E service monitoring and provisioning and greatly promoting work efficiency.



To ensure efficient O&M of the transmission network, Huawei propose to deploy U2000 NMS. As illustrated in the figure below, Huawei U2000 has both EML (element management layer) and NML (network management layer) functions implemented.

The base component includes NE configuration, NE panel view, and topology/fault/security/inventory management functions. The provisioning component includes VPN management and LSP management functions. The assurance component includes performance management, SLA management, Report Management, and Test & Diagnosis functions.

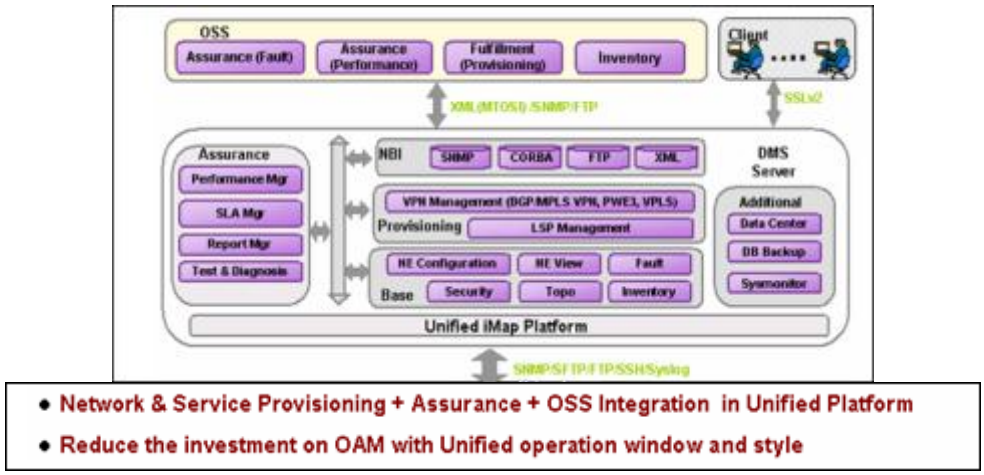
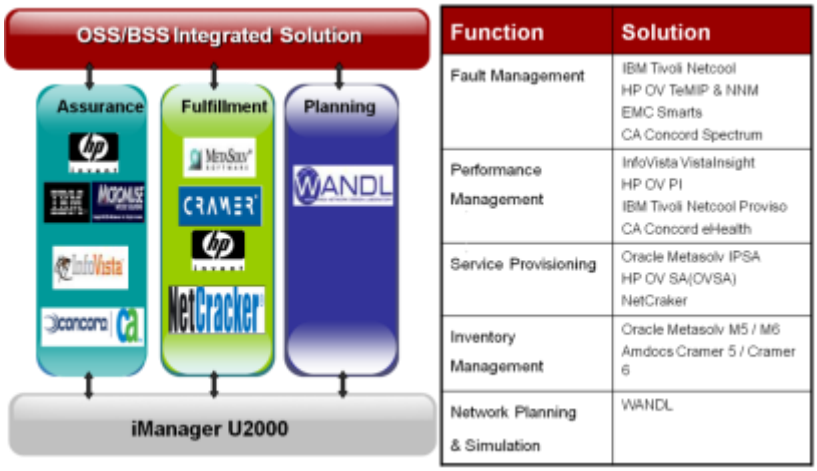



Figure 11 U2000 functionality architecture

The U2000 also has SNMP/CORBA/FTP/XML NBIs (Northbound Interfaces) implemented to integrate with 3rd party OSS/BSS systems for the fault, performance, provisioning, and inventory management. Huawei has long time cooperation with many industry leading OSS vendors as illustrated in the figure below:




| Function | Solution |
|---|---|
| Fault Management | IBM Tivoli Netcool<br>HP OV TeMIP & NNM<br>EMC Smarts<br>CA Concord Spectrum |
| Performance Management | InfoVista VistaInsight<br>HP OV PI<br>IBM Tivoli Netcool Proviso<br>CA Concord eHealth |
| Service Provisioning | Oracle Metasolv IPSA<br>HP OV SA(OVSA)<br>NetCraker |
| Inventory Management | Oracle Metasolv M5 / M6<br>Amdocs Cramer 5 / Cramer 6 |
| Network Planning & Simulation | WANDL |

Figure 12 Huawei OSS Integration Partners

Two U2000 systems can be deployed in different NOCs (network operation center) to achieve NMS redundancy to protect against any disaster. Veritas software is used in Huawei NMS HA solution. Veritas Volume Replicator (VVR) is used for synchronize the data in-between primary and backup NMS servers and Veritas Cluster Server (VCS) is used to monitor the data replication status and trigger the switchover.

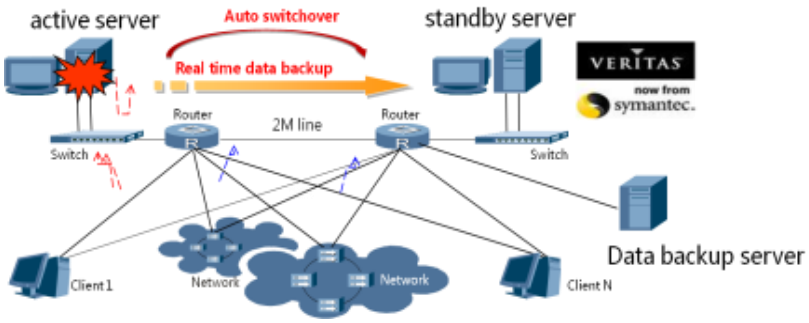



Figure 13 NMS Redundancy

## 8.9 QoS Design

3GPP TS 22.105 V6.2.0 and ITU-T Y.1541 outline the end to end QoS requirements for each traffic classes as illustrated in the following figure. Note that there is no strict one-to-one map between the application/service and traffic classes. The important thing is that the IP/ backbone network shall fulfill the QoS requirements for conversational services.

Table 6 QoS Requirements for Different Services

| Service category | Service | Service type | Bandwidth (kbps) | E2E one way Delay | Jitter | Packet loss |
|---|---|---|---|---|---|---|
| Voice services | Voice call | Conversational | 4-25 | <150 ms typical, 400 ms max. | <1 ms | <3% |
| | Voice media | Streaming | 5-128 | 10s max. | <2 ms | <1% |
| | Voice message | Streaming | 4-13 | <1 s playback, 2 s max | <1 ms | <3% |
| Video services | Video phone | Conversational | 32-384 | <150 ms typical, 400 ms max. <100 ms lip-sync | <10 ms | <1% |
| | Video media | Streaming | 20-384 | 10s max | <2 s | <2% |
| Data 1 | Web browsing | Interactive | By SLA | < 0.5s typical | n/a | 0 |
| Data 2 | Mobile Download | Background | < 1KB | < 0.5s typical | n/a | 0 |
| Data 3 | Telemetry control | Interactive | < 28.8K | < 0.5s typical | n/a | 0 |

There are few factors to define the SLA requirements of one specific service, including bandwidth, delay, jitter, packet loss. The end to end delay is contributed by the following factors: Codec delay, jitter buffering, transmission delay, as well as queuing/scheduling/switching delay caused by the routers. Typically, the transmission delay is about 5us/Km for fiber and the switching delay of router is about 50us per node. Jitter is the variant of delay. A well-engineered IP/ backbone network shall introduce a delay of less than 30ms and a jitter of less than 1ms.

There are number of events that cause congestion in the IP/ backbone and lead to service quality degradation or even service interruption:

- Improper architecture design
- Failure in traffic volume prediction and the capacity planning
- Link/Node failure causes traffic spanning on multiple links aggregate to a single link
- Unexpected traffic such as DDOS attacks

This chapter mainly focuses on the IP/ DiffServ. Other QoS related designs including architecture design, capacity dimensioning, failure/security protections, and SLA Monitoring are included in other chapters.

IP/ DiffServ

IP/ DiffServ is proposed to guarantee QoS for each traffic class including control traffic and service traffic.

There are three DiffServ models as defined in RFC3270, including pipe model, uniform model and short pipe model. Pipe model is suitable for scenarios in which the LSP spans one or more DiffServ Domains with different PHB. Uniform model is suitable for scenarios in which the LSP spans one or more DiffServ Domains with same PHB. Short pipe model is similar to pipe model, but has a different PHB on the LSP egress node. Huawei proposed equipments are able to support all the three DiffServ models.

Before implementing IP/ DiffServ, QoS trust boundary shall be clearly defined. Generally, the nodes in operator's internal networks are trustable, and the nodes in external networks are not trustable. Traffic classification and marking shall be done on the systems in the trust boundary, including end service systems, firewalls, L2 aggregation nodes, PE routers, and then QoS scheduling can be performed on each egress interface of core routers. The following figure illustrates an example of service policies & PHB definitions for each service class. The network control traffic (OSPF, ISIS, BGP, LDP, RSVP) is pure IP traffic, and it will not have tag in the core, so the traffic will not be classified based on EXP, but only on DSCP

Table 7 Priority Definition for Different Services

| Service Type | PHB | DSCP | EXP | 802.1p |
|---|---|---|---|---|
| Network Control | CS6 | 110000 | (6) | 6 |
| VoIP | EF | 101110 | 5 | 5 |
| Signaling | AF4 | 100xx0 | 4 | 4 |
| Video traffic | AF3 | 011xx0 | 3 | 3 |

## 8.10 Equipment Configuration

| Device | Model | Quantity |
|---|---|---|
| NE Router | NE40E-X16 | 6 |
| | NE40E-X8 | 9 |
| | NE40E-X3 | 22 |
| AR Router | AR3260 | 24 |
| Switch | S9700 | 24 |
| | S6700 | 56 |
| | S5700 | 256 |

# 9 Command Center System Design

The surveillance command center was used to provide centralized command for some purpose, a central place for carrying out orders and for supervising tasks, also known as a headquarter. The command control center is also a dispatching center, decision center & information center. There is an interactive interface between the system and users.

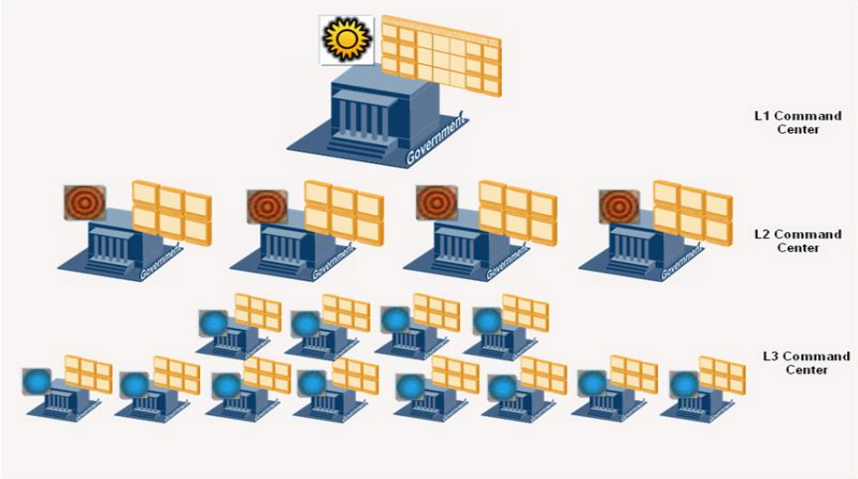



Figure 14 Three-Level Command Center Architecture

In this project, Huawei designed 3-level Command Center (CC) architecture, all the CC are connected. A professional customer surveillance center is composed of physical infrastructure, hardware, software, control console, surveillance management software, communication system, storage, and so on.

其中一级监控中心中部署有云存储 CSS 系统、IVS 系统、统一通信 UC 系统、视频会议 TP 系统和 LTE 的核心网 EPC 系统。在四个二级监控中心中，其中三个除没有部署 EPC 系统外，其它子系统和一级监控中心相同。另外一个(南区监控中心)部署了一套备份 EPC 系统，和一级监控中心相同。下图是一级/二级监控中心的内部组网图。

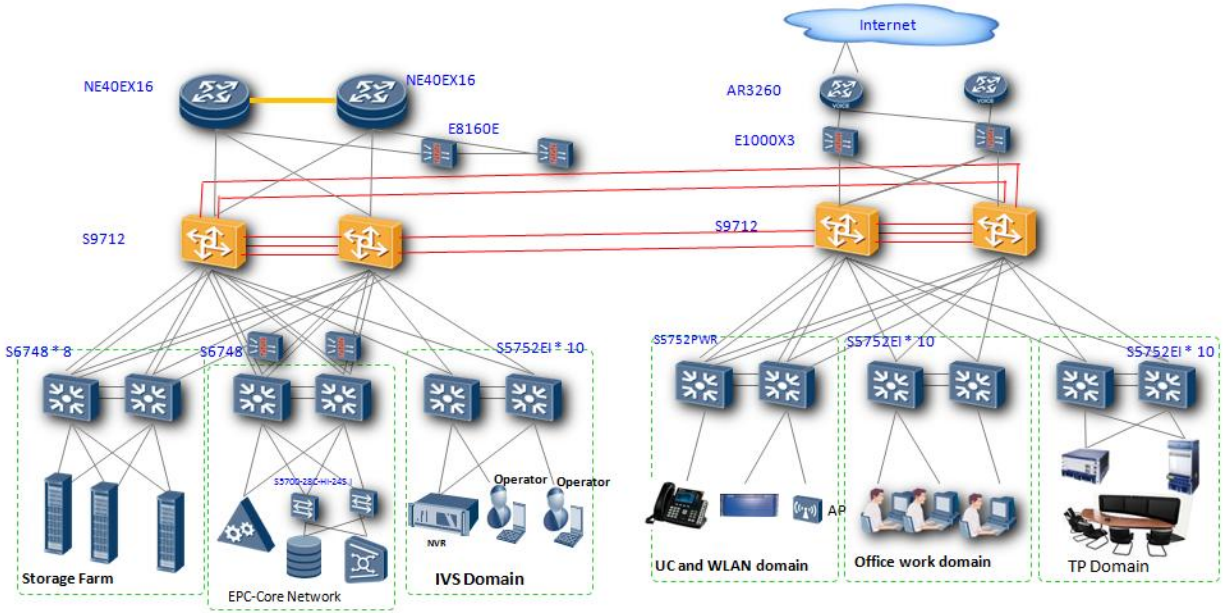



Figure 15 L1/L2 Command Center Networking Diagram

## 9.1 Unified Communication System

### 9.1.1 Services of System

- Basic Voice Services

| Features | Sub-Features | Second Sub-Features |
|---|---|---|

| | | |
|---|---|---|
| Basic Voice Services | | |
| | Narrowband Call Access | |
| | Broadband Call Access | |
| | Various Terminal Access | |
| | Voice Communication | Calls between intra-office users, Outgoing calls to the PSTN or incoming calls from the PSTN, Outgoing calls or incoming calls through IP |
| | Point-to-Point Video Communication | |
| | Call Right Control | |
| | Playback Service | |
| | Number Analysis and process | |
| | Media Resource Control | |
| | SNTP | |
| | Fax | T.30, T.38, G.711 transparent transmission |
| Supplementary Services | | |
| | Local number querying | |
| | Calling line identification | Calling line identification presentation (CLIP), Calling line identification restriction (CLIR), Calling Name Identification Presentation (CNIP), Calling line identification restriction (CLIR) Overstepping |
| | Call forwarding | Call forwarding unconditional (CFU)， Call forwarding no reply，Call forwarding busy，Call forwarding offline， Call forwarding conditional |
| | Call transfer | |
| | Call hold | |
| | Call park | |
| | Call waiting | |
| | Three-party | |
| | Call-out restriction | Call-out restriction, Password modification |
| | Number Portability | |
| | Simultaneous ringing | |
| | Sequential ringing | |
| | Abbreviated dialing (ABD) | |
| | Pickup | Co-group pickup, Designated pickup |
| | Multi-number | |
| | Number replacement | Number replacement on the same phone, Number change announcement |
| | Call on busy | Call back on busy (CBB), Registered call on busy (RCB) |
| | Call back no reply | |
| | Secretary services | Secretary, Secretary station, Advanced chief secretary |
| | Do not disturb (DND) | |
| | Absent Subscriber | |
| | Alarm clock | |
| | Hotline | Delay hotline, Instant hotline |
| | Privilege services | Break-in, Forced release, Monitor, Privilege user |
| | Direct dialing in (DDI) | |
| | Auto attendant | |
| | PBX group line selection | |
| | Distinctive Ring Tone | |
| | Remote Activation of services | |
| | Canceling all registered services | |
| Advanced Services | | |

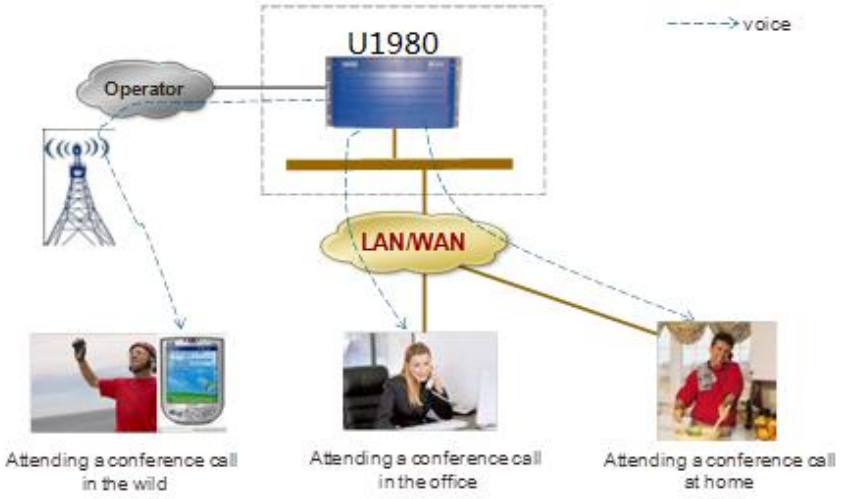
| | | |
|---|---|---|
| | Hierarchical management of subscriber rights | Supplementary service setting based on hierarchical management, Call out authority is hierarchical managed and controlled according to the time segment, Trunk preemption of the privileged subscriber |
| | Call Restriction Strategy | Calling Number-based Call Restriction, Called Number-based Call Restriction, Blacklist and Whitelist, VoIP Domain-based Call Restriction, Customized Password-based Call Restriction, Embedded Card Number-based Call Restriction, Caller ID authentication, Area-based Restriction, Anonymity Call Restriction, Out-office Call Duration Restriction |
| | Intelligent routing | Time segment-based Routing, Charging rate-based Routing, Rerouting, Load sharing of routing, Percentage based polling routing, Subscriber level-based Routing, Trunk Balance Routing |
| | Embedded CRBT | |
| | Missed calls to SMS | |
| One Number Link You (ONLY) | | |
| Audio Conference | | |
| | Scheduled conference | audio conference through individual dialing-in, audio conference through system convening, audio conference through host convening |
| | Instant conference | |
| Virtual IP PBX | | |

- Value-added Services
  - Multimedia Conference

    The audio conference allows three or more subscribers at different places to talk with each other at the same time through telephone call. SoftCo provides built-in audio conference.

    The specifications of audio conference provided by SoftCo

| Parameters | U1980 | U1910 |
|---|---|---|
| Capacity of participants | 960 (8 MRS boards are required) | 6 |
| Capacity of conference room | 320 | 2 |
| Capacity of each conference room | 60 | 6 |
| Note:<br>Each MRS board supports maximum 40 conference rooms and 120 participants.<br>The capacity of conference rooms means the maximum number of rooms that can be used concurrently, and each room has 3 participants. | | |




According to the convening time of a conference, conference service can be divided into scheduled conference and instant conference.

- Scheduled Conference

  Scheduled conference refers to the conference that must be scheduled in advance before it is convened. According to the ways that the attendees join the conference, the scheduled conference service is divided as follows:

  - audio conference through individual dialing-in

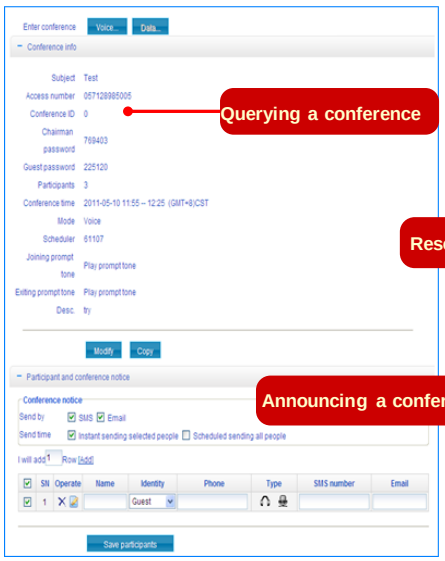
    Attendees can join an audio conference by dialing the preset access code and the password.

  - audio conference through system convening

    The name list of the attendees of an audio conference is preconfigured. The phones of the attendees ring at the preset time simultaneously and the attendees join the conference after picking up their phones.

  - audio conference through host convening

    This audio conference is started by the host who can call the attendees to join the audio conference or kick the attendees out of the conference.




| | |
|---|---|
| Subject | test |
| Access number | 057128985005 |
| Conference ID | 00000001 |
| Chairman password | 949644 |
| Guest password | 250383 |
| Participants | 3 |
| Conference time | 2011-05-10 15:45 -- 16:15 (GMT+8)CST |
| Mode | Voice+data+video |
| Scheduler | 61107 |
| Joining prompt tone | Play prompt tone |
| Exiting prompt tone | Play prompt tone |
| Desc. | 1234456 |

- Unified Messaging Services

  Huawei Unified Messaging System is called UMS (Unified Messaging System) for short or voice and fax mail system. UMS communicates with SoftCo through SIP protocol to implement the features of voice and fax mail, and all the voice and fax messages are stored in the UMS server.

  The core devices of unified messaging solution include U1980 and UMS. U1980 interconnects with UMS through SIP trunk. SMS modem connects with UMS through console interface. And Email server and UMS server can connect with each other when network is reachable.

  - Voice mail

    Voice message leaving: call transfer to voice mailbox unconditional, call transfer to voice mailbox on no reply, call transfer to voice mailbox on no busy.

    Voice message notification: Phone WMI by IP Phone or special analog phone, notification through call, email, and SMS.

    Voice message retrieving: by phone, email, and UMS web system.

  - Fax mail

    Fax message leaving: One-terminal-one-number, Unified access code.

    Fax message notification: Phone WMI by IP Phone or special analog phone, notification through call, email, and SMS.

    Fax message retrieving: by fax machine, email, web system, and sending the fax to the designated fax machine according to the IVR prompt.

    Sending fax to UMS: by fax machine, transferring when phone or fax machine retrieving fax, transferring when UMS web system retrieving fax, UMS web system, and email.

  - Email Message

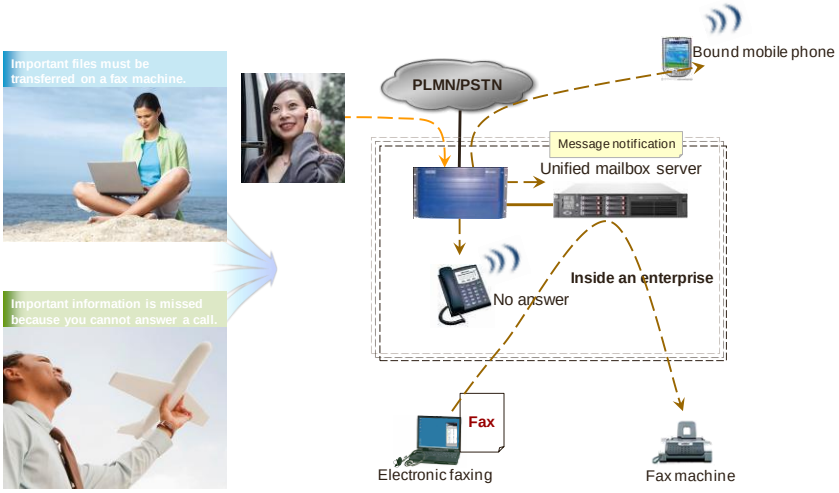
    The user can send the message to the special system mail by the account corresponding email, in which subject is account based phone number of the opposing party, which is separated by semicolon when there are more multiple numbers, the voice of .wav format is attached, and the user of the subject number will receive the attached message. This kind of message has the same effect with the voice message by phone.

- Web transfer message

  The user can transfer the message to the others in the system when logging in to the web system. The following two features are supported:

  Fax transfer by group

  Voice transfer by group



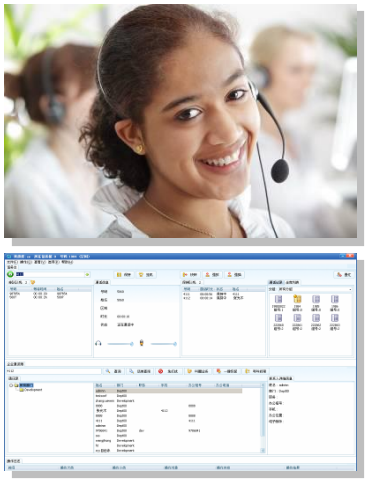

- Console System

  The console system is a computer & telephony integration (CTI) soft phone platform that is provided for subscribers based on the IP interaction technology. The console has all the functions of a physical phone and all the functions of an agent. The console system is composed of Console Server and client SoftConsole, and can extend to the hard terminal for easy call pick-up. The console client is usually called console for short.

  One Console Server can connect to 30 U1980 at most.

| Features | Description |
|---|---|
| Automatic Call Distribution (ACD) | The console system supports automatic call distribution of sequential line selection , auto attendant or virtual user (VU), transferring to night service directly, transferring to VU directly, transferring to queuing when all attendants busy, transferring to queuing when all attendants busy and then transferring to VU after queuing timed out. The system supports the settings of night service number and waiting time of queuing. |
| Basic call | A SoftConsole provides basic call functions, including answering a call, rejecting a call, making a call, ending a call, holding a call, transferring a call, forcibly breaking into or releasing a call, displaying the call information, notifying a user of an incoming call, two-stage dialing, and etc. |
| Attendant Features | The console has the rights of attendant features after singing into the console group, including setting console busy or free, answering the call to the console group, incoming call queuing, adjusting the queue, and call recording etc. |

| | |
|---|---|
| Incoming call queuing | The LMT supports incoming call queuing and displaying, including number of caller, duration of queuing, and etc. The attendant can adjust the sequence of incoming calls in the queue so that the call of a customer with a high priority is answered in preference, and support designated answering; the attendant can pick up the call according to the weightiness of incoming calls immediately so as to ensure the service satisfaction. |
| Call transfer | The LMT supports consultant transfer, blind transfer and multi-line hold. The client can display the information of held queue, and the attendant can resume, hang up and transfer the call selectively. |
| Call recording | The attendant with recording right can record the local conversation. |
| Status Displaying | The LMT supports querying the status of inter-office users, and displaying the status and information of all the attendants in the same console group, including the phone number, group ID, and status of the attendants. |
| Night service | The console can set the night service number based on the console group, and the call will transfer to the night service or VU number when all the attendants are busy, offline or singned out the group. |
| Enterprise phone book | The attendant console can be connected to an enterprise phone book. In this way, the attendant can search the information in the directory, querying the phone number of an incoming call automatically, displaying the detailed information about a record, and making a call based on the query result. |
| Call records | The console supports displaying the call records, including dialed calls, received calls and missed calls, querying the records, deleting and clearing up the records, adding the records to the phone book, dialing from the records, and etc. |
| Incoming call notification | The console supports ringing for the incoming calls, pop-up notification in the minimized state and displaying the call information, including caller and callee numbers, names, conversation duration, and the status of hold and resuming. |



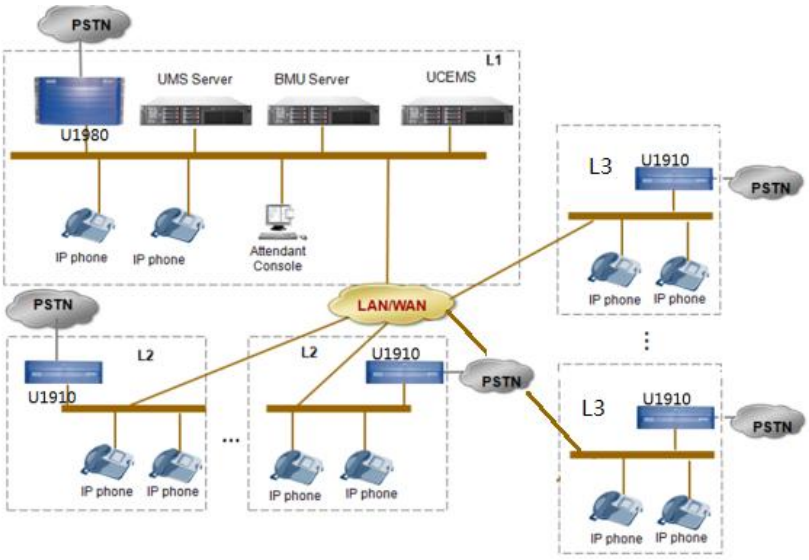
Functions:

- Enterprise address book
- Agent information
- Incoming call queue and call holding queue
- Recording
- Night service
- Control functions:

  Call, reject, answer, hold, resume, forward, break-in, and forced release

### 9.1.2 UC Network Solution

As Huawei designed, there will be 3 Layer of Command Center deployed in W City, considering the communication system among these Command center, Huawei designed Unified Communication network this project, which is shown in the follow figure:




All the Command Centers should provide normal voice service, IP call, fax, multimedia conference, unified messaging services, and Huawei design follow these requirements.

In L1, one U1980 is deployed. The U1980 provides voice services for the whole network including all L2 and L3 as well as works as a gateway connecting with PSTN through E1/PRI. All the IP phones in L1/L2/L3 register to the L1's U1980 in normal situation.

In each of L2, the user number is 45, less than 100, U1910 is deployed. They connect with PSTN via E1/PRI trunk. When the L1's U1980 is down or the IP connection of a L2 fails, the local U910 provides basic voice call service for local users.

In each of L3, the user number is 6, less than 100, U1910 is deployed. They connect with PSTN via E1/PRI trunk. When the L1's U1980 is down or the IP connection of a L3 fails, the local U910 provides basic voice call service for local users.

In this proposed solution, UC (unified communications) applications, including unified messaging, audio conference, attendant console, etc.

### 9.1.3 Features and Highlights

The Huawei UC solution offers the following benefits for customers:

- Reduced construction costs because it fully uses existing network resources and carries voice, video and data simultaneously.
- Reduced communication costs because it routes local and long-distance calls on a dedicated IP network
- Simplified dialing process that enables calls between extensions based on a uniform numbering rule
- Improved communication efficiency because it converges different means of communication
- User-friendly service management system, easy operation, reduced maintenance costs, and improved work efficiency

### 9.1.4 Equipment Configuration

The following table is the configuration list

| Device | Phase 1 | Phase 2 | Phase 3 | Phase 4 |
|---|---|---|---|---|
| U1980 | 1 set | | | |
| U1910 | 2 sets | 2 sets | 8 sets | 4 sets |
| IP phone eSpace 7850 | 252 sets | 90 sets | 48 sets | 24 sets |
| LMT | 1 set | | | |
| BMU | 1 set | | | |
| UCEMS | 1 set | | | |
| UMS | 1 set | | | |

## 9.2 Telepresence System

### 9.2.1 Design Principle

1. 音视频系统技术标准

GBJ16-37《建筑设计防火规范》

JGJ/T16-92《民用建筑电气设计规范》

GB/T50314-2000《智能建筑设计标准》

GB/T50311－2000《建筑与建筑群综合布线工程设计规范》

GB/T50312－2000《建筑与建筑群综合布线系统工程验收规范》

CECS 72:97《建筑与建筑群综合布线工程设计规范（修订本）》

YD/T 926.1－97《大楼通信综合布线系统》

GB-4026-83《电器接线端子的识别和用字母、数字符号标志接线端子的通则》

GB-50169-92《电气安装工程接地装置施工及验收规范》

GB-50254-96《电气安装工程低压电器施工及验收规范》

GB-50258-96《电气安装工程 1kV 以下配线工程施工及验收规范》
GB/T15381-94《会议系统电及音频性能要求》
SJ/T10444-93《电声学术语》
GXX 项目 2060-89《声系统设备一般 8 术语解释和计算方法》
GB/T15135-94《广播及类似用途声系统设备亘连用连接器的应用》
GB/12060-89《声系统设备一般术语解释和计算方法》
GB/T14197-93《声系统设备亘连用连接器的应用》
GB/T14947-94《声系统设备亘连的优选配接值》
ANSI/EIA/TIA-569《电信走道和空间的商用建筑标准》
ANSI/EIA/TIA-606《商用建筑物电信设备的管理标准》
GT/T 50311-2000《建筑与建筑群综合布线系统工程设计规范》
ISO11801《建筑通用布线标准》
GBJ42-81《中国工业企业通信设计规范》
《中华人民共和国广播电影电视部厅堂扩声系统特性指标》GYJ25-86
《扩声系统声学特性指针与测量方法》WH01-93
《厅堂扩声系统声学特性指标》 GY125-86
《民用建筑隔声设计规范》 GXX 项目 118-88
《会议系统及其音频特性要求》 GB/T15381-94
《厅堂扩声特性测量方法》 GB/T4959-95
《电气装置安装工程施工及验收规范》 GBJ232-92
《民用建筑电气设计规范》 JGJ/T16-96
《声系统设备互连的优选配接值》 GXX 项目 4197-93
《厅堂混响时间测量规范》 GBJ76-84
《客观评价厅堂可读懂度的 RASTI 法》 GB/T14476-93

2. 视频会议系统技术标准

**国家标准：**

《64~1920kbit/s 会议电视系统进网技术要求》GB/T 15839-1995
《会议电视系统工程设计规范》YD5032-97

**系统框架协议：**

ITU-T H.261：关于 P X 64kbit/s 视听业务的视频编解码器
ITU-T H.263：关于低码率通信的视频编解码
ITU-T H.264：关于高压缩比通信的视频编解码
ITU-T H.239：关于双视频流传递协议
ITU-T H.221：视听电信业务中的 64～1920kbit/s 信道的帧结构
ITU-T H.224：利用 H.221 的 LSD/HSD/MLP 信道单工应用的实时控制
ITU-T H.225：基于分组网络的多媒体通信系统呼叫信令与媒体流传输协议
ITU-T H.230：视听系统的帧同步控制和指示信号 C&1

ITU-T H.231：用于 2Mbit/s 以下数字信道的视听系统多点控制单元

ITU-T H.242：关于建立使用 2Mbit/s 以下数字信道的视听终端间的通信系统

ITU-T H.243：利用 2Mbit/s 信道在 2～3 个以上的视听终端建立通信的方法

ITU-T H.245：多媒体通信控制协议

ITU-T H.246：支持 H 系列协议的多媒体终端之间的交互

ITU-T H.281：会议电视的远端摄像机控制规程

ITU-T H.320：窄带电视电话系统和终端设备

ITU-T H.323：基于不保证 Qos 的分组网络中多媒体业务的框架协议

### 9.2.2 Networking Scheme

#### 9.2.2.1 Overview

整个系统采用 IP 传输网络，基于标准的 H. 323 架构，是一个开放的系统，视频协议采用业界主流的 H. 264 编码同时兼容 H. 261、H. 263 编码，可以为用户提供 1080P 高清视频图像。采用 VideoIntensifier、ViewProcess 技术，配合最新的 H. 264 HP 编码技术，大大提高了图像压缩比，在同样带宽下，可向用户提供更逼真、更清晰、更流畅的画面。根据用户的实际配置需求，可以提供 50/60 帧/秒技术，在同等带宽下，将屏幕刷新频率增加一倍，增强图像的流畅度。可以提供动态高清双流，实现静态和动态的高清晰图像。通过华为高清 MCU 可以兼容 1080P、720P、4CIF、CIF 等高标清视频会议终端接入，支持智真，RP，高标清视讯终端混网融合。

支持最新的音频编解码协议 AAC-LD/LC，该协议采用 48K 采样率、码率最高达 96k，并且提供多声道语音支持，给实时通讯带来 CD 级的音质效果。

系统支持 H.239 高清双视频流和 SXGA 输入/输出特性，主流支持 1080@60fps, 辅流支持 1080P@30fps，用户直接通过带内的方式就可以实现全景式会议，PowerPoint 演讲稿与 Word 演讲稿可以同步显示。

整个系统高可靠性：支持诸如：IP 网口备份、N＋1 备份、电源备份、芯片备份，保证视频会议系统全天 24 小时，全年 365 天无故障运行。

智真系统组网示意图如下图：

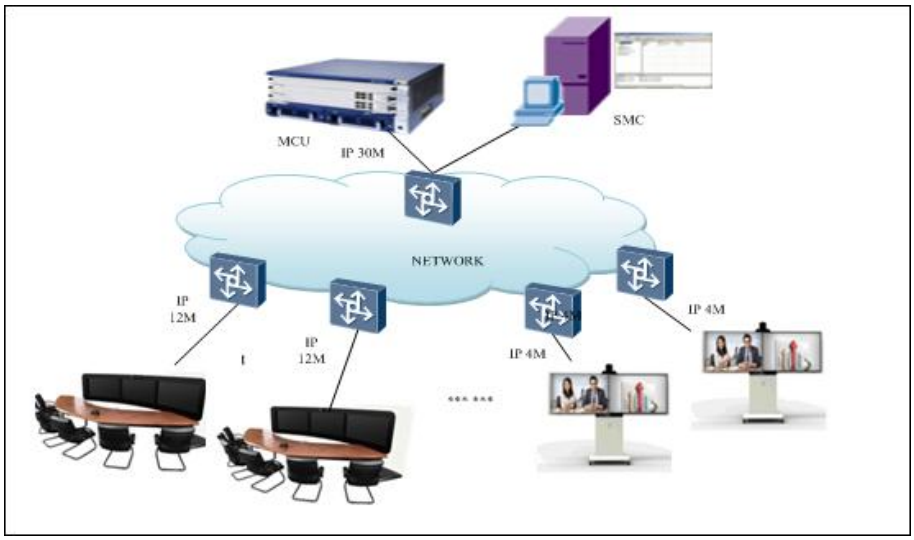



Figure 16 Telepresence System Networking diagram

- 视频会议控制中心

在总部中心机房部署华为高清 MCU8660、会议管理平台 SMC，全网由中心点会议管理平台统一管理，全网资源的统一调度。

华为高清 MCU8660 支持 1080P、720P、4CIF、CIF 视频会议终端接入，MCU 负责将所有会场的码流进行处理与转发；可根据客户的实际需求配置。

华为会议管理平台 SMC 负责会议的召集、管理和结束等会议管理控制功能，通过会议管理平台对这些码流进行分发、交换、会议控制等。

- 视频会议主会场

在主会场可部署华为智真，使用 3 个 65 寸专业显示屏，具备 1080p60 的极致高清视频、三声道音频、真人大小、听声辨位等特点，达到虚拟的面对面高临场感沟通，帮助中高层管理人员的及时沟通，高效协作，快速决策。

智真会场配置华为 TP3106 智真主设备，主要由机架总成和多功能会议桌两大部分组成。其中机架总成包括智真一体化机架、智真主机、三眼摄像机、核心编解码器、65 寸显示屏、交换机、无线路由器、高保真音响系统组成；多功能会议桌包括会议桌、嵌入式麦克风、22 寸自动翻转屏、多功能插座、中控触摸屏，以及桌面按键（含自动翻转屏升降按钮、Mic 开关按钮）。

- 视频会议室分会场

分会场可部署华为 RP 多功能智真，满足中型会议室的需求。华为 RP 多功能智真搭配 46 寸的双屏 LCD 显示屏，采用整体超薄技术，实现 1080P 的全高清视频，带来真人面对面交流的感受；专业声学处理，带来影院级音质享受；人性化的界面和遥控器设计，操作畅通无阻。

RP 会场配置华为 RP 系列智真，主要包括：核心编解码器、高清摄像机、数字阵列麦克风 VP M210，总装结构件及液晶显示器 46 寸。

本设计方案为最典型视讯网络拓扑结构，一套后台管理软件 SMC 和服务器，1 台多点资源控制中心 MCU8660，7 套智真 3106 和 22 套简版智真 RP。

具体设备规格及需求：

| 系统与设备名称 | 需要 IP 的设备 | IP 地址规划 | 推荐带宽 | 安置地点 | 设备功耗 |
|---|---|---|---|---|---|
| TP3106 | 智真主机 | 4 个 | 4M/台 | 会场 | |
| | 左智真编码器 | | | | |
| | 主智真编码器 | | | | |
| | 右智真编码器 | | | | |
| RP200 | 智真编解码器 | 1 个 | 4M/台 | 会场 | |
| MCU8660 | GCCB 主控板 | 1 个 | | 机柜 | |
| | SMC 服务器 | 1 个 | 无要求 | 机柜 | |
| MCU 电源模块 | MCU 可提供交流与直流模块供选择，但需要提前与客户确认机房能够提供的电源类型，避免 MCU 发货的电源模块与客户机房电源不匹配。 | | | | |

#### 9.2.2.2 Network Deployment Requirements

为了实现更好的效果，视讯系统对网络建设有一定的要求。

**1**：为了保证视讯各节点的连通性，必须保障视讯系统通信的端口在通信链路上打开。

**2**：为了保证视讯的可用性，必须保障视讯节点之间，网络必须可以提供一定的带宽。

**3**：为了保证视讯质量的流畅性，对视讯节点间网络的延时、抖动等有一定的要求。

**4**：如果业务流不是在提供固定带宽的专网上传输，还需要对网络的 **QOS** 有一定的要求。

♦ 系统端口设置

系统端口范围数据如下标所示，网络建设必须在各站点之间，站点与 MCU 之间的网络上，保证相关端口的连通。

| 发起端设备 | 接收端设备 | 服务端端口 | 协议 | 说明 |
|---|---|---|---|---|
| Telnet | 8660 | 23 | TCP | Telnet 接口（缺省端口、可以修改） |
| GK | 8660 | 1719 | UDP | RAS 信令（缺省端口、可以修改） |
| 其它 H.323 节点 | 8660 | 1720 | TCP | Q.931 呼叫信令接口（缺省端口、可以修改） |
| 其它 H.323 节点 | 8660 | 11720-12744 | TCP | H.245 信令接口（缺省端口、可以修改，跨度 1024） |
| 其它 H.323 节点 | 8660 | 10010-10010+MAX(512*10*4) | UDP | 双向视音频码流收发（缺省端口、可以修改;端口跨度 License 的接入路数相关） |
| 8660 | ftp 服务器 | 21 | TCP | 连接 ftp 服务器升级软件、License 和导出文件接口 |
| RMCC | 8660 | 5000 | TCP | RMCC 管理接口（缺省端口、可以修改） |
| 地址扫描工具 | 8660 | 10001 | UDP | IP 地址扫描组播接口 |
| 8660 | Syslog 日志服务器 | 514 | UDP | 上传日志服务器接口（缺省端口、可以修改） |
| Mediamanager | 8660 | 161 | UDP | 网管接口 |
| 终端或 MCU | 高清终端 | 7684、7685 | UDP | 7684：摄像机控制 RTP 接收端口 |
| | | | | 7685：摄像机控制 RTCP 接收端口 |
| 终端或 MCU | 9039 | 10002-10005 | UDP | 10002：音频码流 RTP 接收端口 |
| | | | | 10003：音频码流 RTCP 接收端口 |
| | | | | 10004：主流视频码流 RTP 接收端口 |
| | | | | 10005：主流视频码流 RTCP 接收端口 |

| | | | | |
|---|---|---|---|---|
| 终端或 MCU | 9039 | 10006-10007 | UDP | 10004：辅流视频码流 RTP 接收端口 |
| | | | | 10005：辅流视频码流 RTCP 接收端口 |
| 9039 | MCU | 4101,3333-3336 | UDP | SNP 协议下使用，如果无 SNP（静态 NAT 时）不需要开放 |
| 8660 | GK | 700 | TCP | 主叫呼集端口（终端接收端口是系统自动选定的，通常会从 1025 开始递增） |
| 9039 | MCU 或终端 | 1320-1416 | TCP | H245 信令监听端口（如果采用 MediaCentre，开放 1320-1416 端口，如果采用了 8620，则开放 1320-1327 端口，新 MCU 为 11720-12744 |
| 9039 | MG | 80（可在 MG 上配置） | UDP | 与 MG 通信时配置，RTCP、RTP 视音频码流汇聚的接收端口 |
| Pc | 9039 | 5000 | TCP | 后台软件通信 |
| SIP 客户端 | 业务管理中心 | 5060(可修改) | TCP | SIP 通信 |

- IP 网络质量要求

| Qos等级 | 默认值 | 0级 | 1级（交互式） | 2级（一般模式） | 3级（U级） |
|---|---|---|---|---|---|
| 网络延时上限 | 未规定 | 150ms | 400ms | 1s | U |
| 延时抖动上限 | 未规定 | 50ms | 50ms | 1s | U |
| 丢包率上限 | 未规定 | 1/1000 | 1/1000 | 1/1000 | U |
| 包误差率上限 | 1/10000 | 默认 | 默认 | 默认 | 默认 |

| 业务类型 | 802.1p | 调度 |
|---|---|---|
| 协议报文管理 | 6 | 优先队列 PQ |
| 音频报文 | 5 | 优先队列 PQ |
| 视频报文 | 4 | 轮询队列 WRR |
| 其他 | _ | _ |

- IP 网络带宽要求

由于视频会议及时交互性的特点决定了视频会议要求网络速率上下行对等，所以必须保证视频会议有固定带宽保障，为了确保视频会议召开期间，会议带宽的稳定性，提出如下建议

1. 在网络设备层面，开通流量管理等 QOS 保障手段，保证视频会议的有足够固定的带宽；在高清（720P）视频效果的情况下，建议每个会场带宽建议不小于 2M，双流会议带宽建议不小于 3M；在高清（1080P）视频效果的情况下，建议每个会场带宽建议不小于 3M，双流会议带宽建议不小于 4M；三屏幕智真系统在 1080P 时建议会场带宽建议不小于 6M。
2. 要求建立视频会议专用网络，以便于与其他业务独立分开，保证良好的网络质量，丢包率要求不超过 5%；
3. MCU 平台的汇聚带宽为 MCU 下挂的会场终端带宽以及级联的下级 MCU 所占用带宽需求总和的 1.2 倍。

要在 IP 承载网络上开展实时多媒体视讯业务，承载网络本身必须对端到端的通信服务质量 Qos 提供保障。实时多媒体视讯业务的 Qos 实现要求 IP 承载网络在承载端到端的视讯业务的视音频 IP 包码流时，做到延迟小、抖动低、丢包率低。

开展视讯业务没有辅流的最低会议带宽要求（该会议带宽下，流畅度和清晰度一般）

开展视讯业务有辅流的建议会议带宽要求（该会议带宽下，视频和辅流的帧率都比较高，流畅度和清晰度都能保证）。

会议带宽与网络带宽的区别：

| 视频格式 | 最小（会议带宽） | 主流帧率 | 辅流帧率 |
|---|---|---|---|
| 标清级（CIF） | 512kbps | 视频 25/30 帧/s | 5～7 帧/s |
| 标清级（4CIF） | 1Mbps | 视频 25/30 帧/s | 5～7 帧/s |
| 高清级（720p） | 1.5Mbps | 视频 25/30 帧/s | 10～15 帧/s |
| 高清级（720p） | 2Mbps | 视频 50/60 帧/s | 10～15 帧/s |
| 高清级（1080p） | 3Mbps | 视频 25/30 帧/s | 10～15 帧/s |
| 高清级（1080p） | 4Mbps | 视频 50/60 帧/s | 25～30 帧/s |

### 9.2.3 Key Indicators Parameters

- 音频指标

网络必须支持以下类型的音频编码传输：G.711、G.722、G.728、AAC-LD 等标准。要保证具有自动唇音同步，误差应不可察觉，音频视频相对延迟小于 40ms。承载网端到端丢包率必须小于或等于 3%。

- 视频指标

网络必须支持以下类型的视频编码传输：H.261、H.263、H.263++、H.264 协议。为保证图像质量良好，画面流畅无卡顿等，承载网端到端丢包率必须小于 3%时。

- 时延指标

为了保证视频会议设备（MCU，终端）时延小于 310ms，在承载网端到端时延在 130ms 以内。

- 稳定性指标

在承载网络和设备保障稳定性良好，在视频设备正常得情况下，因为网络原因导致的掉线率应小于 0.01 次/方/小时，即 2 小时内 50 方的会议掉线不能多于 1 方。

### 9.2.4 Equipments Configuration

| 设备名称或者型号 | 产品描述 | 数量 |
|---|---|---|
| 总部中心机房 | | |
| MCU--8660  | 电信级全高清的综合媒体交换平台。全系列支持1080p、720p 高清视频、AAC-LD宽频语音和SXGA桌面数据内容呈现（满配支持到1024路2M用户同时召开会议） | 1 |
| 会议管理平台---SMC  | 视讯业务管理系统，对企业所有视频资产如MCU、GK、终端进行集中管理。具有简洁灵活的统计报表，及时了解视频资产的使用情况，便于分级分权管理。内置GK。 | 1 |
| 主会场 | | |
| 三屏智真TP3106  | 华为沉浸式智真，实现6人座位真人大小的超大宽屏完美画面的远程呈现。采用全数字视频拼接技术，专业的多声道采集与还原技术，实现全方位的声像同位，<br>支持触摸控制等特色功能 | 7 |
| 分会场 | | |
| RP200-46  | 华为RP系列多功能智真，主要包括：1080P核心编解码器、高清摄像机、数字阵列麦克风、总装结构件及LCD液晶显示屏 | 22 |

### 9.2.5 Features and Highlights

- 业界顶级 1080P@50/60 端到端极致高清体验；
- 标准架构，良好的融合互通能力；
- 超强稳定性多重安全备份机制；
- 超强低带宽能力及智能自适应；
- 一站式交付 AV 集成、可定制；
- 无线触摸屏简易操控注重细节，人性化设计；

## 9.3 Video Display System

### 9.3.1 Design Principle

监控中心图像显示子系统设计遵循的标准主要有下列规范

1）《民用闭路监控电视系统工程技术规范》；

2）《安全防范工程程序与要求》；

3）《电子计算机机房设计规范》；

4）《电工电子产品基本环境试验规程》

在系统设计时基于以下原则进行：

1) 系统的可行性

DID 液晶拼接墙拼接可任意组合（M×N），考虑到现实效果，通常会采用 16：9 的长宽比例。通常会根据不同的客户对拼接系统提出的系统规模、尺寸和应用要求，选择合适的产品和拼接方式，提出具体实施方案，满足系统的应用需求。 DID 大屏幕系统通过 RS-232 通讯接口以及控制台来控制图像控制器来实现任意组合显示模式的切换、信号的切换等。

2) 系统的实用性

可以根据用户对输入信号的要求，选择不同的视频处理系统，实现 VGA、复合视频、S-VIDEO、YPBPR/YCBCR、DVI/HDMI 信号、IP 网络信号的输入，满足不同使用场合，不同信号输入的需求。可以通过控制软件，实现各种信号的切换、拼接成全屏显示、任意组合显示、图像拉伸显示、图像漫游显示、图像叠加显示等。

3) 系统的可靠性

华为液晶拼接墙所用的拼接单元采用工业级的 DID 液晶专用屏，拼接单元可一天 24 小时一年 365 天连续工作，拼接单元具有可靠性、稳定性高等特点，以保证系统稳定可靠地运行。由于低功耗、重量轻、寿命长，无辐射等特点，使得液晶拼接墙可靠性极高。

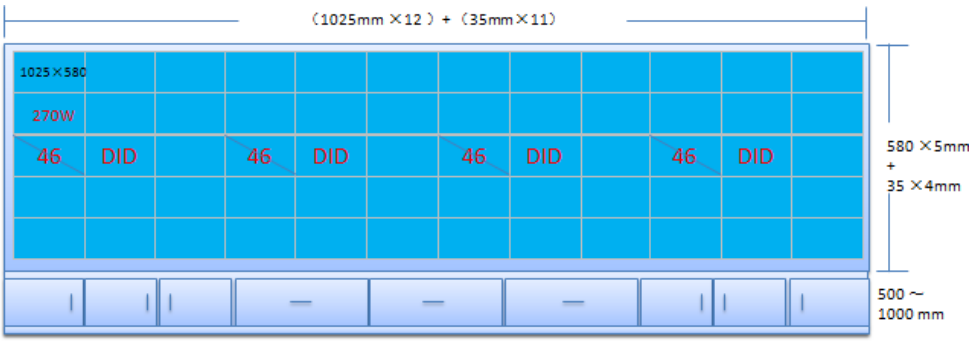
### 9.3.2 Display System Design

For the convenience of real time monitoring, every command center has a set of DID screen.For splicing large screen, the most apparent advantage is to display high-resolution system application program on the united logical screen, namely whole wall by using the transmission and display of multi-screen display controller, so as to realize full-screen display and resolution superimposing, such as GPS and GIS electric maps, and it can be used as the base map, on which all kinds of application windows can be opened, the resolution for single-screen display is 1024×768, and the composite screen of all systems can realize resolution superimposing, then the display resolution of whole 2×2 composite screen configured can reach 2048×1536.

1. All signals can be flexibly displayed.
2. Video signal: such as monitoring video signal from monitoring lens, DVD and video recorder.
3. Computer signal in network connection: for example, terminal signal from network computer, the cross-platform display between Windows and Unix system is for network display, in theory, the quantities of terminals in network segment are not limited.
4. Non-network connecting computer signal: terminal signal from notebook computer, local user terminal or one specific terminal.
5. All signals can be straightly displayed on the single screens or displayed, roamed, amplified, reduced and superimposed across screens in random dimension through multi-screen display controller.

#### 9.3.2.1 L1 Command Center Design

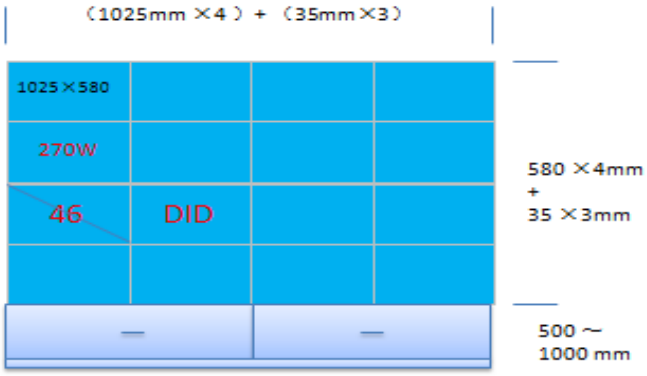
The following figure provides an example of the DID Screen of the level-1 surveillance center. TV wall is consisted of 5*12 DID Screen.




Use the 5*12 DID screen, operators can put the GIS information on the several screens in the middle. And the rest can display the real time monitoring image or remain to display the alarming spot. The following figure provides an example of DID screen display plan.

9.3.2.2 L2 Command Design

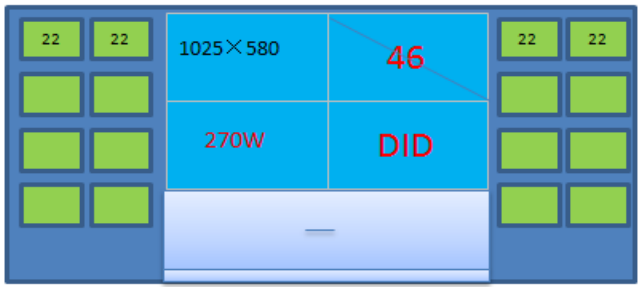
The following figure provides an example of the DID Screen of the level-2 surveillance center. TV wall is consisted of 4*4 DID Screen.




For the function design of L2 command center, DID screen can be use to monitor the sensitive area. The following figure provides an example:


9.3.2.3 L3 Command Design

The main function of L3 Command Center is small scale of monitoring. So it is deploy 2*2 DID Screen and 4*4 TV Wall.




### 9.3.3 Networking Scheme

9.3.3.1 Network Overview

XX 项目三级监控中心均采用 DID 拼接大屏幕方案，DID 大屏幕系统主要由 DID 大屏幕拼接显示墙投影子系统，多屏拼接控制器、数字视频矩阵分配器、RGB 矩阵分配器、控制软件等控制子系统组成。DID 大屏幕拼接系统的逻辑组网图和物理组网图如下图所示：

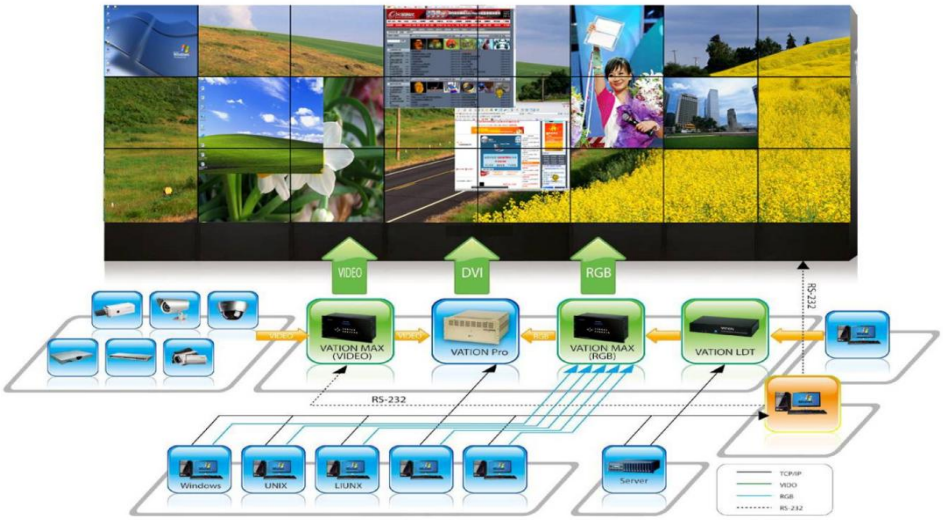



Figure 17 DID Large-screen System logical networking diagram

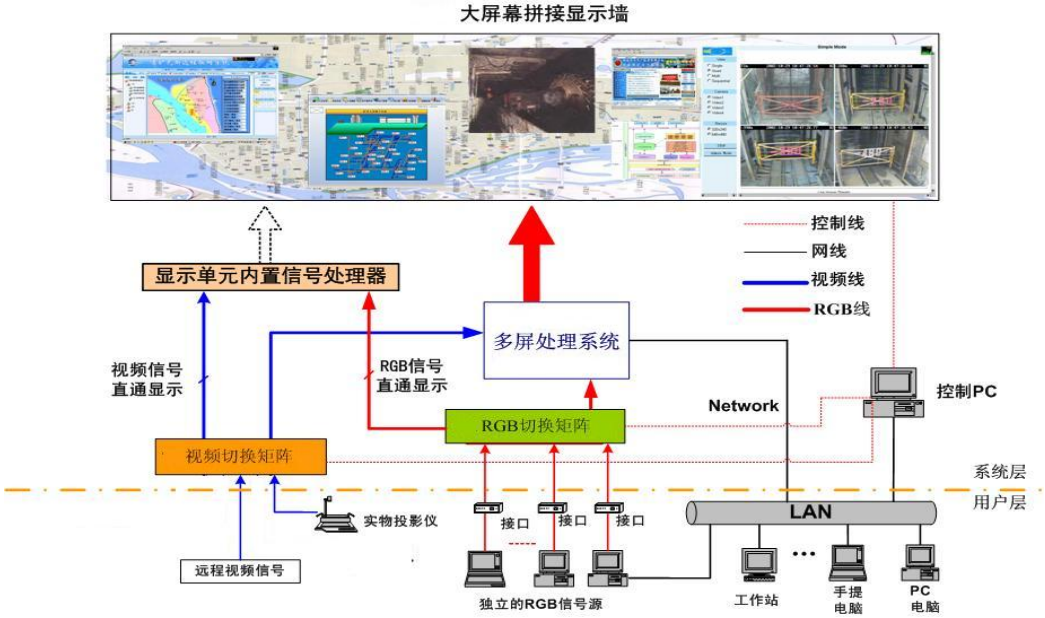



Figure 18 DID Large-screen system physical networking diagram

### 9.3.3.2 Large-screenSystem Design

- 高分辨率显示

  对于拼接大屏幕，最明显的优势就是可以通过网络图像处理器的传输显示，可以把全墙作为统一的逻辑屏来显示高分辨率的系统应用程序，实现全屏显示和分辨率的叠加，比如 GPS、GIS 电子地图等，并且可将其作为底图，在上面开启各类应用窗口，作为单屏显示的分辨率为 1024×768，而在 6 块屏的显示分辨率就为 8192×2304；

- 视频信号显示

本系统提供双通道视频输入：经图像处理器的视频信号输入、经投影单元内置图像处理器直通视频信号输入。两种方式互为备份。 本系统图像处理器配备有多路视频信号输入接口。用户的的视频信号通过视频矩阵切换器或直接接入图像控制器，经图像处理器处理的视频信号可以窗口形式同时显示于大屏幕上。视频窗口可以实现单屏显示、任意大小显示、跨屏显示、整屏漫游、任意缩放显示等功能。

两种方式输入的视频信号均可以实现单屏显示、整屏显示、跨屏显示、任意缩放显示等功能。

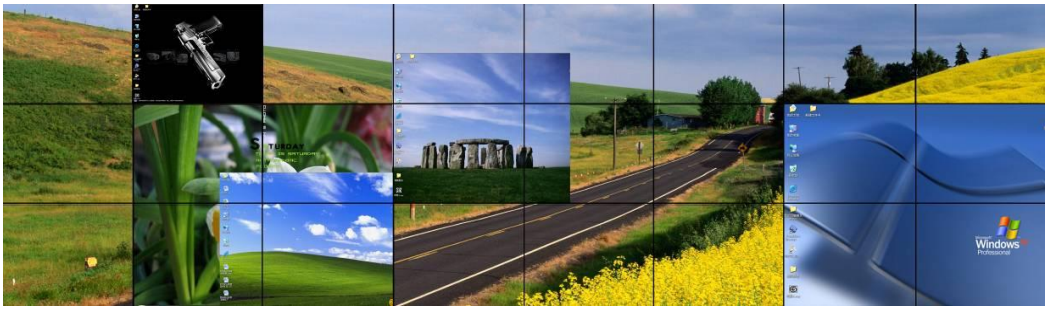
- RGB 信号显示

本系统提供双通道计算机信号输入：经图像处理器的计算机信号输入、经投影单元内置图像处理器直通计算机信号输入。两种方式互为备份。

图像处理器具有 2 路 RGB 输入接口，可以将计算机信号以窗口形式同时显示于大屏幕上。RGB 窗口可以实现单屏显示、任意大小显示、跨屏显示、整屏漫游、任意缩放、任意叠加且叠加信号不影响底层信号的显示等显示功能，并且可以实现图象的分组切换、巡检、预案显示等功能。

显示单元配备了 RGB 输入接口，通过 RGB 输入接口，可以在不依赖外部图像控制器的情况下直接从 RGB 矩阵输入信号，并在组合屏上以屏幕为单位显示 24 路计算机 RGB 图像。

通过显示单元的内置图像处理器，直通的 RGB 信号除了可以单屏显示以外，还可以 M×N 方式实现任意多屏拼接显示，及全屏显示。如 1×2，2×1，2×2，2×3 等方式。



- 网络信号的显示

通过网络方式连接的各种计算机工作站数量无限制，可同时在大屏幕上任意位置、任意比例显示网络信号，且具备一定的响应速度，并且可以显示标清视频信号。经过扩展可允许各个不同网段上的计算机或工作站将信号在大屏幕投影墙上显示，同时又不需要改变现有网络环境。用户原有的基于网络的图形应用可以立即获得投影墙提供的大画面、高分辨率显示效果。

- 各类信号混合显示

本系统通过内置图像处理器和图像拼接控制器实现了拼接系统灵活多变的拼接处理功能，使大屏幕拼接系统具有处理计算机 RGB 信号、视频信号及网络信号的同时显示和不同类型信号混合显示的功能。网络、RGB、视频信号均能够以开窗口方式任意位置、缩放、拖动、拼接、整屏显示，网络、RGB 信号可与视频信号叠加显示，达到完全动态实时。

#### 9.3.3.3 IP Address Planning

监控中心大屏幕系统需要分配两个内网 IP 供内部通信，分别供拼接控制器和控制台使用，单路解码器每台需要一个内网 IP 供内部通信，每台 workstation 需要一个内网 IP 供图像数据调用，每个监控中心设备建议统一划分一个 VLAN，各监控中心之间通过三层互通，根据上述需求，监控中心的 IP 地址规划需求建议为：

| 监控中心 | L1 | L2 | L3 |
|---|---|---|---|
| VLAN | A | XX 项目～B4 | C1～C12 |
| 内网 IP | 192.168.1.0/24 | 192.168.1.0/24 | 192.168.1.0/24 |
| 互联 IP | 10.0.0.1/24 | 10.0.1.1/24<br>10.0.2.1/24<br>10.0.3.1/24<br>10.0.4.1/24 | 10.0.5.1/24 |

### 9.3.4 Equipment Configuration

| 监控中心 | L1 | L2 | L3 |
|---|---|---|---|
| DID 大屏幕 | 60 | 16*4 | 6*12 |
| 拼接控制器 | 1 | 4 | 12 |
| 工作站 | 164 | 45*4 | 6*12 |
| 监视器 | 0 | 0 | 16*12 |

## 9.4 IVS Platform System

### 9.4.1 Design Principle

Huawei IVS platform designed with following standards:

| Protocol and Standard | Description |
|---|---|
| IEEE 802.3 | Ethernet standards including 802.3ab, 802.3u, and 802.3z |
| IEEE 802.1d | IEEE MAC Bridges standard |
| IEEE 802.1q | VLAN standard |
| IEEE 802.1p | Priority |
| ITU-T H.323-98 | Standard for packet-based multimedia communications systems |
| ITU-T H.261-1993 | Video codec standards for P x 64 Kbit/s audio and video services |
| ITU-T H.263-1998 | Video codec standard for low bit rate communications |
| ITU-T H.264 (MPEG 4 part 10) | Digital video encoding standard |
| ITU-T G.729 (1996) | Speech encoding at 8 Kbit/s using Conjugate-Structure Coded-Excited Linear Prediction (CS-CELP) |
| RFC775 | File Transfer Protocol (FTP) |
| RFC872 | Transmission Control Protocol (TCP) |
| RFC877 | Internet Protocol (IP)<br>TCP and User Datagram Protocol (UDP) |
| RFC2139 (1997) | RADIUS accounting protocol |
| RFC2326 | Real-Time Streaming Protocol (RTSP) |

| Protocol and Standard | Description |
|---|---|
| RFC3261 | Session Initiation Protocol |
| MPEG-2 | Digital video encoding standard |
| MPEG-4(ISO/IEC 14496) | Multimedia standard for complicated audio and video communication |
| ISOC/IETF RFC 2068 | Hypertext Transfer Protocol (HTTP), version 1.1, January 1999 |
| CCITT G.711 (1988) | Pulse Code Modulation (PCM) of audio signals |
| CCITT G.722 (1988) | 64 Kbit/s audio encoding at 7 kHz |
| CCITT G.728 (1992) | Speech encoding at 16 Kbit/s using Low-Delay Code Excited Linear Prediction (LD-CELP) |
| IETF RFC 1889<br>IETF RFC 1890 | Real-Time Transfer Protocol (RTP) and Real-Time Transport Control Protocol (RTCP) |
| H.323 | IP-network-based audio and video communication protocol suite |

### 9.4.2 Platform Architecture Design

IVS 视频监控平台从逻辑上主要分为中心管理模块 SMU、业务控制模块 SCU、媒体数据分发及录像模块 MU、第三方接入模块 CG 以及前端 PU、CU 接入模块等。IVS 视频监控平台从业务功能上主要包括监控业务管理、报警管理、存储管理、GIS 电子地图管理、网络设备管理、用户安全管理、日志管理、人机交互管理等。

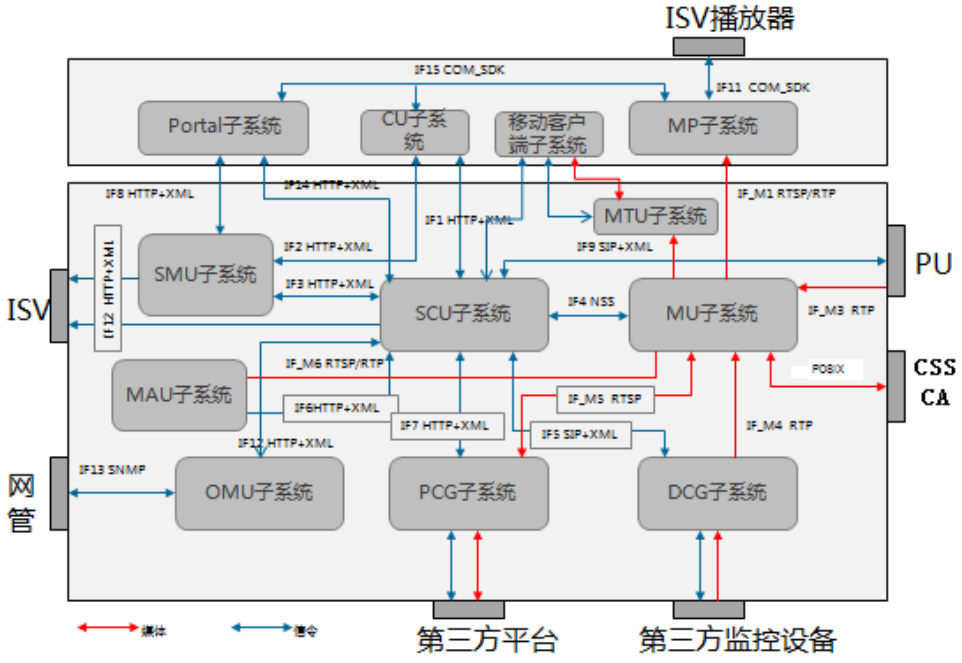



Figure 19 IVS Platform architecture

IVS 子系统的录像单元 MU 需要部署 CSS 存储子系统的客户端代理 CA， MU 通过 CA 采用 POSIX 协议接口，对 CSS 存储系统进行数据读写访问。

### 9.4.3 IVS Networking Scheme

#### 9.4.3.1 Network Overview

XX 项目基于异地容灾及备份的需求，在平台设计上采用的是分级设计，根据物理位置的布局，在 W 市区选择了 1 个一级监控平台、1 个一级录像备份中心、4 个二级监控平台中心，一级监控平台与一级录像备份中心备份是录像备份同步设计，一级监控平台与二级监控平台是容灾设计，多级监控平台的设计保障了业务和录像数据的可靠性和安全性。

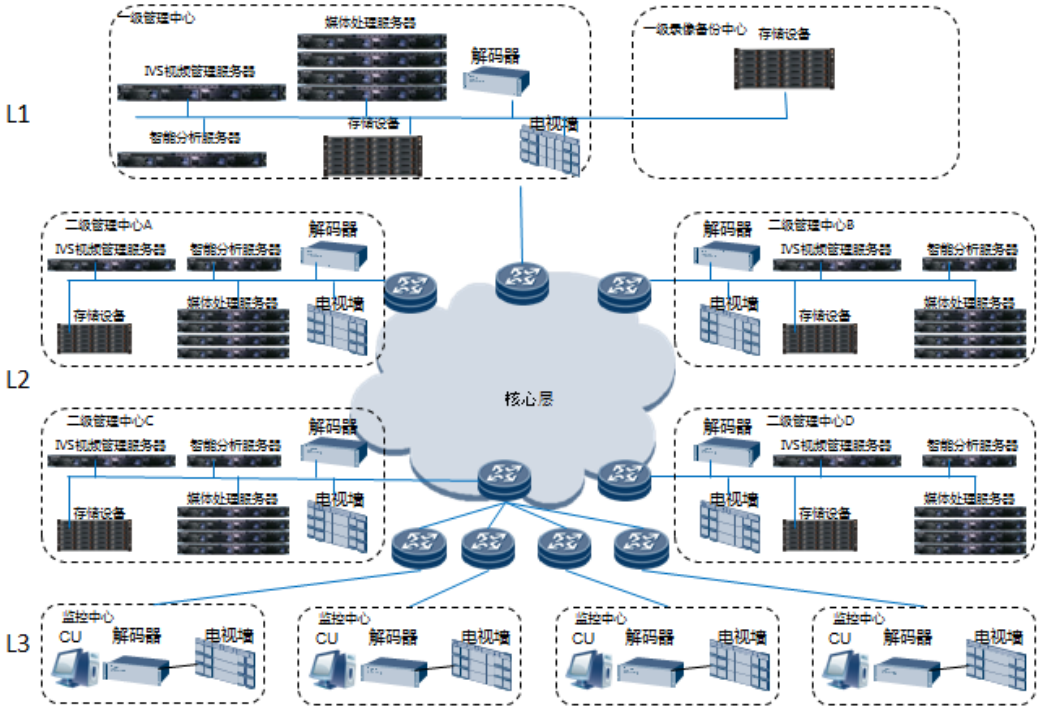
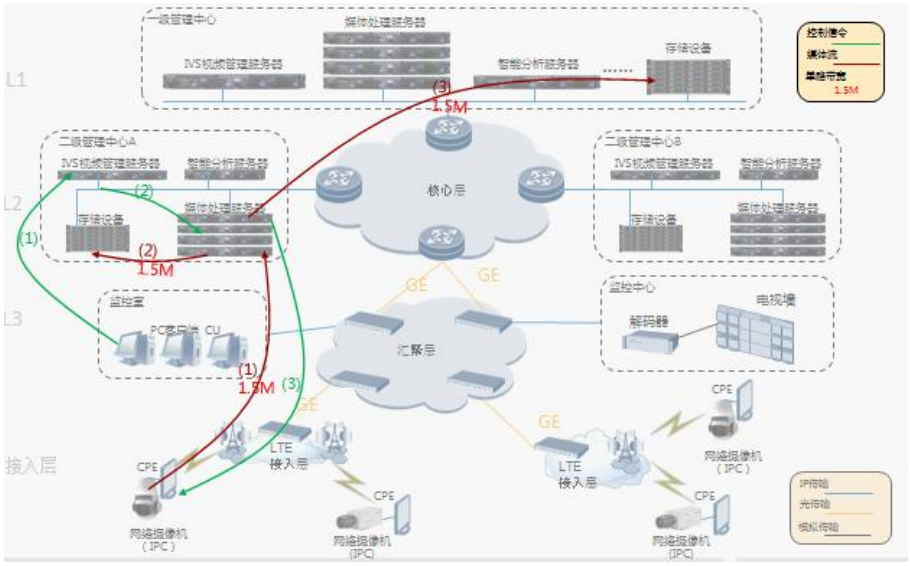



Figure 20 IVS Platform network topology

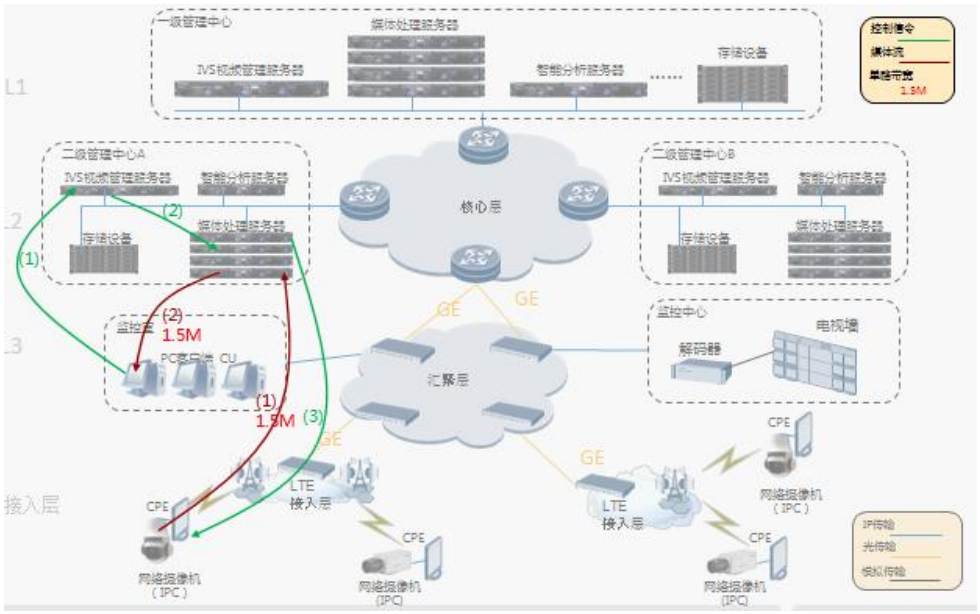
#### 9.4.3.2 Main Business Processes

根据 XX 项目的整体组网设计，IVS 解决方案中涉及与承载网交互的业务流程主要有 5 大部分，分别为 PU 设备录像存储及控制、CU 客户端实况和回放、PU 图像上墙、智能分析业务、PU 设备版本升级，这 5 大部分的主要业务流程示意图如下：

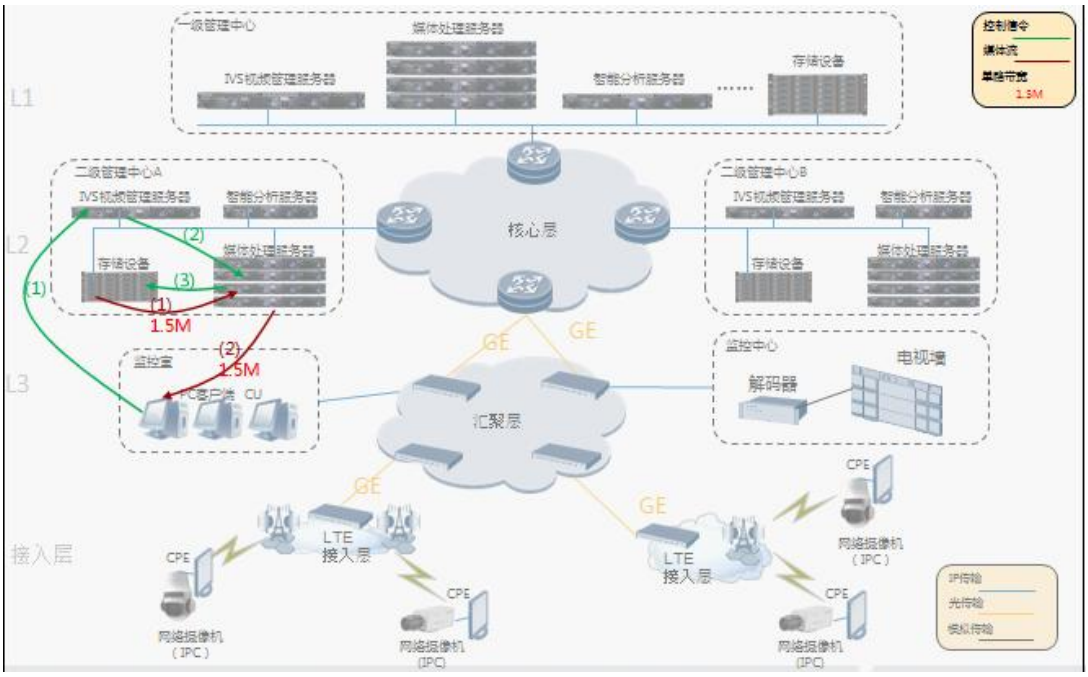
1. PU 设备录像与控制




2. CU 客户端实况与回放

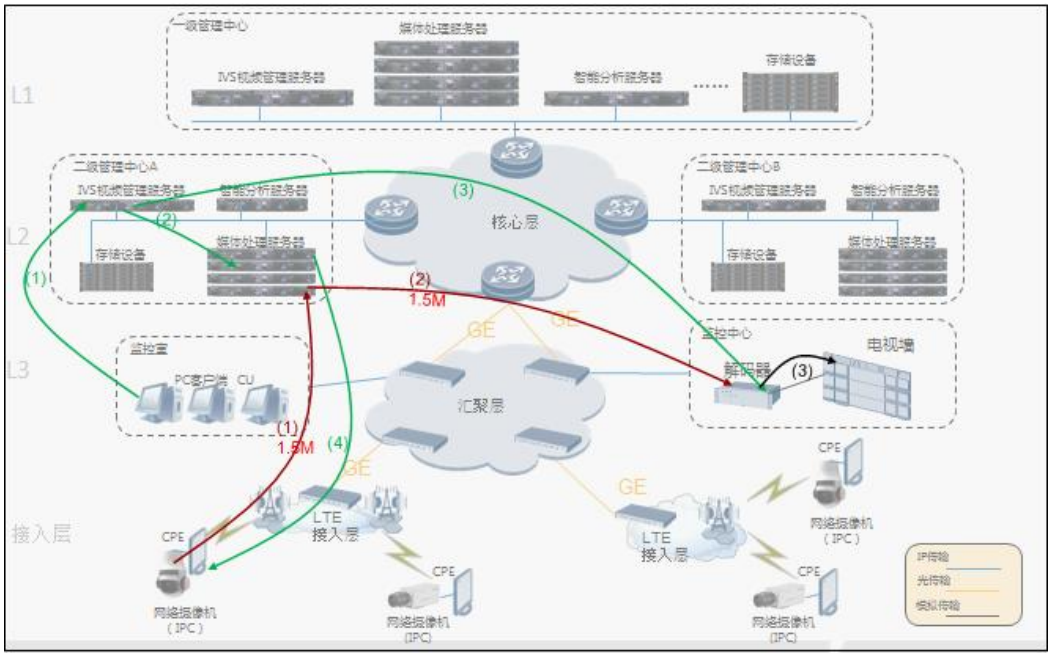



实况流程

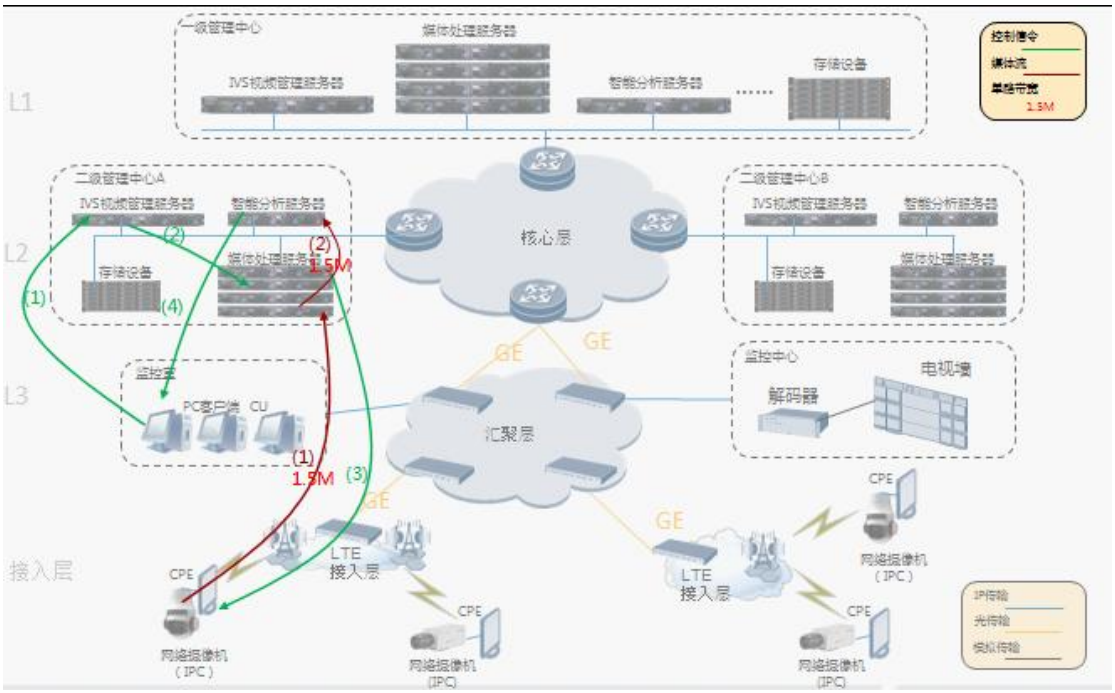



回放流程

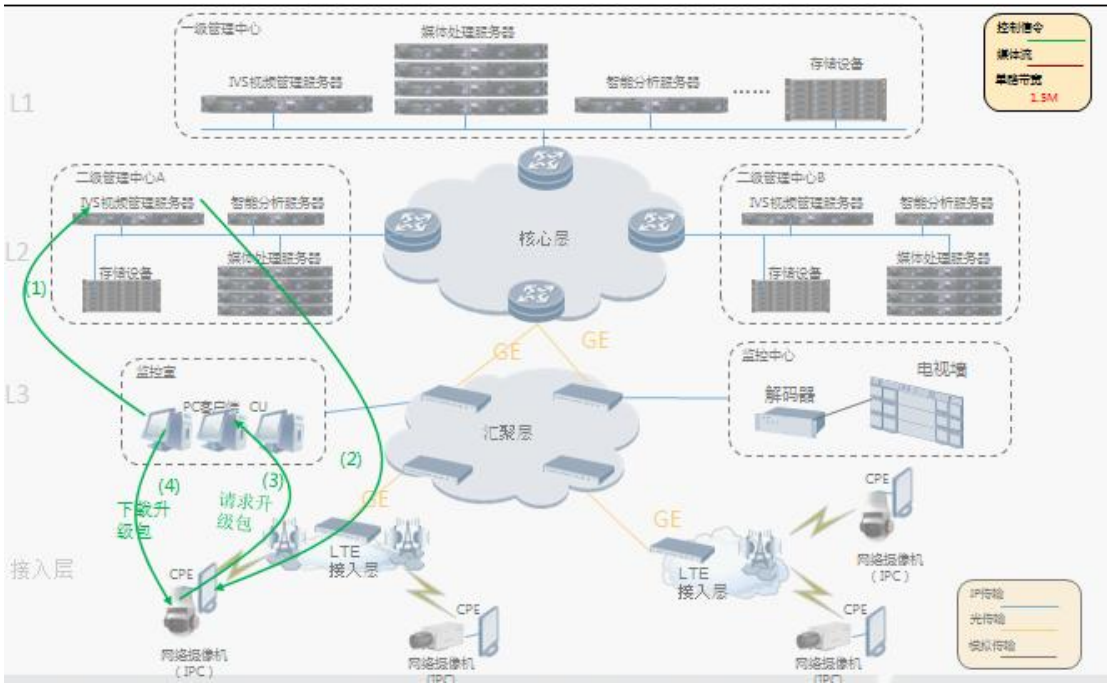
3. PU 图像上墙




4. 智能分析业务




5. PU 设备版本升级




9.4.3.3 Traffic Bandwidth Design

IVS 平台的核心业务流量设计集中在 L1 指挥中心、L1 备份中心、L2 指挥中心，L1 的出口带宽和 L2 的出口带宽需求对数据网络的配置和组网密切相关。根据 IVS 平台的组网架构，IVS 业务包含的四个主要网间流量包括 L1 CC 到 L1 backup 之间的录像备份流量；L1 EPC 正常运行下 L1 到防火墙、各

级 L2CC 的业务流量；L2 EPC 接替 L1EPC 运行后，L2 到防火墙、L1CC、其余 L2CC 之间的业务流量；各级 L3CC 到各自对应 L2CC 的流量。下面两张表主要描述了各主要业务节点的业务流量及相应的流量统计。

Table 8 Video Flow statement

| 监控中心 | 流量名称 | 流量数据过程 | 数据流向 | 媒体流量小计（Mbps） | 备注 |
|---|---|---|---|---|---|
| L1 | L2 IVS 向 L1 IVS 转发的媒体流 | 每个 L2 IVS 向 L1 IVS 转发媒体流为 1.5Mbps*3279 路摄像机 | L2 IVS->L2<br>S5752EI->L2<br>S9712->L2<br>NE40E-X16->L1<br>NE40E-X16->L1<br>S9712->L1<br>S5752EI->L1 IVS | 4918.5 | 该流量对于->L1<br>NE40E-X16->L1<br>S9712->L1<br>S5752EI->L1<br>IVS 链路而言，媒体流量为<br>4918.5*4=19674Mbps |
| | L1 IVS 向 L1 客户端 PC 分发的实况媒体流 | L1 IVS 向每台 L1 客户端 PC 分发的流量为 1.5M*16 路，共 162 台 L1 客户端 PC | L1 IVS->L1<br>S5752EI->L1 PC | 3888 | |
| | L1 IVS 向 L1 客户端 PC 分发的录像回放媒体流 | L1 IVS 向每台 L1 客户端 PC 分发的流量为 1.5M*16 路，共 162 台 L1 客户端 PC | L1 CSS->L1<br>S6748->L1<br>S9712->L1<br>S5752EI->L1<br>IVS->L1<br>5752EI->L1 PC | 3888 | |
| | L1 IVS 向 L2 IVS 转发的外域访问媒体流 | L1 IVS 向 L2 监控中心里申请外域访问的 PC 机转发媒体流的流量为 1.5M*16 路*PC 机数,每个 L2 外域访问 PC 机数按 10 台计算 | L1 IVS->L1<br>S5752EI->L1<br>S9712->L1<br>NE40E-X16->L2<br>NE40E-X16->L2<br>S9712->L2<br>S5752EI->L2 IVS | 960 | |
| | L1 IVS 向 L1 解码器分发的媒体流 | L1 IVS 向每台 L1 解码器分发的流量为 1.5M，共 60 台解码器 | L1 IVS->L1<br>S5752EI->L1 解码器 | 90 | |
| | L1 IVS 向 L1 CSS 转发的存储媒体流 | L1 IVS 向 CSS 云存储进行写数据，录像媒体流为 1.5Mbps*13116 路 | L1 IVS->L1<br>S5752EI->L1<br>S9712->L1<br>S6748->CSS | 19674 | |
| | L1 接管 L2 时,L1 IVS 接收的摄像机媒体流 | L1 IVS 接收的摄像机媒体流等于所接管的 L2 的媒体流 | IPC->L3<br>NE40E-X3/8->L2<br>NE40E-X16->L1<br>NE40E-X16->L1<br>S9712->L1 EPC<br>S6748->L1<br>S9712->L1<br>S5752EI->L1 IVS | 19674 | 容灾时的情况，最多支持 4 个 L2 系统故障；与正常情况下 IPC 注册到 L2 IVS 不会存在并发，勿重复计算 |

| | | | | | |
|---|---|---|---|---|---|
| L2 | L2 IVS 接收的摄像机媒体流 | L2 IVS 接收的媒体流为 1.5Mbps*3279 路摄像机 | IPC->L3<br>NE40E-X3/8->L2<br>NE40E-X16->L1<br>NE40E-X16->L1<br>S9712->L1 EPC<br>S6748->L1<br>S9712->L1<br>NE40E-X16->L2<br>NE40E-X16->L2<br>S9712->L2<br>S5752EI->L2 IVS | 4918.5 | 该流量对于->L1<br>NE40E-X16->L1<br>S9712->L1 EPC<br>S6748->L1 S9712->L1<br>NE40E-16->链路而言，媒体流量为<br>4918.5*4=19674Mbps |
| | L2 IVS 向 L1 IVS 转发的实况媒体流 | 每个 L2 IVS 向 L1 IVS 转发媒体流为 1.5Mbps*3279 路摄像机 | L2 IVS->L2<br>S5752EI->L2<br>S9712->L2<br>NE40E-X16->L1<br>NE40E-X16->L1<br>S9712->L1<br>S5752EI->L1 IVS | 4918.5 | 该流量与 L1 的第一个相同，计算时勿重复 |
| | L2 IVS 向 L3 转发的实况媒体流 | L2 IVS 向 L3 每台客户端转发的媒体流为 1.5M*16 路，共 6 台*3 L3 客户端 PC；向 L3 解码器转发的媒体流为 1.5M*4 台*3 | L2 IVS->L2<br>S5752EI->L2<br>S9712->L2<br>NE40E-X16->L3<br>NE40E-X3/8->L3<br>S9706->L3<br>S5752EI->L3 PC | 450 | |
| | L2 IVS 向 L3 转发的录像媒体流 | L2 IVS 向 L3 每台客户端转发的媒体流为 1.5M*16 路，共 6 台*3 L3 客户端 PC； | L2 IVS->L2<br>S5752EI->L2<br>S9712->L2<br>NE40E-X16->L3<br>NE40E-X3/8->L3<br>S9706->L3<br>S5752EI->L3 PC | 432 | |
| | L2 IVS 向 L2 客户端 PC 分发的实况媒体流 | L2 IVS 向每台 L2 客户端 PC 分发的流量为 1.5M*16 路，共 45 台 L1 客户端 PC | L2 IVS->L2<br>S5752EI->L2 PC | 1080 | |
| | L2 IVS 向 L2 客户端 PC 分发的录像回放媒体流 | L2 IVS 向每台 L2 客户端 PC 分发的流量为 1.5M*16 路，共 45 台 L1 客户端 PC | L2 CSS->L2<br>S6748->L2<br>S9712->L2<br>S5752EI->L2<br>IVS->L2<br>5752EI->L2 PC | 1080 | |
| | L2 IVS 向 L2 解码器分发的媒体流 | L2 IVS 向每台 L2 解码器分发的流量为 1.5M，共 16 台解码器 | L2 IVS->L2<br>S5752EI->L2 解码器 | 24 | |
| | L2 客户端接收 L1 共享的媒体流 | L2 客户端接收 L1 IVS 转发媒体流的流量为 1.5M*16 路*PC 机数，以 10 台计算 | L1 IVS->L1<br>S5752EI->L1<br>S9712->L1<br>NE40E-X16->L2<br>NE40E-X16->L2<br>S9712->L2<br>S5752EI->L2 IVS | 240 | 该流量与 L1 的“L1 IVS 向 L2 IVS 转发的外域访问媒体流”相同，计算时勿重复 |

| | | | | | |
|---|---|---|---|---|---|
| | L2 IVS 向 L2 CSS 转发的存储媒体流 | L2 IVS 向 CSS 云存储进行写数据，录像媒体流为 1.5Mbps*3279 路 | L2 IVS->L2 S5752EI->L2 S9712->L2 S6748->CSS | 4918.5 | |

Table 9 Statistics of Video Flow

| 业务流向 | | 上行带宽 | 下行带宽 | 出口带宽 |
|---|---|---|---|---|
| L1出口 (EPC) | L1-L1 backup | 87G | 87G | 87G |
| | L1 NE 40E <-->L1 S9712媒体 | 40G | 21G | 40G |
| | L1 NE 40E <-->L1 S9712信令 | 5G | 5G | 5G |
| | L1 NE 40E <-->L1 E8160E媒体 | 20G | 20G | 20G |
| | L1 NE 40E <-->L1 E8160E信令 | 5G | 5G | 5G |
| | L1CC到各L2CC之间的流量 | 5.3G | 6G | 6G |
| | L2CC到各L3CC之间的流量 | 1G | 1G | 1G |
| L2出口 (EPC) | L1 NE 40E <-->L1 S9712媒体 | 20G | 1G | 20G |
| | L1 NE 40E <-->L1 S9712信令 | 5G | 5G | 5G |
| | L1 NE40E <-->L1 E8160E媒体 | NA | NA | NA |
| | L1 NE40E <-->L1 E8160E信令 | NA | NA | NA |
| | L2 NE 40E <-->L2 S9712媒体 | 20.3G | 21G | 21G |
| | L2 NE 40E <-->L2 S9712信令 | 5G | 5G | 5G |
| | L2 NE40E <-->L2 E8160E媒体 | 20G | 20G | 20G |
| | L2 NE40E <-->L2 E8160E信令 | 5G | 5G | 5G |
| | L2CC到其他L2CC之间的流量 | 5.3G | 6G | 6G |
| | L2CC到各L3CC之间的流量 | 1G | 1G | 1G |

### 9.4.4 Reliability Design

IVS 平台在所有监控平台全部正常情况下，L1 和 L2 的 IVS 系统是域间的关系：L2 管理和控制自有区域内的所有 IPC，通过 L2 的 MU 服务器进行录像，同时 MU 会向 L1 转发媒体流； L1 通过外域共享方式管理系统内全部 IPC，同时 L1 会接收 L2 的 MU 服务器转发的媒体流进行录像；此种情况下，L1 和 L2 的系统需要各自独立制定录像计划，即 L1 和 L2 的录像是根据相应的客户制定的，因此录像数据可以是不同的。

L1 和 L2 之间建立域间保活机制，通过心跳线进行定期保活探测（每 30 秒一次）。L1 通过心跳保活探测到 L2 没有给出响应时，需人工判断是 L2 系统故障还是心跳保活网络出现故障，如果是心跳保活线路故障，而 L2 正常，则仅处理心跳保活线路的修复，不切换容灾机制；如果确定是 L2 系统故障，则需手动启动容灾机制，此时 L1 IVS 系统将主动发现相应 L2 的所有 IPC 并进行接入，实现接管。

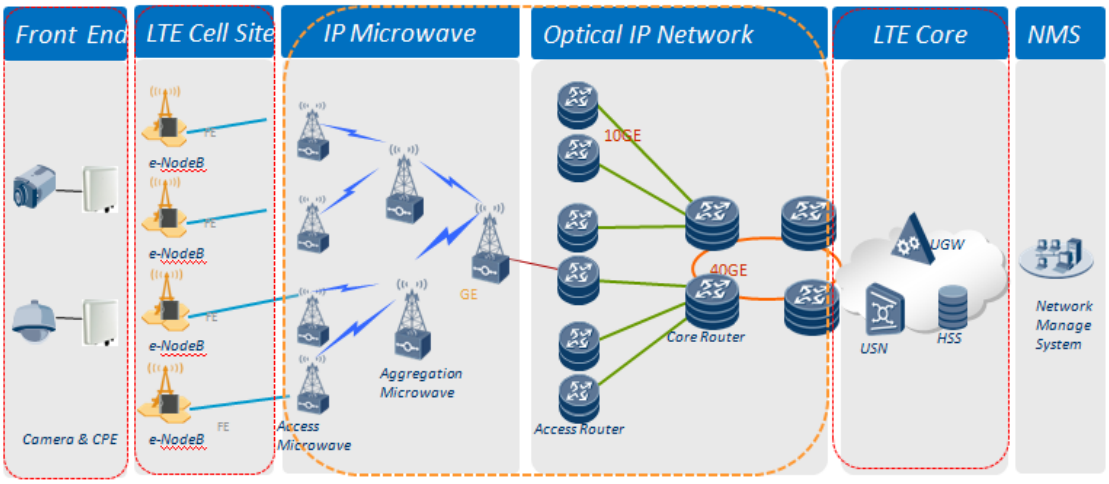
L1 通过心跳保活机制探测到系统故障，再手动启动容灾机制。接管期间业务会出现短暂中断，中断时长小于 1 小时。

L1 系统故障时，由于 L1 和 L2 是域间关系，由于 IVS 有域间自治的机制，因此不会影响到 L2 的业务。监控业务是正常运行的，不需要考虑容灾方案。

L1 的 CSS 会定期（比如每小时）将数据备份到 L1 备的 CSS 中。在需要时，可以手动操作将 L1 备的数据恢复到 L1 主的 CSS 中，L1 到 L1 备的备份功能就是纯粹将 L1 的文件原样复制到 L1 的 backup 中，不涉及到重删和压缩功能。

### 9.4.5 Key QoS Design

XX 项目组网是采用分层次的网络架构设计，接入层采用的是无线 LTE 技术，汇聚层主要采用微波传输，骨干核心全部采用光传输，业务网络以 10GE 以太网为基础，XX 项目整体网络架构设计如下图：




根据 XX 项目的组网设计，IVS 业务流量在无线 LTE 接入侧的 QOS 是需要重点关注的，汇聚层和骨干层原则上可以保证足够的带宽，目前暂不做 QOS 设计考虑。IVS 业务流量与无线 LTE CPE 之间的主要是 IPC 的信令控制流和媒体流，根据无线 LTE 的 QOS 设计结合 IPC 业务流量的承载要求，IPC 媒体流的优先级最高，信令流次之，目前 IPC 对 LTE 承载网的主要 QOS 设计请参照下表：

- QOS 分类

| Services | Protocol | Src IP | Src Port | Dst IP | Dst Port |
|---|---|---|---|---|---|
| 信令流 | TCP | CPE IP | - | SCU | 5080,5081 |
| 媒体流 | TCP/UDP | CPE IP | - | MDU | TCP:25000~25999<br>UDP:26000~29999 |
| 升级 | TCP | CPE IP | - | SCU | 8800 |

- QOS 建议

| QCI | Resource Type | Priority | Packet Delay Budget | Packet Error Loss Rate | Services |
|---|---|---|---|---|---|
| 1 | GBR | 2 | 100 ms | $10^{-2}$ | 无 |
| 2 | | 4 | 150 ms | $10^{-3}$ | 媒体流 |
| 3 | | 3 | 50 ms | $10^{-3}$ | 无 |
| 4 | | 5 | 300 ms | $10^{-6}$ | 无 |
| 5 | Non-GBR | 1 | 100 ms | $10^{-6}$ | 无 |
| 6 | | 6 | 300 ms | $10^{-6}$ | 信令流 |
| 7 | | 7 | 100 ms | $10^{-3}$ | 无 |
| 8 | | 8 | 300 ms | $10^{-6}$ | 版本升级 |

### 9.4.6 Equipments Configuration

Table 10 Video Surveillance Equipment configuration

| 站点 | 设备类型 | 型号 | Karada | 一期 | 二期 | 三期 | 四期 | 合计 |
|---|---|---|---|---|---|---|---|---|
| L1CC | 服务器 | RH2285 | 70 | 70 | 0 | 0 | 0 | 140 |
| | 存储 | S2600F | 1 | 1 | 0 | 0 | 0 | 2 |
| | 数据库 | Oracle | 4 | 4 | 0 | 0 | 0 | 8 |
| | 双机软件 | VCS | 3 | 3 | 0 | 0 | 0 | 6 |
| | IVS 平台 | 基本包 | 1 | 1 | 0 | 0 | 0 | 2 |
| | IVS 平台 | 媒体包 | 2 | 3 | 0 | 0 | 0 | 5 |
| | IVS 平台 | PU 许可 | 13116 | 0 | 0 | 0 | 0 | 13116 |
| | IVS 平台 | GIS 许可 | 500 | 0 | 0 | 0 | 0 | 500 |
| | IVS 平台 | 智能分析许可 | 140 | 0 | 0 | 0 | 0 | 140 |
| L2CC | 服务器 | RH2285 | 20 | 40 | 40 | | | 100 |
| | 存储 | S2600F | 0 | 2 | 2 | | | 4 |
| | 数据库 | Oracle | 4 | 4 | 8 | | | 16 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 双机软件 | VCS | 2 | 4 | 4 | | | 10 |
| | IVS 平台 | 基本包 | 0 | 0 | 1 | | | 1 |
| | IVS 平台 | 媒体包 | 0 | 0 | 3 | | | 3 |
| | IVS 平台 | 许可 | 0 | 0 | 0 | | | 0 |
| | IVS 平台 | GIS 许可 | 0 | 0 | 0 | | | 0 |
| | IVS 平台 | 智能分析许可 | 160 | 0 | 0 | | | 160 |

## 9.5 Cloud Storage System

### 9.5.1 Design Principle

云存储系统为用户提供海量存储的手段，结合云存储技术，在专网专用的结构下可提供面向视频监控的存储服务和播放服务。云存储系统遵循的行业标准如下：

1) 基于以太网标准——IEEE 802.3
2) 基于快速以太网标准——IEEE 802.3u
3) 基于千兆位以太网标准——IEEE 802.3z
4) IEEE 标准测试接口和边界扫描结构——IEEE 1149.1-2001
5) 故障模式影响分析（FMEA）过程——IEC 812
6) 可靠性、维护性和可用性标准——IEC 863
7) 环保标准——ECMA TR/70
8) 洁净室及相关受控环境——ISO 14664-1 Class8
9) 气体污染物及环境标准——ANSI/ISA-71.04-1985 气体腐蚀等级 G1

### 9.5.2 Networking Scheme

云存储子系统数采用二级网络拓扑结构，构建存储网络，其网络拓扑图如下图所示。

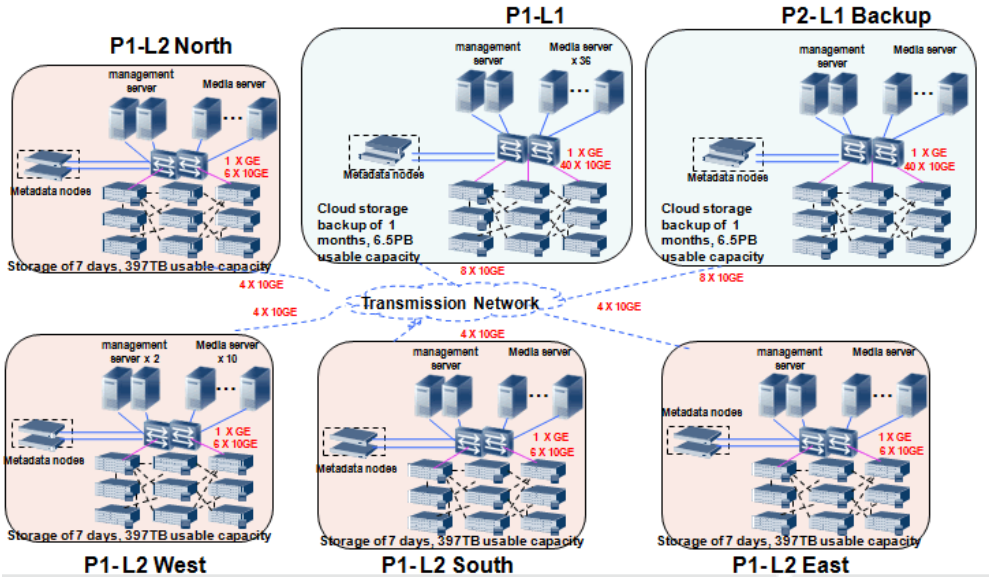



Figure 21 CSS architecture

每个 L2 监控中心内的 CSS 内部组网示意图如下：

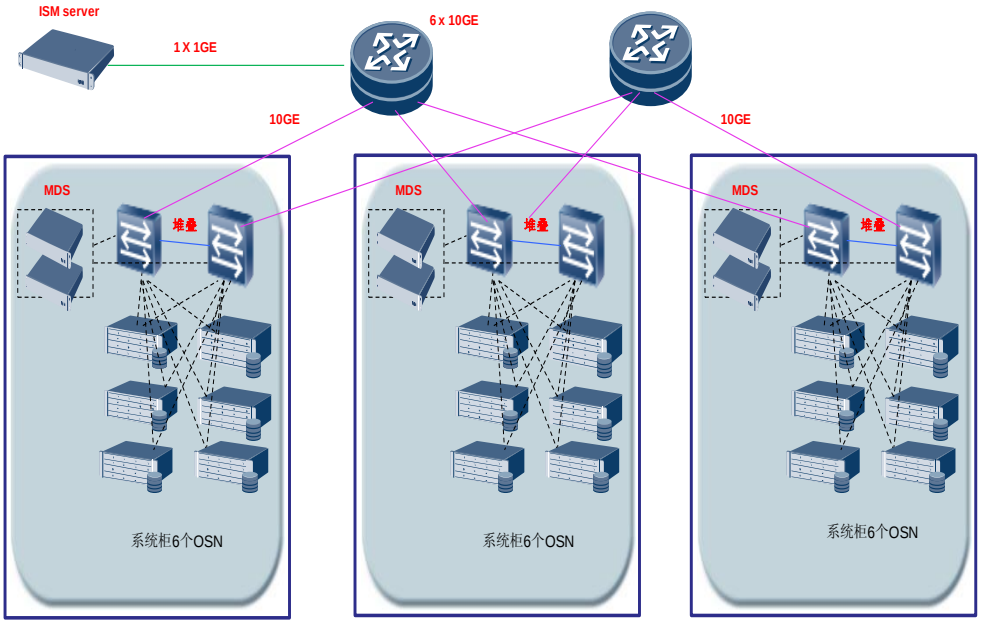



Figure 22 L2 CSS architecture

说明：各个 L2 数据指挥中心分别部署了 3 套 CSS 的 2+6 的域。

L1 指挥中心和 L1 备份指挥中心内的 CSS 内部组网示意图如下：

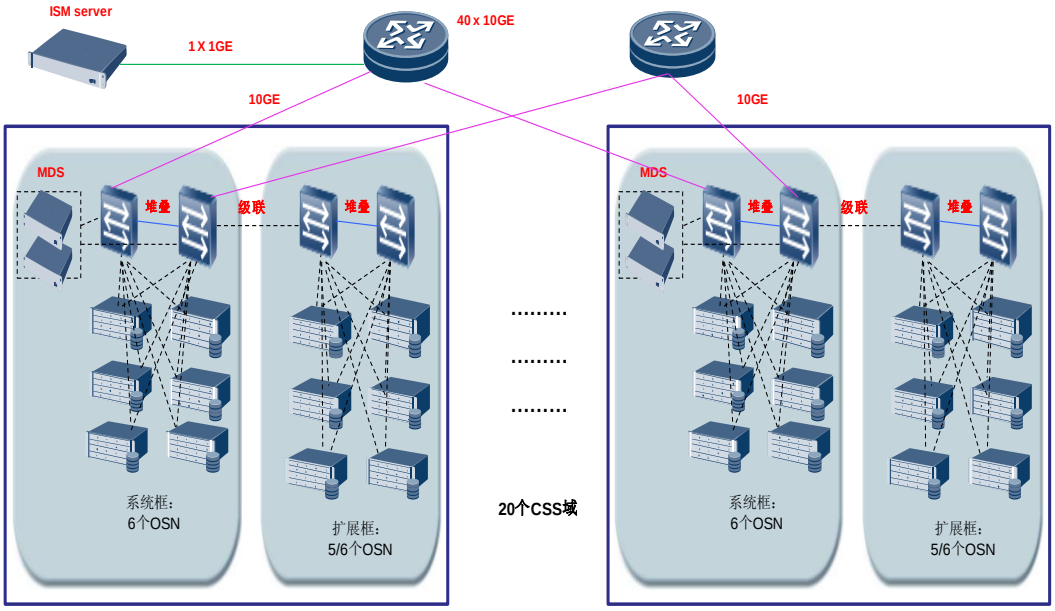



Figure 23 L1&L1 Backup CSS architecture

说明：L1 和 L1 备数据指挥中心分别部署了 20 套 CSS，5 个的 2+12 的域，15 个 2+11 的域。

### 9.5.3 Storage Scheme Design

#### 9.5.3.1 L1 Command Center

L1 层指挥中心容量和带宽：

1. 容量设计

L1 层指挥中心需要存储 13116 个摄像头 31 天的数据，因此，需要提供 6586.9TB 的有效存储空间(= 13,116 x 16.2GB x 31days)。

为了提供高质量的视频数据可靠性，内部采用 M:N= 9:2 的冗余比例来配置存储节点，并且为整个项目预留 10%的预留空间，为系统的故障硬盘提供预留空间。

因此 L1 层指挥中心需要提供总容量为：

9890TB（=13,116 x 16.2GB x 31days / 74%利用率 / 0.9 预留）

说明：按照 L1 存储容量及并发路数计算, 需要 20 个域,其中 15 个域有 11 个 OSN,5 个域有 12 个 OSN ；2. 按照 9:2 配置,在 11 个节点的情况下系统能够达到的磁盘利用率是最高的

9/9+2 （存储利用率：9 份数据/总数据）* 90%(元数据开销) = 74%

2. 带宽设计

每个摄像头码流是 1.5Mbps，共 13116 个摄像头，所以 L1 层指挥中心所需的实时写带宽需要：

大于 19.7Gbps (= 13,116 x 1.5Mbps ).

L1 到 L1 备份中心要进行准实时备份，需要 L1-L1 备的带宽只要满足：

大于 19.7Gbps (= 13,116 x 1.5Mbps ).

3. 并发数设计

L1 层指挥中心需要存储 13116 个摄像头的数据，即需要支撑 IVS 上层应用的 13116 路并发写请求。

IVS 回看或录像下载业务对应的读请求并发数单个 MU 最大支持 64 路并发。

L1 到 L1 备份中心要进行数据备份，每个 OSN 节点起一路读线程，L1 上总计 225 个节点，合计 225 路并发读请求。

#### 9.5.3.2 L1 Backup Command Center

L1 层指挥中心容量和带宽：

1. 容量设计

L1 层指挥中心需要存储 13116 个摄像头 31 天的数据，因此，需要提供 6586.9TB 的有效存储空间(= 13,116 x 16.2GB x 31days)。

为了提供高质量的视频数据可靠性，内部采用 M:N= 9:2 的冗余比例来配置存储节点，并且为整个项目预留 10%的预留空间，为系统的故障硬盘提供预留空间。

因此 L1 层指挥中心需要提供总容量为：

9890TB（=13,116 x 16.2GB x 31days / 74%利用率 / 0.9 预留）

2. 带宽设计

L1->L1 备，需要实时备份，需要带宽满足：

大于 19.7Gbps (= 13,116 x 1.5Mbps).

L1 备->L1，需要在 L1 故障恢复后，尽快将 L1 备份的数据恢复到 L1 上来，假定以 7 天完成所有的数据恢复为目标来计算带宽，6586.9TB 的数据完全恢复回来的带宽需要为：

87.1Gbps（= 6586.9 * 8 *1024 Gb / (7 * 24 * 3600)）

说明：L1 到 L1 备的网络部署，建议采用二层局域网部署，以提高 L1 到 L1 备的存储备份效率，带宽要求满足至少 80Gb。

3. 并发数设计

L1 备份每个 OSN 节点起一路写线程，L1 备上总计 225 个节点，合计 225 路并发写请求，在 L1 主存储故障，L1 备份进行数据恢复时，L1 备上总计有 225 个并发读请求。

#### 9.5.3.3 L2 South Command Center

L2 层指挥中心容量和带宽：

1. 容量设计

L2 层指挥中心需要存储 3500 个摄像头 7 天的数据，因此，需要提供 396.9 TB 的有效存储空间(= 3500 x 16.2GB x 7days).。

为了提供高质量的视频数据可靠性，内部采用 M:N= 4:2 的冗余比例来配置存储节点，并且为整个项目预留 10%的预留空间，为系统的故障硬盘提供预留空间。

因此 L2 层指挥中心需要提供总容量为：

735TB（=3500 x 16.2GB x 7days / 60%利用率 / 0.9 预留）

2. 带宽设计

每个摄像头码流是 1.5Mbps，L2 层指挥中心所需写带宽需要：

大于 10.4Gbps (= 3500 x 1.5Mbps x2 ).

假定每天有 6 个小时需要读 1%的存储数据读，则读带宽需要：

大于 1.47Gbps (= 396.9TB x 1% / 6 / 3600s x 8)

3. 并发数设计

L2 层指挥中心需要存储 3500 个摄像头的数据，即需要支撑 IVS 上层应用的 3500 路并发写请求。

IVS 回看或录像下载业务对应的读请求并发数单个 MU 最大支持 64 路并发。

按照 L2 存储容量及并发路数计算, 需要 3 个域,每个域 6 个 OSN；按照 4:2 配置,在 6 个节点的情况下系统能够达到的磁盘利用率是最高的

4/4+2 （存储利用率：4 份数据/总数据）* 90%(元数据开销) = 60%

#### 9.5.3.4 L2 North Command Center

L2 层指挥中心容量和带宽：

1. 容量设计

L2 层指挥中心需要存储 3500 个摄像头 7 天的数据，因此，需要提供 396.9 TB 的有效存储空间(= 3500 x 16.2GB x 7days).。

为了提供高质量的视频数据可靠性，内部采用 M:N= 4:2 的冗余比例来配置存储节点，并且为整个项目预留 10%的预留空间，为系统的故障硬盘提供预留空间。

因此 L2 层指挥中心需要提供总容量为：

735TB（=3500 x 16.2GB x 7days / 60%利用率 / 0.9 预留）

2. 带宽设计

每个摄像头码流是 1.5Mbps，L1 层指挥中心所需带宽需要：

大于 10.4Gbps (= 3500 x 1.5Mbps x2 ).

假定每天有 6 个小时需要读 1%的存储数据读，则读带宽需要：

大于 1.47Gbps (= 396.9TB x 1% / 6 / 3600s x 8)

3. 并发数设计

L2 层指挥中心需要存储 3500 个摄像头的数据，即需要支撑 IVS 上层应用的 3500 路并发写请求。

IVS 回看或录像下载业务对应的读请求并发数单个 MU 最大支持 64 路并发。

#### 9.5.3.5 L2 West Command Center

L2 层指挥中心容量和带宽：

1. 容量设计

L2 层指挥中心需要存储 3500 个摄像头 7 天的数据，因此，需要提供 396.9 TB 的有效存储空间(= 3500 x 16.2GB x 7days).。

为了提供高质量的视频数据可靠性，内部采用 M:N= 4:2 的冗余比例来配置存储节点，并且为整个项目预留 10%的预留空间，为系统的故障硬盘提供预留空间。

因此 L2 层指挥中心需要提供总容量为：

735TB（=3500 x 16.2GB x 7days / 60%利用率 / 0.9 预留）

2. 带宽设计

每个摄像头码流是 1.5Mbps，L1 层指挥中心所需带宽需要：

大于 10.4Gbps (= 3500 x 1.5Mbps x2 ).

假定每天有 6 个小时需要读 1%的存储数据读，则读带宽需要：

大于 1.47Gbps (= 396.9TB x 1% / 6 / 3600s x 8)

3. 并发数设计

L2 层指挥中心需要存储 3500 个摄像头的数据，即需要支撑 IVS 上层应用的 3500 路并发写请求。

IVS 回看或录像下载业务对应的读请求并发数单个 MU 最大支持 64 路并发。

#### 9.5.3.6 L2 East Command Center

L2 层指挥中心容量和带宽：

1. 容量设计

L2 层指挥中心需要存储 3500 个摄像头 7 天的数据，因此，需要提供 396.9 TB 的有效存储空间(= 3500 x

16.2GB x 7days).。

为了提供高质量的视频数据可靠性，内部采用 M:N= 4:2 的冗余比例来配置存储节点，并且为整个项目预留 10%的预留空间，为系统的故障硬盘提供预留空间。

因此 L2 层指挥中心需要提供总容量为：

735TB（=3500 x 16.2GB x 7days / 60%利用率 / 0.9 预留）

2. 带宽设计

每个摄像头码流是 1.5Mbps，L1 层指挥中心所需带宽需要：

大于 10.4Gbps (= 3500 x 1.5Mbps x2 ).

假定每天有 6 个小时需要读 1%的存储数据读，则读带宽需要：

大于 1.47Gbps (= 396.9TB x 1% / 6 / 3600s x 8)

3. 并发数设计

L2 层指挥中心需要存储 3500 个摄像头的数据，即需要支撑 IVS 上层应用的 3500 路并发写请求。

IVS 回看或录像下载业务对应的读请求并发数单个 MU 最大支持 64 路并发。

汇总如下：

| 数据中心名称 | 视频监控存储时间 | 容量 | 类型 | 配置 | 带宽要求 |
|---|---|---|---|---|---|
| L1 指挥中心 | 1 months | 6.5 PB | online | 40 Racks | 80Gb |
| L1 备份指挥中心 | 1 months | 6.5 PB | Backup | 40 Racks | 80Gb |
| L2 南指挥中心 | 7 days | 397 TB | online | 3Racks | 20Gb |
| L2 北指挥中心 | 7 days | 397 TB | online | 3 Racks | 20Gb |
| L2 东指挥中心 | 7 days | 397TB | online | 3Racks | 20Gb |
| L2 西指挥中心 | 7 days | 397 TB | online | 3 Racks | 20Gb |

### 9.5.4 IP Address Design

#### 9.5.4.1 L1 Command Center

VLAN1：306 个内网业务 IP + 266 个内网 IPMI 管理 IP

说明：L1 有 20 个域共 265 个节点，每个节点都需要有一个内网 IP 对外通信，每个机柜的交换机上要配置一个内网 IP 用做第三方节点，即 20 个域共 40 个交换机 IP，合计共 306 个内网业务 IP 地址。另外，每个节点都需要有一个 IPMI 管理 IP，即 266 个 IPMI 管理 IP。

VLAN2：1 个管理 IP（管理网络）

私网：192.168.X.X 、 128.20.X.X 、128.10.X.X

#### 9.5.4.2 L1 Backup Command Center

VLAN1：306 个内网业务 IP + 266 个内网 IPMI 管理 IP

说明：L1 有 20 个域共 265 个节点，每个节点都需要有一个内网 IP 对外通信，每个机柜的交换机上要配置一个内网 IP 用做第三方节点，即 20 个域，每个域都有一个系统柜和一个扩展柜，共需 40 个交换机 IP，合计共 306 个内网业务 IP 地址，另外，每个节点都需要有一个 IPMI 管理 IP，即 266 个 IPMI 管理 IP。

VLAN2：1 个管理 IP（管理网络）

私网：192.168.X.X 、 128.20.X.X 、128.10.X.X

#### 9.5.4.3 L2 South Command Center

VLAN1：28 个内网业务 IP + 25 个内网 IPMI 管理 IP

说明：L2 有 3 个域共 25 个节点，每个节点都需要有一个内网 IP 对外通信，每个机柜的交换机上要配置一个内网 IP 用做第三方节点，即 3 个域共 3 个系统柜，共需要 3 个交换机 IP，合计共 28 个内网业务 IP 地址，另外，每个节点都需要有一个 IPMI 管理 IP，即 25 个 IPMI 管理 IP。

VLAN2：1 个管理 IP（管理网络）

私网：192.168.X.X 、 128.20.X.X 、128.10.X.X

#### 9.5.4.4 L2 North Command Center

VLAN1：28 个内网业务 IP + 25 个内网 IPMI 管理 IP

说明：L2 有 3 个域共 25 个节点，每个节点都需要有一个内网 IP 对外通信，每个机柜的交换机上要配置一个内网 IP 用做第三方节点，即 3 个域共 3 个系统柜，共需要 3 个交换机 IP，合计共 28 个内网业务 IP 地址，另外，每个节点都需要有一个 IPMI 管理 IP，即 25 个 IPMI 管理 IP。

VLAN2：1 个管理 IP（管理网络）

私网：192.168.X.X 、 128.20.X.X 、128.10.X.X

#### 9.5.4.5 L2 East Command Center

VLAN1：28 个内网业务 IP + 25 个内网 IPMI 管理 IP

说明：L2 有 3 个域共 25 个节点，每个节点都需要有一个内网 IP 对外通信，每个机柜的交换机上要配置一个内网 IP 用做第三方节点，即 3 个域共 3 个系统柜，共需要 3 个交换机 IP，合计共 28 个内网业务 IP 地址，另外，每个节点都需要有一个 IPMI 管理 IP，即 25 个 IPMI 管理 IP。

VLAN2：1 个管理 IP（管理网络）

私网：192.168.X.X 、 128.20.X.X 、128.10.X.X

#### 9.5.4.6 L2 West Command Center

VLAN1：28 个内网业务 IP + 25 个内网 IPMI 管理 IP

说明：L2 有 3 个域共 25 个节点，每个节点都需要有一个内网 IP 对外通信，每个机柜的交换机上要配置一个内网 IP 用做第三方节点，即 3 个域共 3 个系统柜，共需要 3 个交换机 IP，合计共 28 个内网业务 IP 地址，另外，每个节点都需要有一个 IPMI 管理 IP，即 25 个 IPMI 管理 IP。

VLAN2：1 个管理 IP（管理网络）

私网：192.168.X.X 、 128.20.X.X 、128.10.X.X

### 9.5.5 Port Design for Aggregation Switch

1. P1-L1 指挥中心
   数据流网段：40 个 10G 光口（汇聚层）
   管理流网段：1 个 1G 以太口（管理网络）
   光模块（多模）：160 个
2. P2-L1 备份指挥中心
   数据流网段：40 个 10G 光口（汇聚层）
   管理流网段：1 个 1G 以太口（管理网络）
   光模块（多模）：160 个
3. P1-L2 南指挥中心
   数据流网段：6 个 10G 光口（汇聚层）
   管理流网段：1 个 1G 以太口（管理网络）
   光模块（多模）：12 个
4. P1-L2 北指挥中心
   数据流网段：6 个 10G 光口（汇聚层）
   管理流网段：1 个 1G 以太口（管理网络）

光模块（多模）：12 个

5. P2-L2 东指挥中心

数据流网段：6 个 10G 光口（汇聚层）

管理流网段：1 个 1G 以太口（管理网络）

光模块（多模）：12 个

6. P2-L2 西指挥中心

数据流网段：6 个 10G 光口（汇聚层）

管理流网段：1 个 1G 以太口（管理网络）

光模块（多模）：12 个

### 9.5.6 Key Technology Parameters

CloudStor CSS 的软硬件规格如下：

Table 11 CSS System Hardware Specifications

| | MDS 规格 | OSN 高性能版本规格 | OSN 标准版本规格 |
|---|---|---|---|
| 基本特性 | 2U/12 bay | 4U/ 24 bay | 4U/ 24 bay |
| CPU 数量及类型 | 2 个 Inter 至强 E5504CPU | 2 个 Inter 至强 E5504 CPU | 1 个 Inter 至强 E5504 CPU |
| 内存 | 8*4GB 共 32GB 内存 | 8*4GB 共 3GB 内存 | 4*4GB 共 16GB 内存 |
| 硬盘类型及数量 | 2 个 300GB SAS 硬盘<br>2～10 个 100GB SSD 硬盘 | 2 个 300GB SAS 硬盘<br>22 个 1/2/3 TB SATA 硬盘 | 2 个 300GB SAS 硬盘<br>22 个 1/2/3 TB SATA 硬盘 |
| 以太网口 | 至 6 个 GE 业务端口 | | |
| 其它 IO 接口 | 1*VGA, 2* USB 2.0, 1 * serial | | |
| 其他可靠性组件 | 冗余电源，冗余风扇，支持热插拔 | | |
| 尺寸 | 高*宽*深<br>=2U(86.1mm)*446mm*685mm | 高*宽*深=4U(175mm)*446mm*685mm | |

Table 12 CSS Softwore specifications

| 描述 | 规格内容 |
|---|---|
| 协议支持 | POSIX、NFS、CIFS |
| 最大节点/单域 | 每个域最大可支持 24 个存储节点（2 个 MDS，22 个 OSN） |
| 最大域数 | 系统支持的最大域数为 128 个 |
| 文件大小 | 单个文件大小最大为 2TB |

| | |
|---|---|
| 文件数 | 每个域最多支持 12 亿级文件 |
| 负载均衡 | 支持存储节点间及存储节点内负载均衡 |
| 架构 | 采用基于对象存储的分布式架构 |
| 恢复时间 | 1TB 数据恢复时间小于 8 小时 |
| MDS Active-Standby | 支持域内 MDS Active-Standby 方式 |
| 切换时间 | MDS 主备切换时间少于 60 秒 |
| 状态监控 | 支持系统总体和各节点设备的运行状况监控 |
| 性能监控 | 支持系统性能，包括 IO 性能的监控 |
| 资源监控 | 支持系统资源的动态跟踪（包括磁盘空间、CPU、内存、网络流量、文件系统） |
| 故障定位 | 支持软硬件的故障定位功能 |
| 远程告警 | 支持多种方式的远程告警，包括短信告警、邮件告警 |
| 用户管理 | 支持三种级别网管用户（超级管理员用户、管理员用户和普通用户）；支持用户分权分域管理 |
| 在线升级 | 支持在线升级；升级不影响系统配置和日志、告警、用户保存的数据 |
| 同步升级 | 支持在线帮助与软件的同步升级 |
| 自动部署 | 支持自动化部署配置 |
| CPU 降频 | 支持根据业务量进行自动的 CPU 降频(管理开关) |

### 9.5.7 Equipments Configuration

云存储配置的设备及其数量汇总如下；

Table 13 Device Number

| 站点 | 设备 | 型号 | 数量 |
|---|---|---|---|
| P1-L1 指挥中心 | CSS | MDS | 40 |
| | | OSN | 225 |
| | | ISM | 1 |
| | | SSD | 80 |
| | | 交流存储系统柜 | 20 |
| | | 交流存储扩展柜 | 20 |
| | | 光模块（多模） | 160 |
| P1-L2 南指挥中心 | CSS | MDS | 6 |

| | | | |
|---|---|---|---|
| | | OSN | 18 |
| | | ISM | 1 |
| | | SSD | 18 |
| | | 交流存储系统柜 | 3 |
| P1-L2 北指挥中心 | CSS | MDS | 6 |
| | | OSN | 18 |
| | | ISM | 1 |
| | | SSD | 18 |
| | | 交流存储系统柜 | 3 |
| | | 光模块（多模） | 12 |
| P2-L1 备份指挥中心 | CSS | MDS | 40 |
| | | OSN | 225 |
| | | ISM | 1 |
| | | SSD | 80 |
| | | 交流存储系统柜 | 20 |
| | | 交流存储扩展柜 | 20 |
| | | 光模块（多模） | 160 |
| P2-L2 东指挥中心 | CSS | MDS | 6 |
| | | OSN | 18 |
| | | ISM | 1 |
| | | SSD | 18 |
| | | 交流存储系统柜 | 3 |
| | | 光模块（多模） | 12 |
| P2-L2 西指挥中心 | CSS | MDS | 6 |
| | | OSN | 18 |
| | | ISM | 1 |

| | | | |
|---|---|---|---|
| | | SSD | 18 |
| | | 交流存储系统柜 | 3 |
| | | 光模块（多模） | 12 |

### 9.5.8 Features and Highlights

1. 可靠性

CloudStor CSS 采用是电信级可靠性理念设计，可靠性高达 99.999%，具体可靠性设计如下：

存储网络冗余设计

业务服务器通过以太网绑定方式接入 IP 网络，云存储内部交换模块具备电信级可靠性,且与用户 IP 环境组成双交换网络,通过 IP 协议确保任何一个网络端口、网络交换模块（如：交换机）、网络链路发生故障，业务系统依然能够正常访问 CloudStor CSS 中的数据，从而保证系统可靠性。

云存储系统硬件可靠性

CloudStor CSS 云存储节点采用电信级硬件，有效的提高系统的可靠性，使用的可靠性技术包括：

多 BIOS 设计，任何一个 BIOS 离线或故障，其余的 BIOS 将接管服务，对外业务不中断，从而使得硬件和 Fireware 支持在线升级；

风扇采用 2+1 冗余，支持热插拔、自动调速；电源采用 1+1 冗余。节点内热敏位置都布置了温度监控部件，通过这些部件实时监控系统中各个产生热敏位置的温度，根据温度的高低平滑的调控风扇转速。

可以有效防止系统过热，造成不稳定；

风扇无须时刻都工作在高转速状态，降低风扇的故障率和能耗；

有效减少灰尘的进入、提高了系统的可靠性；

云存储系统可靠性

分布式对象 RAID

分布式对象 RAID 是在 Esasure code 冗余技术的基础上自主研发的一项分布式可靠性技术，是传统 RAID 的超集，能够支持比传统 RAID 算法更高的可靠性和更灵活的冗余策略，其设计思路是对文件进行原始分片（M 份），通过纠错编码生成 N 个冗余校验块文件。写入时，由客户端进行切片（M）和转码（N），系统自动从各存储节点中选择一个硬盘组成一个 M+N 个磁盘的磁盘组，分别写入 M+N 份数据，同时损坏 N 份数据保证数据不丢失，极大的保证系统业务的连续性。分布式 RAID 的技术优势主要体现在以下几个方面：

- 强大的数据冗余性

更加灵活的冗余方式，N+1，N+2，N+3，强于传统的 RAID5、RAID6，为用户的数据存储提供更大的安全保障。

- 更高的读写高性能

独特的算法和软件实现，保证系统最大磁盘的并行读取，提供更高的性能体验，实现更快的访问速度。

- 效率极高的数据恢复能力

分布式 RAID 数据重构完成后不会回拷回原来槽位更换后的磁盘，而是智能的在整个系统中选择空闲空间来存储校验后的切片文件，效率比 RAID 的重构回拷方式更优。

2. 高性能

- 高带宽设计

CloudStor CSS 云存储系统内部采用 GE 网络绑定技术，每个节点最多提供 4*GE 的网络带宽，内部交换模块支持 GE 和 10GE 两种上行网络接口，对业务系统提供数十 GE 的网络带宽，满足海量日志存储对带宽的需求。

- 智能预取

CloudStor CSS 云存储系统采用智能预取技术，智能识别业务系统对数据访问的特点，预测出即将读取的元数据和内容数据，提高系统 Cache 命中，从而提高系统性能。

3. 可扩展性

CloudStor CSS 云存储系统提供 Scale-out 方式进行扩容，对上层提供透明的存储服务，屏蔽底层的硬件差异，使得云存储系统扩容对业务完全透明。

- 系统扩展性

CSS 云存储系统采用 Scale-out 方式扩容：每个云存储节点都具备一定的 CPU、内存、磁盘，且 CPU/内存/磁盘比基本相同，因此在增加存储节点时，整个系统硬件的 CPU/内存/磁盘比保持稳定，从硬件层面提供了 Scale-out 的能力；整个系统在软件层面通过统一的资源和 IO 调度，使得新接入的存储节点能够与已有的节点共同、并发的为上层业务提供存储服务。因此 CSS 云存储系扩容能够保证容量与性能的线性增长。

CloudStor CSS 云存储系统扩容时，不但只增加了磁盘空间，同时扩展了 CPU、内存、网络端口等各种硬件资源。CSS 云存储系统通过软件协调大量的存储节点并发对外提供服务，从而使得系统在扩展了存储容量的同时提升存储系统的性能。

- 网络可扩展性

CSS 云存储系统组网使用以太网方式连接各个存储节点，以太网是目前使用最广的一种组网形式，具有成本低、扩展性好、易维护等多种优势。CSS 云存储系统默认使用华为 S5300 系列、S9300 系列千兆以太网交换机。网络层面可通过堆叠，组合，汇聚以太网方式完成超大规模存储系统的建设，满足系统 10PB 级扩展对网络的要求。

- 业务透明

CSS 云存储系统采用特有的基于对象的虚拟化技术，将底层的物理资源与上层的业务解耦，上层业务透过 CSS 云存储系统的 CA/MDS 看到的只有已经池化的逻辑存储资源。CSS 云存储系统在增加存储节点时，自动的识别和管理新接入节点，整个系统无需停机或重启，系统扩容对业务完全透明。

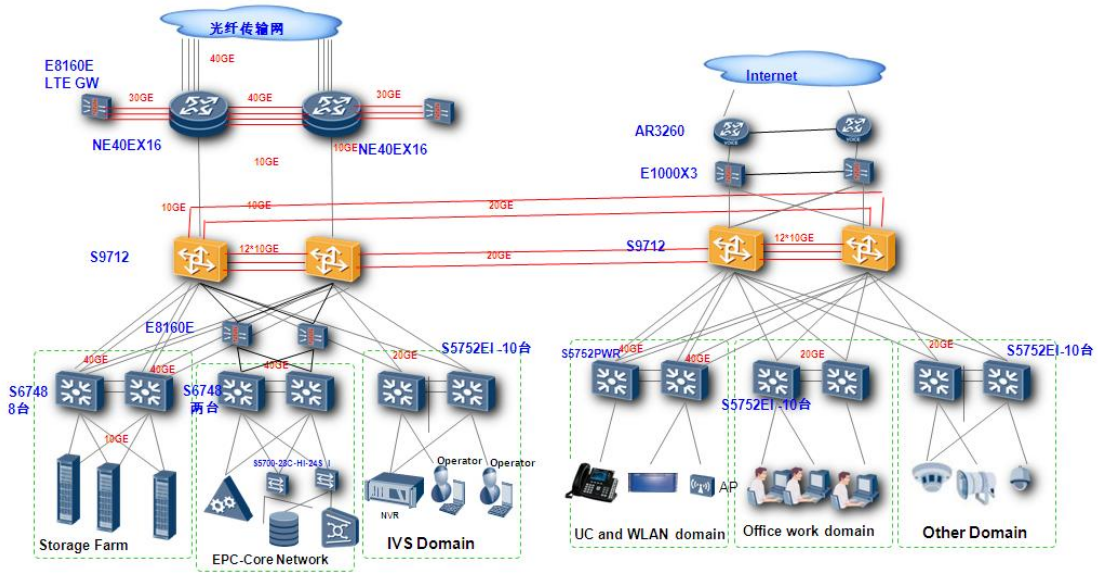
- 100PB 级容量

CSS 云存储系统采用非对称分布式架构，有效的改善了传统对称分布式各节点间的复杂的通信和数据同步过程，使得系统扩展上限极大提高，目前 CSS 云存储系统最大支持 185PB 存储容量。

# 10 End to end Security System Design

## 10.1 Networking Scheme

### 10.1.1 Firewall Solution Overview

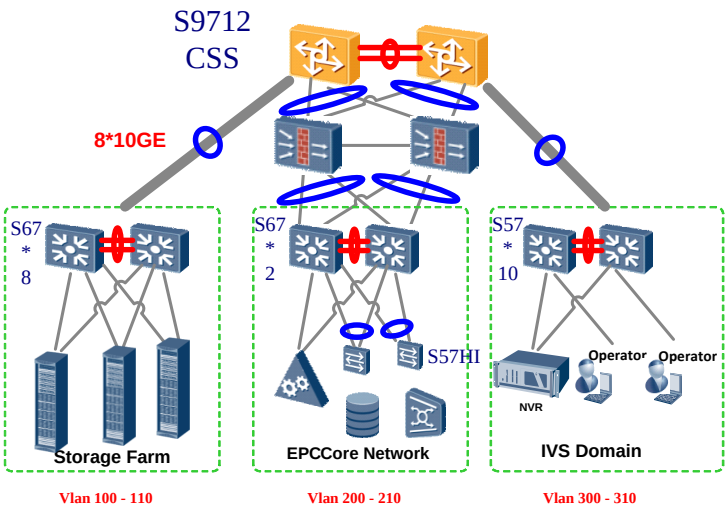



E8160E 分别在 L1 和 L2 South 以双机热备方式侧挂部署在核心路由器上做 LTE 安全网关，与基站建立 IPSec 连接，传输业务流量，保证业务的安全性，两台 E8160E LTE 网关运行在主备方式，并且每台 E8160E 与核心路由器 NE40E-X16 通过三个 10GE 光口互联。

同时在 L1 和 L2 South 核心网出口 E8160E 以双机热备方式做安全防护，E8160E 与上行两台堆叠的 S9712 分别通过 2 个 10GE 光接口互连，与下行两台堆叠的 S6748 分别通过 2 个 10GE 光接口互连，进行核心网设备的安全防护。

E1000E-X3 部署在 L1 和 L2 Command Center 的 internet 出口位置，启用防火墙攻击防范以及访问控制和 IPS 功能，抵御外来的各种攻击，E1000E-X3 与上行 AR 路由器通过 1 个 1GE 光接口互联，同时与下行两台堆叠的 S9712 分别通过 2 个 10GE 光接口互连。

### 10.1.2 E8160E Deployment Scheme for Core Network




E8160E 部署在核心网出口，采用路由方式，以主备方式直入部署在 S67 和 S97 交换机之间，S67 和 S97 采用堆叠方式，各采用两个 10GE 接口和 E8160E 相连，上下行两个 10GE 接口分别用 eth-trunk 进行静态捆绑，上行 S97 和下行 S67 是二层透明桥接模式，防火墙运行在三层路由模式，和上行 NE40E-X16 运行 OSPF 路由。

1. E8160E 路由设计

E8160E 和上行核心路由器 NE40E-X16 之间，推荐运行 OSPF 路由协议，能够满足 internet 出口流量的快速增长，并对未来扩展性提供了便利。

OSPF 参数规划:

| Network | OSPF Area |
|---|---|
| P1-L1 Intranet | 1 |
| P1-L2-South | 4 |

OSPF Instance planning:

Use OSPF instance 1as Network IGP instance.

Link Cost Planning:

Set OSPF link cost as 10 by default.

Link type Design:

p2p

Authentication Design:

OSPF enables security authentication, and the MD5 password is *W City-Huawei*..

Timers:

OSPF Parameters Table

| Parameter | Value |
|---|---|
| Hello Interval | 10 s |

| | |
|---|---|
| Dead Interval | 40 s |
| ospf timer retransmit interval LSA | 5 s |
| lsa-arrival-interval | 0 s |
| lsa-originate-interval | 0 s |
| ospf trans-delay interval | 1 s |
| spf-schedule-interval | 1 s |

2. E8160E 开启 DDOS 防攻击功能

E8160E 可以支持以下 DDos 攻击:

Attack defense function

- DNS flood attack
- ICMP flood attack
- SYN flood attack
- TCP flood attack
- UDP flood attack

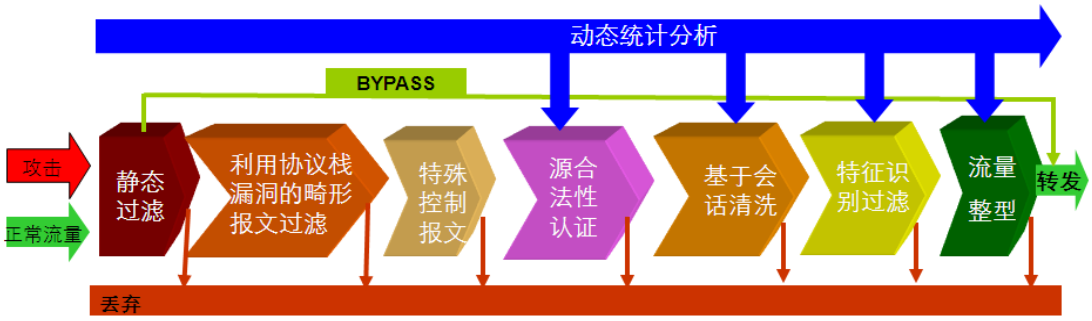
Scanning attack defense function

- IP sweep
- Port scan

Other

- Fraggle attack
- ICMP redirect attack
- ICMP unreachable attack
- IP Fragment attack
- IP Spoofing attack
- LAND attack
- Large ICMP attack
- PING of death attack
- Route Record attack
- SMURF attack
- Source Route defense
- TCP Flag attack
- Teardrop attack
- Time Stamp attack
- Tracert defense
- Winnuke attack

DDOS 工作流程：




第一步，静态过滤技术：直接丢弃位于黑名单的 IP 发出的流量，或者直接让位于白名单的 IP 发出的流量 bypass；

第二步，单包攻击过滤：过滤掉利用协议栈漏洞的畸形报文攻击和特殊控制报文过滤；

第三步，认证源合法性：基于应用认证源的合法性，防范虚假源或工具发出的攻击流量，在此步骤之前基本由清洗中心代理服务器和客户端完成会话，确保在应用认证通过之前，连接不会透到后端服务器；

第四步，基于会话清洗：基于会话清洗并发或新建或异常连接超过阈值的连接耗尽类攻击；

第五步，指纹学习：主要靠指纹学习技术防范僵尸工具或通过代理发起的攻击流量，以区别正常用户的访问行为；

第六步，流量整形：在流量经过此前各步过滤之后，流量依然很大，超过用户实际带宽，此时采用流量整形技术，确保用户网络带宽可用；

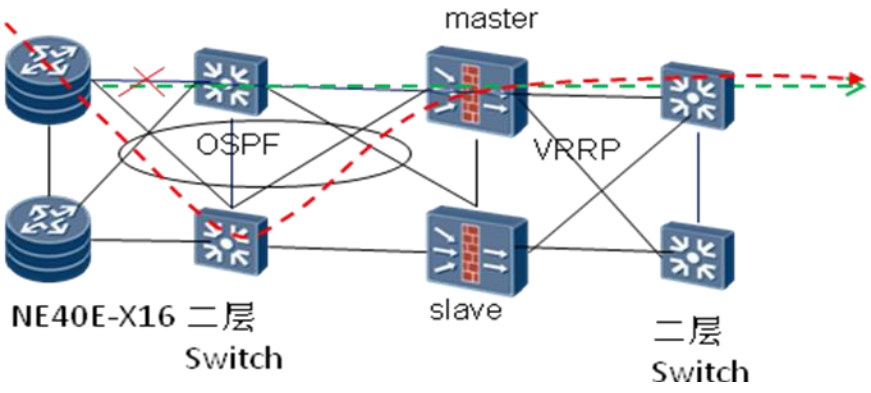
3. E8160E 安全防护功能

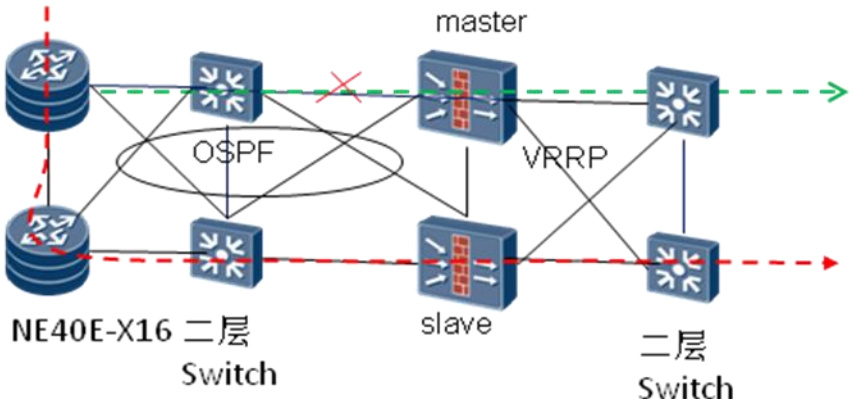
建议 Command Center 端网络划分到高安全级别的安全域，internet 端网络划分到低级别安全域，域间采取严格的包过滤策略。防火墙只能允许匹配到安全策略的 IP 从外网向内网的访问。包过滤作为一种网络安全保护机制，用于控制在两个相同或不同安全级别网络之间数据的流入和流出，是 E8160E 安全功能的重要组成部分。

对于需要转发的报文，E8160E 先获取报文头信息，包括报文的源 IP 地址、目的 IP 地址、IP 层所承载的上层协议的协议类型、源端口号和目的端口号等，然后和预先设定的过滤规则进行匹配，并根据匹配结果对报文采取转发或丢弃处理。

为了实现包过滤功能，需要配置一系列的过滤规则。E8160E 采用 ACL 定义过滤规则，然后将 ACL 应用于相同的安全区域或不同安全区域之间，当报文流动时，包过滤功能生效。

4. 可靠性方案





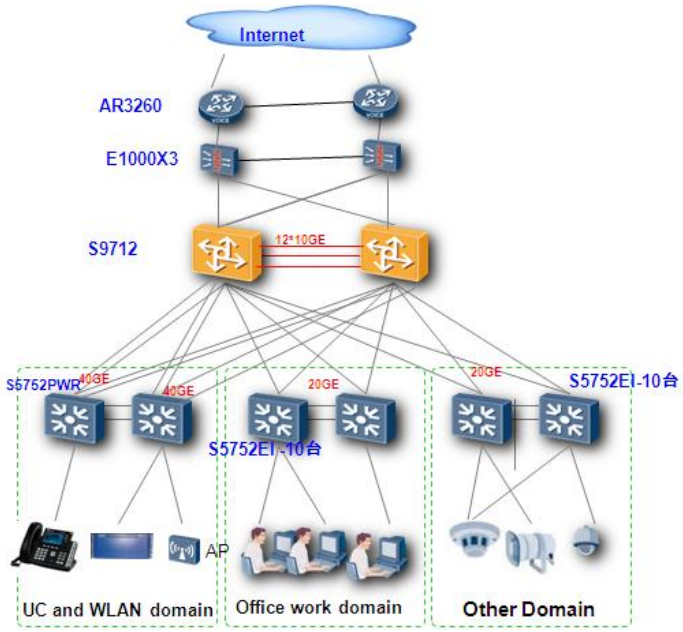

防火墙需要和 NE40E-X16 路由器之间运行 OSPF 协议，防火墙对 S67 交换机一侧起 VRRP 协议，使 VRRP 虚地址作为交换机下面设备的下一跳地址来保证报文转发到主防火墙上。

E8160E 形成主备组网，在防火墙的上下行路由器上对特定的链路调整 COST 值，保证业务都从同一边的路由器上转发，或者是在防火墙上配置根据 HRP 状态调整 OSPF 路由的 COST 值的命令，使备防火墙发布路由的时候增大 COST，保证业务在同一边的路由器上转发，同时防火墙上配置一个 VGMP，把所有的接口上的 VRRP 加入到同一个 VGMP 组中。

主备两台防火墙之间的状态同步选择多个链路作为心跳链路。但是为了避免链路拥塞导致的心跳报文丢失，建议采用专线作为心跳线。确保不会出现双主的情况。

上下行接口配置 link-group，作用是保证起 VRRP 的接口 down 的时候，OSPF 的邻居必须 down，否则会出现环路；默认路由的下一跳必须指定出接口是因为保证默认路由能真正失效。

### 10.1.3 E1000E Deployment Scheme for Internet



E1000E 部署在互联网出口，采用路由模式，一主一备直入部署在 S97 和 AR 路由器之间，S97 采用堆叠方式，各采用两个 10GE 接口和 E1000E 相连，AR 各采用一个 GE 接口与 E1000E 互连，和上下行都运行 OSPF 路由。

1. E1000E-X3路由设计

E1000E-X3 和上下行三层路由器或者三层交换机之间，推荐运行 OSPF 路由协议，能够满足 internet 出口流量的快速增长，并对未来扩展性提供了便利。

OSPF 参数规划:

| Network | OSPF Area |
|---|---|
| Command Center Inter-connection | 0 |
| P1-L1 Intranet | 1 |
| P1-L2-North | 2 |
| P2-L2-West | 3 |
| P1-L2-South | 4 |
| P2-L2-East | 5 |

OSPF Instance planning:

Use OSPF instance 1as Network IGP instance.

Link Cost Planning:

Set OSPF link cost as 10 by default.

Link type Design:

p2p

Authentication Design:

OSPF enables security authentication, and the MD5 password is *W City-Huawei*..

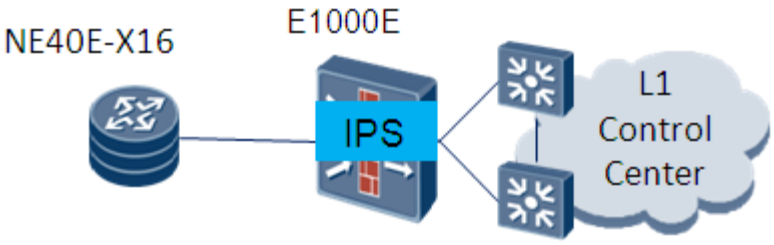
Timers:

OSPF Parameters Table

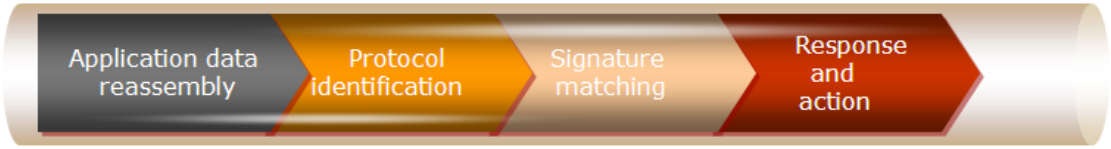
| Parameter | Value |
|---|---|
| Hello Interval | 10 s |
| Dead Interval | 40 s |
| ospf timer retransmit interval LSA | 5 s |
| lsa-arrival-interval | 0 s |
| lsa-originate-interval | 0 s |
| ospf trans-delay interval | 1 s |
| spf-schedule-interval | 1 s |

2. E1000E-X3开启 IPS 入侵防御

提供实时的入侵检测，进行报警及动态防护，有效识别应用层攻击，减少恶意流量的冲击；防范恶意软件如蠕虫、病毒、广告软件等，来自 Internet 的无授权访问，内部用户的安全违规，同时 IPS 提供事后审计功能，实时记录入侵事件。




IPS 工作流程：




- 应用层数据重组
  防火墙支持重组 IP 分片包和 TCP 流分组，保证应用层数据的连续性，防止网络攻击通过分片包方式逃避安全检测；
- 协议识别
  防火墙 IPS 功能与传统的基于端口的协议识别有很大区别，防火墙可以基于报文内容识别应用层协议，检测报文内容，从而提高检出率。
- 匹配特征库
  防火墙采取基于状态的匹配引擎，引擎针对报文内容与特征进行对比，只有匹配特征的报文才会被进一步处理。
- 检测动作
  防火墙根据预配置的策略和匹配后的检测动作，匹配 IPS 特征，特征匹配后，进行报文的丢弃，向用户发送告警等行为。

3. E1000E-X3开启 DDOS 防攻击功能， E1000E-X 可以支持以下 DDos 攻击

Attack defense function

- DNS flood attack
- ICMP flood attack
- SYN flood attack
- TCP flood attack
- UDP flood attack

Scanning attack defense function

- IP sweep
- Port scan

Other

- Fraggle attack
- ICMP redirect attack
- ICMP unreachable attack
- IP Fragment attack

- IP Spoofing attack
- LAND attack
- Large ICMP attack
- PING of death attack
- Route Record attack
- SMURF attack
- Source Route defense
- TCP Flag attack
- Teardrop attack
- Time Stamp attack
- Tracert defense
- Winnuke attack

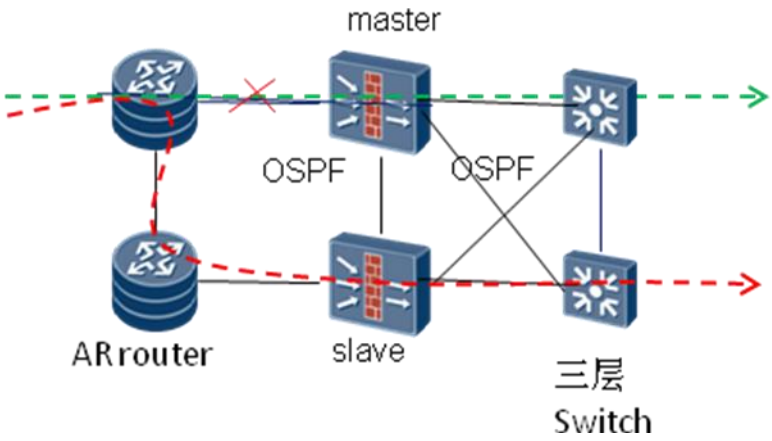
4. E1000E-X3安全防护功能

建议 Command Center 端网络划分到高安全级别的安全域，internet 端网络划分到低级别安全域，域间采取严格的包过滤策略。防火墙只能允许匹配到安全策略的 IP 从外网向内网的访问。包过滤作为一种网络安全保护机制，用于控制在两个相同或不同安全级别网络之间数据的流入和流出，是 E1000E-X3 安全功能的重要组成部分。

对于需要转发的报文， E1000E-X3 先获取报文头信息，包括报文的源 IP 地址、目的 IP 地址、IP 层所承载的上层协议的协议类型、源端口号和目的端口号等，然后和预先设定的过滤规则进行匹配，并根据匹配结果对报文采取转发或丢弃处理。

为了实现包过滤功能，需要配置一系列的过滤规则。E1000E-X3 采用 ACL 定义过滤规则，然后将 ACL 应用于相同的安全区域或不同安全区域之间，当报文流动时，包过滤功能生效。

5. 可靠性方案




防火墙与上行 AR 路由器和下行三层 S97 之间启动 OSPF 协议。

E1000E-X3 形成主备组网，可以在防火墙的上下行路由器上对特定的链路调整 COST 值，保证业务都从同一边的路由器上转发，或者是在防火墙上配置根据 HRP 状态调整 OSPF 路由的 COST 值的命令，使备防火墙发布路由的时候增大 COST，保证业务只在主防火墙上转发。

当 E1000E-X3 和 AR 之间的链路故障，防火墙发生主备倒换，E1000E-X3 备变成主防火墙，E1000E-X3 主变成备防火墙。

在防火墙发生主备倒换之后，E1000E-X3 主备都会更新自身的路由并对外发布路由，此时 E1000E-X3-1 为主，对外直接发布自身的路由，而 E1000E-X3-2 变成了备防火墙，对外发布路由的时候会另外加上一个 cost 值（默认是 65500），路由重新计算并收敛，业务都从 E1000E-X3-1

上走。此组网图中任何一个和防火墙相连的路由器的链路 down 或者是路由器故障，都会引发上述过程。

### 10.1.4 E8160E Deployment Scheme for LTE

IPSec 提供 IP 传输下的安全机制，用于保证传输的机密性、完整性和可用性。由于 IPSec 是对 IP 层提供的安全服务，因此上层协议，例如 TCP、UDP、ICMP、SCTP 等，都可以利用这些服务。

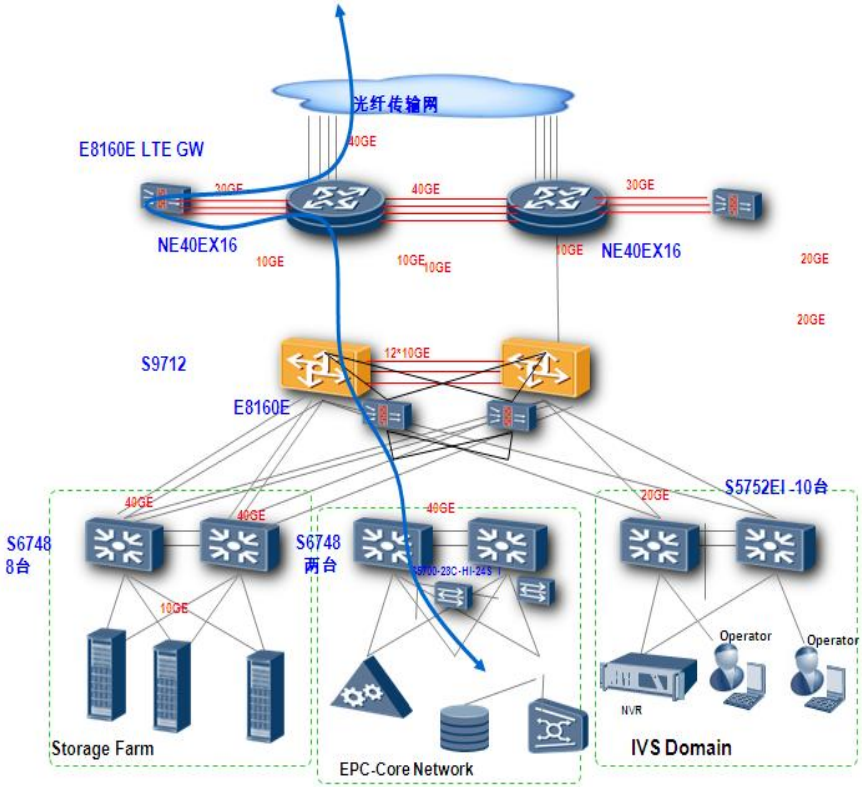
IPSec 是一个用于保障 IP 安全通信的协议框架族，为 IP 数据包的传输提供了高质量的、可互操作的、基于密码学的安全性。通信双方之间在 IP 层通过加密与完整性验证等方式，来保证数据包在网络上传输时具有以下安全特性：

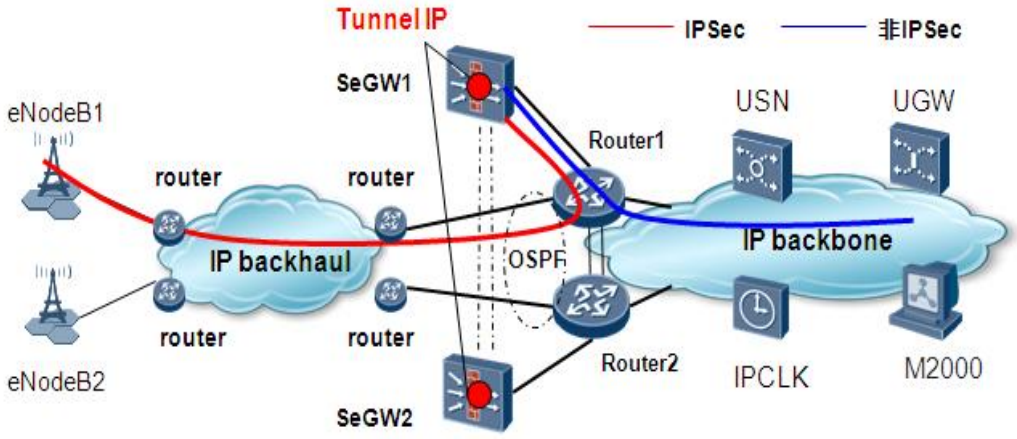
- 私有性——IPSec 双方在传输数据包之前将其加密，以密文的形式传输，保证数据的私有性。
- 完整性——IPSec 接收方对发送方发送来的数据包进行验证，以保证该数据包在传输过程中没有被窜改。
- 真实性——IPSec 接收方对 IPSec 包的源地址进行验证，以保证该数据真的是由声称的发送方发送来的。
- 防重放——IPSec 接收方可以检测和拒绝被重放的包，防止数据包被捕捉并重新投放到网上，以免受到攻击。

IPSec 是一个协议族，需要依赖多个协议完成 IPSec 隧道的建立，使用因特网密钥交换 IKE（Internet Key Exchange）协议来建立安全联盟，该协议建立在由 Internet 安全联盟和密钥管理协议 ISAKMP（Internet Security Association and Key Management Protocol）定义的框架上。

1. 部署方案

2 个安全网关采取一主一备的方式，侧挂在 NE40E-X16 上，和 NE40E-X16 运行 OSPF 协议，两个 SeGW 对外提供同一个 tunnel IP 作为 eNB 隧道终点的地址。eNB 和安全网关之间启用一个加密隧道承载所有的业务，包括 S1 和 OAM。流量从 eNB 到安全网关之间进行加密传输，根据承载面的路由进行转发。S1 和 OAM 的流量解密后在送往核心网。反方向，从核心网侧回来的流量在 SeGW 上进行加密后，转发给 eNB。




2. 认证方式

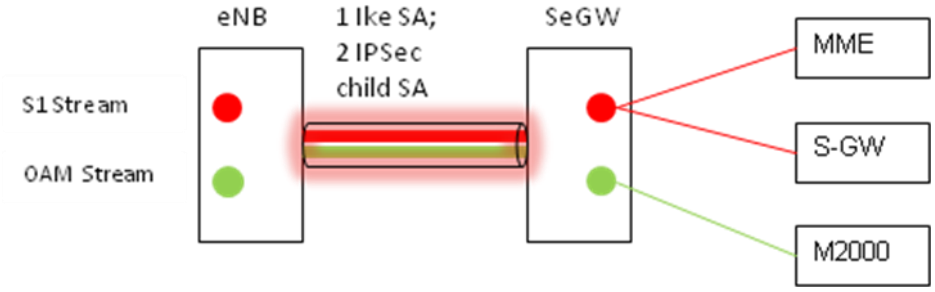
本项目认证方式采取：预共享密钥认证，Pre-Shared 密钥是 VPN 端点间共享一个密钥（字符串）的认证方法。

3. 加密方式

LTE 接入网络的主要传输数据有：

- S1 interface 数据，包括 S1 控制面（S1-C）和 S1 用户面（S1-U）数据；
- OAM，操作和维护数据

本项目加密方式为：基于接口 IP，端点之间共用一个 IKE SA，同时，根据不同业务 IP，协商多对 IPSec_Child_SA 对应不同的业务流量。




4. 路由设计

E8160E-1，E8160E-2 与两侧路由器 NE40E-X16 的直连口配置静态 OSPF cost，且 E8160E-1 接口的 cost 小于 E8160E-2 的 cost，使上下行路由器的下一跳优选 E8160E-1；

上行流量处理：eNB 到 ePC（MME/SGW/NMS…）的上行流量经过 NE40E-X16 -1 走 IPSec 隧道，隧道起点是 eNB 接口地址，终点是 E8160E-1 的 Tunnel-IP；IPSec 流量在 E8160E-1 解封装查路由转发给 NE40E-X16 -1， NE40E-X16 -1 转发到 ePC 设备；

下行流量处理：ePC（MME/SGW/NMS…）到 eNB 的下行流量，在 Backbone 侧出口路由下一跳优选 E8160E-1 接口地址，流量在 E8160E-1 通过策略控制需要加密的流量进 IPSec 隧道。

## 10.2 Reliability Design

链路捆绑方案

SeGW 目前支持 Eth-trunk 捆绑。

- Eth-trunk：将多个以太网端口捆绑为一个 Eth-Trunk 接口，Eth-Trunk 接口的总带宽是各成员带宽之和，通过这种方式，可以增加接口的带宽，可以实现负载分担。在 Eth-Trunk 接口中，如果某个成员端口状态为 Down，流量还能依靠其他的端口进行传输。

链路检测方案

SeGW 目前支持的链路检测方案有： BFD 检测。

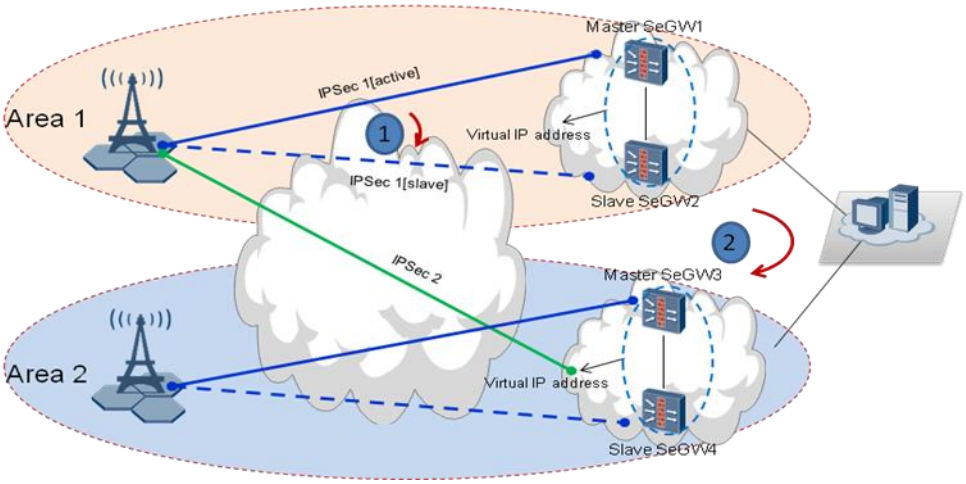
- BFD 检测：BFD 是一套全网统一的检测机制，属于标准协议，BDF 用于快速检测，采用 10ms 检测周期，探测级别可以达到毫秒级。

本地双机热备份方案

1. eNodeB 基站和对端2台主备工作的 SeGW 的 tunnel IP 建立 IPSec 隧道，正常情况下，Master SeGW 处理 IPSec 业务，Slave SeGW 处于备份状态，LTE 业务流量方向为：eNodeB<—>Master SeGW<—>EPC，Master SeGW 故障后，Slave SeGW 切换为主，LTE 业务流量方向为：eNodeB<—>Slave SeGW<—>EPC，双机主备发生切换，IPSec 业务可以平滑切换不受影响。
2. 2台防火墙与 NE40E-X16启用 OSPF 协议，eNB 与防火墙 tunnel ip 建立 IPSec 隧道，主备两台防火墙采用相同的 tunnel ip，当主用设备故障时，通过 OSPF 动态路由 cost 值调整，会切换到未故障设备。同时，启用 BFD 进行链路探测，路由快速收敛。OSPF 可与 BFD 绑定使用，当 BFD 链路探测出现异常时，可引起 OSPF 的切换。
3. 2台设备之间启用 HRP 协议进行 IPSec 的状态备份，HRP 与 OSPF 相关联，当 SeGW 进行切换时 HRP 的状态也随之切换，SeGW 由于做了状态备份，切换时，eNB 无感知。

异地可靠性方案

两组防火墙分别部署在两个核心网站点，一组部署在 L1,一组在 L2 south，eNB 分别和两组防火墙建立两个 IPSec 隧道。两组站点间的防火墙进行异地冷备，如果站点 1 的两台防火墙全部故障，那么 eNB 会自动把隧道 1 切换到隧道 2，保证业务流量不受到影响。




## 10.3 Equipments Configuration

The Huawei E8160E proposal fulfils the above RFP requirements and also provides the enough scalability required for future expansions:

Table 14 Equipment List for XX 项目 IP carrier Network

| Network Element Name | E8160E Accumulated Quantity | E1000E Accumulated Quantity |
|---|---|---|
| L1 Command Centre | 4 | 2 |
| L2 Command Centre North | | 2 |
| L2 Command Centre South | 4 | 2 |
| L2 Command Centre West | | 2 |
| L2 Command Centre East | | 2 |
| summary | 8 | 10 |

## 10.4 Features and Highlights

华为安全解决方案解决了针对核心网设备，互联网出口和 LTE 网络中出现的安全问题，通过打开防火墙安全防护功能，和在 eNBe 基站和安全网关之间建立 IPSec VPN 隧道来实现防止业务数据泄露、篡改，安全网关对不同安全域进行隔离，对安全业务进行接入控制；华为安全解决方案优势如下：

- 安全：优异的安全能力，除防火墙外，同时支持 IPS、DPI 及专业 Anti-DDoS 特性，深入保护运营商网络。

- 高效：万兆线速转发，高达 200G 吞吐量+8000 万并发连接+50 万/s 新建连接，保障网络顺畅运行；分布式并行处理技术整机实现 10 倍的性能线性倍增；99.999%可靠性保证，保障业务连续性。
- 完整：完善的 IKEv1、IKEv2 支持能力，有效解决网络演进需求；完整的 PKI 证书认证系统完善了各节点的身份认证接入功能，防止非法 eNodeB 基站接入；
- 可靠：高可靠网络组网，可根据需要提供主备组网，主主分担组网，异地容灾备份方案，多方面考虑客户可靠性需求；
- 低 TCO：onebox 功能集成，能够同时支持多种安全与 IPv6 过渡特性，真正实现多业务一体化，节省硬件投资；分布式扩展架构，根据业务流量增长，分阶段按需投资，提升投资回报比。

# 11 Data Center Engine Room Design

## 11.1 Design Principle

Data Centre is the core of business activity, suitable expansion space should be considered and the design should be based on 24/7/365 operation, especially with the unstable power situation, a customized power solution should be recommended with 24/7/365 operation, low cost and easy maintenance;

International standards are very important reference for Data Center design. We shall design Data Center to match international standards.All the design followed international standard as below:

ANSI/TIA-942-2005: Telecommunications Infrastructure Standard for Data Center

ANSI/TIA/EIA-568-B.1: Commercial Building Telecommunications Cabling Standard; Part 1 General Requirements

ANSI/TIA/EIA-568-B.2: Commercial Building Telecommunications Cabling Standard; Part 2 Balanced Twisted-Pair Cabling Components

ANSI/TIA/EIA-568-B.3: Optical Fiber Cabling Components Standard

ANSI/TIA-569-B: Commercial Building Standard for Telecommunications Pathways and Spaces

ANSI/TIA/EIA-606-A: Administration Standard for Commercial Telecommunications Infrastructure

ANSI/TIA/EIA-J-STD-607, Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications

ANSI/TIA-758-A: Outside Plant Telecommunications Cabling Standard

IEEE C2-2002: National Electrical Safety Code

NFPA 70: National Electrical Code

IEEE Std. 1100: Recommended Practice for Powering and Grounding Electronic Equipment

IEEE Std. 446: Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications

Principle:

Data Center requires high availability to run the business. But not all Data Centers can meet the availability criteria. According to ANSI/TIA-942 standards, Data Center can be classified to four tiers.

1. Availability Tiers

| Availability Tiers | Tier Ⅰ | Tier II | Tier III | Tier IV |
|---|---|---|---|---|
| Redundant Components | N | N+1 | N+1 | 2(N+1) |
| Annual IT Downtime due to Site | 28.8 hrs | 22.0 hrs | 1.6 hrs | 0.8 hrs |
| Site availability | 99.67% | 99.75% | 99.98% | 99.99% |

2. Security

   Because of sensitive business, Data Center is a critical place. Physical security is necessary to be built up for Data Center protection. It should be able to prevent unauthorized people entering Data Center.

3. Reasonable cost

   As energy consumption increasing continually and energy being more and more expensive, power consumption of Data Center is the biggest part of operation cost. Reducing power consumption is one important consideration during Data Center design.

4. Manageability

   Data Center is an integrated project with all kinds of subsystems. Modular design allows to create highly complex systems from smaller, more manageable building blocks. These smaller units are more easily defined and can be more easily managed.

5. Design Level

   Based on the understanding of A country W City Security Surveillance Project, Huawei recommends a Tier2+ design;

## 11.2 Design Requirement

### 11.2.1 L1 Command Center

主机房等级：Tier3；

交流设备备电时间：2h；

机柜数量与功耗：64 个交流机柜，12 个直流机柜；

功耗：交流功率需求 400KW，直流功率需求 52KW；

交流机柜最大功耗：6.25kW；

直流机柜最大功耗：4.33kW；

监控：L1 机房内设置一套动环监控系统对机房内环境及设备进行监控，设置 2 个网络摄像机对机房内模块进行视频监控。

### 11.2.2 L2 Command Center

主机房等级 Tier3；

交流设备备电时间：2h；

IT 机柜数量：14 个交流机柜，12 个直流机柜；

IT 机柜功耗：交流功率需求 50kW，直流功率需求 42kW；

交流机柜最大功耗：3.6kW；

直流机柜最大功耗：3.5kW；

监控：每个 L2 机房内设置一套动环监控系统对机房内环境及设备进行监控，设置 2 个网络摄像机对机房内进行视频监控，视频监控系统可支持扩展至 7 个网络摄像机。设置 2 个温湿度传感器对机房内温湿度进行监控。

## 11.3 Power system

Huawei will be responsible for a total power solution after utility station, including Primary & secondary power distribution board, ATS, Generators, UPS, DC Power, Battery, PDU, PDF and power cables, etc;

MOI should supply required utility lines with abundant power capacity for L1~L3 sites;

### 11.3.1 System overview

The power supply system is a key element in Data Center infrastructure. The system should include dedicated electrical distribution panels and enough redundancy to guarantee constant uptime. A well-designed electrical system will provide consistent power and minimize unscheduled outages. Equipment subjected to frequent power interruptions and fluctuations is susceptible to a higher component failure rate than equipment connected to a stable power source.

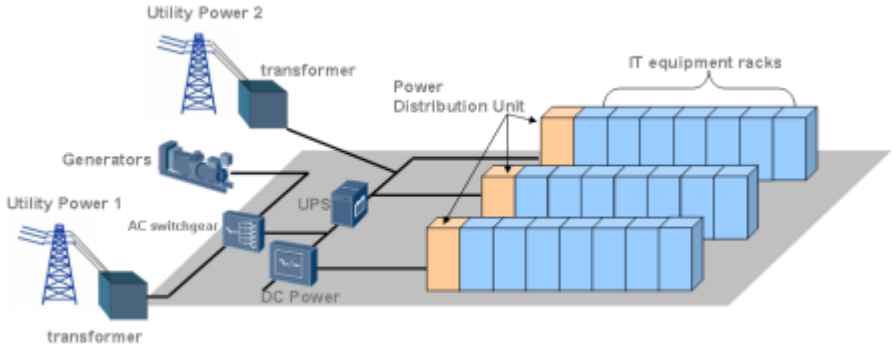



Figure 24 General Data Center Power Flow

### 11.3.2 Generator

Consider the unstable power state in W city, if available, two utility inputs from different shut-off schedule lines is recommended to be supplied, which can greatly reduce the fuel cost of generator system. Also N+1 redundancy generators should be considered as one on-duty, one standby, the diesel generator system is composed of two basic subsystems: (1) the generator, which is made up of the prime mover, the alternator, and the governor, (2) the distribution system, which is made up of the Automatic Transfer

Switch (ATS) and associated switchgear and distribution. Permanent load banks or accommodations to facilitate connection of portable load banks should be provided for large size generator system.

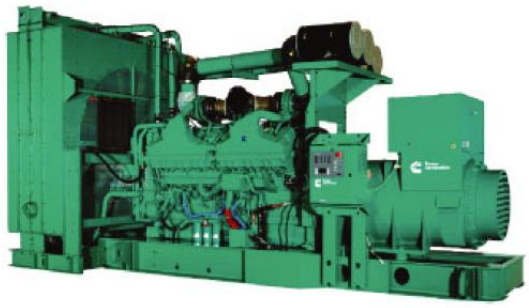


Figure 25 Generator

### 11.3.3 UPS

- 600KVA UPS

  To save space and reduce final investment, Huawei recommends to supply 2pcs 600kVA UPS to cover the IT loads of L1 (refers to Figure 2-1 Equipments Plan of L1Type Site and Figure 5-1 Power Plan for L1Type Site)

  Emerson UPS is recommended or equal products;

Hipulse U series UPS is manufactured by the Emerson company which is one of the Fortune 500 companies. The main technical features of Hipulse U series UPS includes:

- Online dual-conversion design, completely eliminating the influence of grid pollution and failure of mains and generator on the load
- Output power factor up to 0.9, more suitable for the servers, computers and network centers which adopt power factor correction technology, with over 10% more loading capacity than traditional UPS
- Advanced DSP and digital control technology (the 6th generation) with higher system stability
- Multiple input harmonic suppression technologies to achieve higher power efficiency Zero phase shift output isolation transformer minimizes the influence of neutral-ground voltage and load harmonic current on the inverter
- Outstanding output overload and short circuit capacity ensures system stability and safety under extreme circumstances

- Advanced distributed parallel technology, 6-unit parallel without centralized bypass cabinet
- Super wide input voltage and frequency range, adaptive to adverse grid
- Input/output filter as standard configuration increases the EMC of the system
- Intelligent battery management achieves automatic battery maintenance and prolongs the service life of battery
- 6-inch large LCD, user-friendly Chinese/English display interface
- Isolated duct and redundancy fan design by layer, coating protection for circuit board and built-in dust filter screen ensure efficient heat dissipation and provide effective protection in adverse environment

➢ 60KVA UPS

It will be deployed 3pcs 60KVA UPS in L2 Command centre according to the power consumption of equipment

New Technical Features:

- Superior Energy saving and environment-friendly

  Energy > 96% at 50%-75% rated load, and>95% at 25% rated load; input PF>0.99, input THDi<3%

- Superior capacity of powering load:

  Output PF is 0.9, no need of power duration with load of leading or lagging PF

- Easy-to-install:

  Top or bottom cabling, no need of input cabling cabinet, weight of 160KVA UPS<300kg with footprint of 0.5Sqm

- Easy-to-maintain:

  Full front access, UPS, failed part can be replaced shortly

- Easy-to-modify:

  The number of battery cells can be configured flexibly, so the original batteries can be used when modifying the legacy system; moreover, the battery cell can be replaced in time when it fails without interrupting the normal operation of UPS

Main Technical Features:

- On-Line Double Conversion, fully isolating the influences of power grid pollution and power failure from utility power supply and diesel generator to load
- Advanced DSP full digital control technologies realize higher system stability, online capacity expansion and maintenance
- Advance distributed active parallel technology realizes parallel operation of 4 UPS units and online capacity expansion without centralized bypass cabinet
- Digital load sharing technology features extra low cross current and extreme high system reliability in parallel operation
- Adaptive to severe power grid environment due to extra wide input voltage and frequency ranges
- Extra strong capability to withstand output overload and short circuit, ensuring the system stability and system safety at limit conditions

- Intelligent battery management maintains battery automatically to prolong the battery life
- 6-inch extra large LCD that can display in English, which is convenient to use

  Efficient heat dissipation and effective protection under severe environment due to its independent layer-sealed ventilation channel and redundant fan design, as well as the paint-protected circuit boards and built-in dust filter

➢ 20KV UPS

2pcs 20KVA UPS with 5minutes backup battery will be supplied for working area to avoid power interruption when power switchover;

### 11.3.4 Primary & Secondary Power Distribution Panel

DB cabinet should be made of steel sheet with proper painting, lightning protector, current leakage protector, opened from top and bottom for cable entrance, analog voltage and current meter should be supplied;

### 11.3.5 Power Cable

- ➢ The ambiance temperature as well as the load for cable accumulation shall be taken in account as per the country requirements.
- ➢ Power cables are installed with different sizes according to the load requirement.
- ➢ Power cables shall be steel strip armored type EYR.
- ➢ Grounding cables shall be yellow/green colors with different sizes according to the site requirements, NYA type;

### 11.3.6 Power Socket

Two types of power sockets will be supplied, one type is used for regular loads, when power switch over between utility lines or generators, this kind loads will be acceptable to be shortly shut-off, and the other type power socket should be connected by 20KVA UPS, which can supply stable power without power interruption, this type power socket will be used for the critical loads, such as desktop, wall screen, printer, emergency lighting, etc;

A dual power sockets should be supplied for each seat and proper position in data center and office area;

## 11.4 Air Conditioning System

A/C system is used to produce cooling power to balance the heat and control air humidity. Suitable temperature and humidity can not only help equipments working stably, but also increase lifecycle of IT equipments. A/C system also creates a comfortable surrounding for people.

Recommended air conditioning:

| | |
|---|---|
| Temperature | 22℃±1℃ |
| Humidity | 50% RH±15% |

Consider the size of data centers are middle or small size and the heat density of racks is not designed as 3kW/rack, general data center cooling solution that raised floor plus under wards air flow precision air conditioning can meet the requirements, as follow

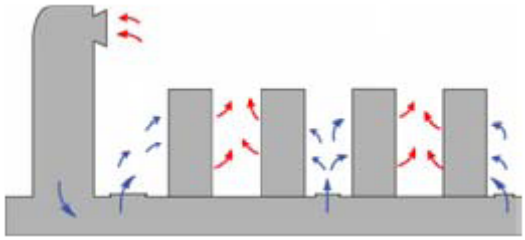


Figure 26 Air Flow Plan of Data Center

Hot and cold aisles is a basic and important condition for thermal management, by configuring cabinets, racks back-to-back pointing to hot aisle and front-to-front facing cold aisle as following figure. Cold and hot aisles can observably increase efficiency of cooling power.

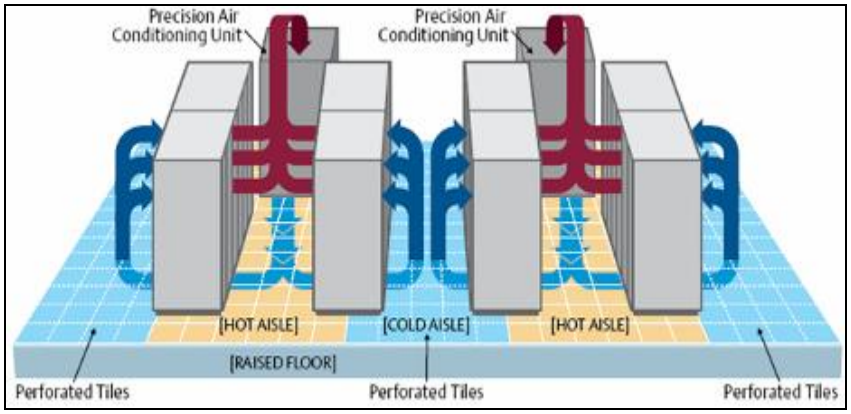



Figure 27 Figure 6-2 Cold and Hot Aisles

The whole system should be designed for 24hours x 365days, and extreme weather should be considered, so abundant cooling capacity and standby unit should be supplied;

Considering of the climate in A country, T3 type air conditioning will be supplied. （Highest running temp.: T1- 43℃; T2- 35℃; T3- 52℃; ）

For L1 site data center room:

Average load of racks' power consumption is 3 kW. Data Center Room 1 can contain 72 cabinets. The cooling capacity of the AC in Data Center Room1 follows:

Equipment electric thermal load: 449kW;

Light thermal load: η×S1×ρ = 2.24kW;

Frame thermal load: W×S2 = 5.34 kW;

Total thermal load: 390Kw + 2.24kW + 5.34kW = 397.58kW;

Cooling capacity: 180kW/0.8=497kW;

(compressor efficiency=0.8)

Take （N + 1）, 497kW/7，each AC's cooling capacity >71 kW。

contain: φ: DC equipment heat elimination modulus 0.9;

AC equipment heat elimination modulus 0.8;

η: daylight lamp power consumption in one square meter=17;

ρ: heat dissipating capacity of daylight lamp =0.8;

S1:area of the room，L×D（L: length，D: width）;

S2:frame area of the room，L×D + （L + D）×H;（H: high）;

W : loss heat in one square meter=20W;

Conclusion:

Data Center Room1 need 8pcs precision AC，cooling capacity of one >71kW，Blowing-in method is UA。Only for 76pcs racks in phase1;

For Data Center, Huawei proposes Liebert PeX precision air conditioning or as equal, and N+1 redundancy solution will be considered;

Figure 28 Pex A/C Photo

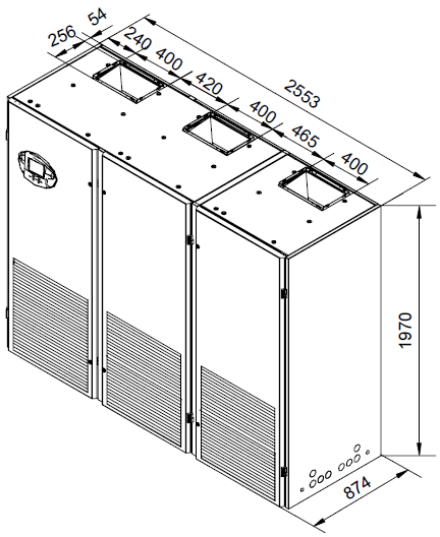
Downflow - DX

| Model Size | 2050 | 2060 | 2070 | 3070 | 3080 | 3090 | 3100 |
|---|---|---|---|---|---|---|---|
| DX - Air based on 24℃ DB, 50%RH, 45℃ condensing | | | | | | | |
| Scroll compressor, FC Fan | | | | | | | |
| DX Total Kw | 46.4 | 60.6 | 66.9 | 73.9 | 81.4 | 89.3 | 100 |
| Sensible Kw | 43.2 | 53.5 | 59 | 68.2 | 71.1 | 79.6 | 88.4 |
| Air Flow $m^3/h$ | 12960 | 16200 | 16020 | 20160 | 20160 | 23940 | 23760 |
| Evaporator Fan | | | | | | | |
| Standard FC | 2.2 | 3 | 3 | 2.2 | 2.2 | 3 | 3 |

| Motor Kw | | | | | | | |
|---|---|---|---|---|---|---|---|
| Compressor - Copeland Compliant Scroll with Crankase Heater | | | | | | | |
| No. of Compressors | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Unit Cooling Steps | 2 via Compressors | | | | | | |
| Humidification | | | | | | | |
| Standard Infrared - kg/h | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| Unit Dimensions & Weight | | | | | | | |
| Width - mm | 1703 | 1703 | 1703 | 2553 | 2553 | 2553 | 2553 |
| Depth - mm | 873 | 873 | 873 | 873 | 873 | 873 | 873 |
| Height - mm | 1970 | 1970 | 1970 | 1970 | 1970 | 1970 | 1970 |
| Unit Weight - kg | 670 | 700 | 720 | 970 | 990 | 1030 | 1050 |

Notice:

All rated capacities are nominal values based on ESP for downflow 20pa and for upflow 50pa at sea level for R22. For net capacities, deduct fan input power.




For Power Room, Huawei proposes Liebert DME precision air conditioning, and N+1 redundancy solution will be considered;

Cooling capacity request of Power Supply Room is（290～320kW）/m2。

Cooling capacity: 22.3 ×10.2×（290 ~ 320kW）/m2 = 66~72.8kW, Take max 72.8。Power Supply Room need 8pcs AC including one standby A/C unit， cooling capacity >10.4kW。

Product Photo:

Figure 29 DME Product Photo

Product Parameter:

| A/C Type | DME07 | DME012 |
|---|---|---|
| Cooling Capacity(22 $^{o}$C, 50%rh) | | |
| Total Cooling Capacity | 7.5KW(6485 Kcal/h) | 12.5KW (10802 Kcal/h) |
| Sensible Cooling Capacity | 6.8KW(5848 Kcal/h) | 11.3KW (9735 Kcal/h) |
| Sensible Heat Ratio | 0.9 | 0.9 |
| Fan Parameter | | |
| Fan-High Speed $m^3$/h | 2250 | 2700 |
| Fan-Low Speed $m^3$/h | 1950 | 2400 |

| | | |
|---|---|---|
| Full load current A | 2.4 | 2.4 |
| Compressor Parameter | | |
| High Pressure Protection（MPa） | 2.8 | 2.8 |
| Low Pressure Protection（MPa） | 0.14 | 0.14 |
| Max. Current（A） | 4.8 | 9.1 |
| Electricity Protection Parameter | | |
| Over-high Voltage Protection（V） | 475 | 475 |
| Over-low Voltage Protection（V） | 285 | 285 |
| Phase-loass Protection | OK | OK |
| Phase Reversal Protection | OK | OK |

Product Installation Space Design:

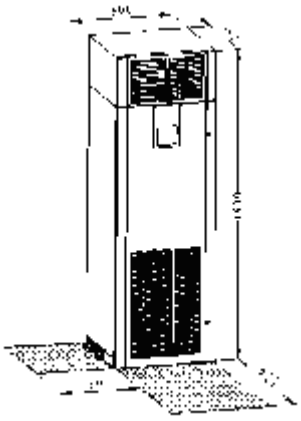


Figure 30 Installation Space Requirement

For L2 Data Centre, 3pcs 76kw air conditioner will be deployed in data centre room,

For office area, comfort air conditioning will be supplied for cooling as required;

## 11.5 Fire Fighting System

Huawei will supply FM200 fire suppression system for data center rooms, and fire detection system for other area and equipped with handle fire extinguishers;

Fire fighting system consists of repeater panel, smoke detectors, heat detectors and control system in the data centre. Short circuits can generate heat, melt components, and start a fire. Today there are three ways of detecting; smoke detectors, heat detectors, and flame detectors. For the purposes of protecting a Data Center, smoke detectors and heat detectors are more effective. Spot type detectors are effective in small Data Centers and Core Rooms. The intelligent detectors shall be distributed and fixed using screws in the ceiling of the data centre, looking more or less like a ceiling lamp.

Control systems are the “brains” behind the automatic extinguishing system. Fire alarm panels are either conventional panels or intelligent addressable panels working with detectors of the same type (conventional or intelligent / addressable) and with the same communication protocol. Depending on the panel, it can control the sensitivity levels of various components such as smoke detectors and can be programmed to alarm only after a certain sequence of events have taken place. The control panel shall be of the wall mounted type, and shall also be suitable for mounting flush in a console.

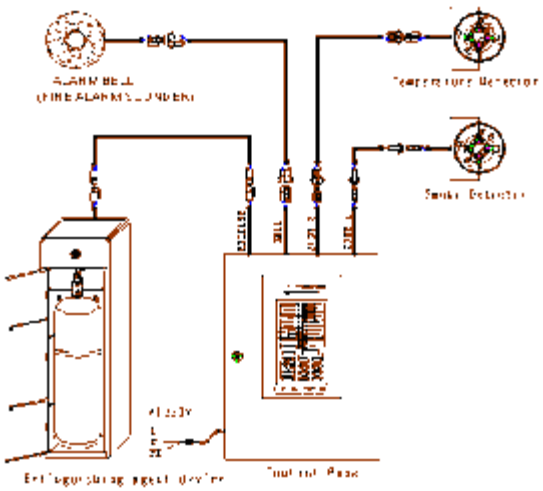


Figure 31 Automatic detection and extinguishing system (For Data Center Only)

Once a fire is detected in a Data Center, Fire Suppression Systems is critical to quickly extinguish the fire with no effect on the Data Center operation. The system shall consist of a gas control unit, connected to the fire detection system and storage vessel, mounted against the wall or equivalent extinguishing agent for the area required.

A fire-extinguishing agent is a gaseous chemical compound that extinguishes a fire, as a gas, by means of “suffocation” and or heat removal. There are some methods can be provided to extinguish fire, but we recommend FM200 fire suppression system. FM200 uses the gas which is quickly dispersed around the equipment. It works quickly, is safe for people, doesn’t damage hardware, won’t interrupt electrical circuits, and requires no post-discharge cleanup.


Figure 32 Schematic Diagram of fire suppression system

## 11.6 Cabling System

In this design, cabling system only consider cable tray/ladder for installation requirements of generation, power distribution, UPS, DC Power, Air Conditioning, etc; the cables and cable installation work will be proposed with equipments installation;

Data Center Cabling System Overview


Figure 33 Data Center Cabling Case Sample

Cable tray

Cable trays shall be hot dip galvanized to a minimum of 70 microns installed to carry and protect the power, control and grounding cables with the following dimensions: Height 60mm, Width 600mm or otherwise specified, Length 3000mm and Thickness 0.75mm.

No sharp edges in the cable trays and covers are permitted.

Cable trays will be installed between generators, ATS, A/C and MDB.

All cable trays shall be grounded to the earthing system.

Figure 34 Data Center Cable Ladder Installation Effect Picture

## 11.7 Facility Management System

As a centralized platform, building management system should integrate with NOC for continuous alarm monitoring and event reporting, including building automation system, access control system, water detection, fire protection, CCTV system, air-conditioning, UPS and other power systems.

The system should be capable of local and remote monitoring and operation through LAN connections. All individual equipment/ systems shall remain in operation upon failure of the central Building Management System.

Facilities management system includes three subsystems: power and environment surveillance system, access control system and CCTV surveillance system. They defend all kinds of threats in the data center. When the moment is necessary, the subsystems can act together to reduce the risk to the least.

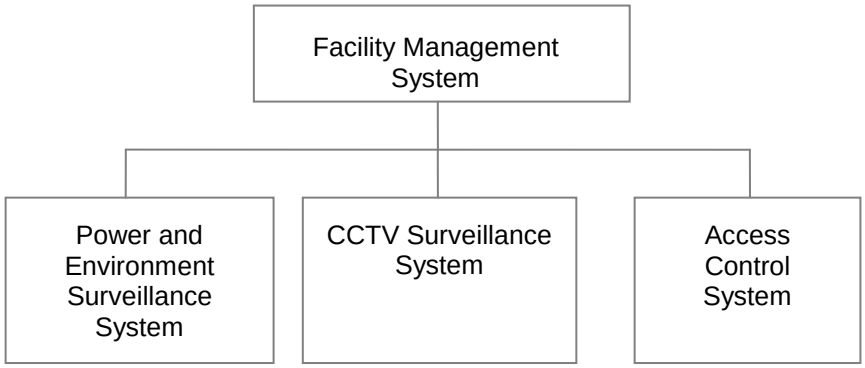



Figure 35 The component of the data center facility management system

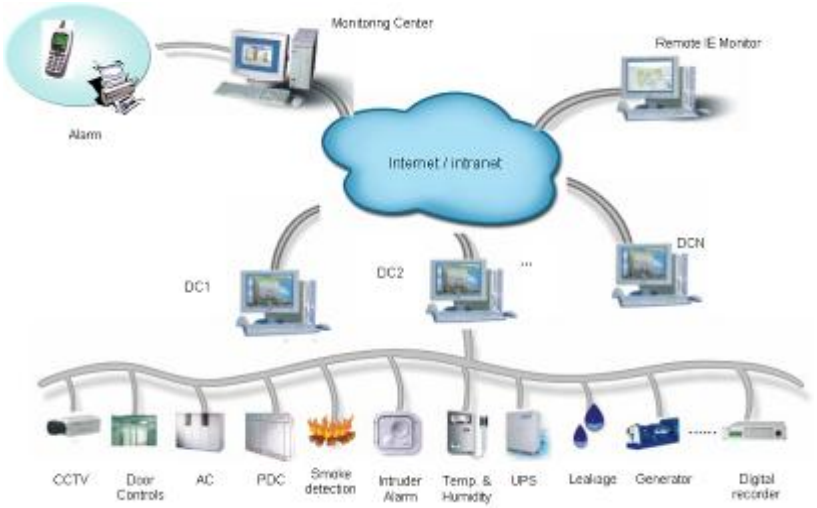



Figure 36 Topology of the data center facility management system

## 11.8 Power and Environment Surveillance System

- Requirement Analysis

  Traditional methodologies for monitoring the data center environment are no longer sufficient. With technologies such as blade servers driving up cooling demands and human activity such as malice driving up data center security requirements, the physical environment in the data center must be watched more closely.

  In data center, the physical threats to data center equipment include power quality, air quality, smoke and fire, water leaks, and human error or malice.

  In order to reduce the risk to the least, Huawei can provide a professional facilities management system: power unit monitor power quality, load, and battery health; cooling units monitor input and output temperatures and humidity; fire suppression system - the one that are required by building codes - monitor the presence of smoke or heat; access control system keeps the unauthorized personnel out of the data center; CCTV system monitor the data center by real-time video.

- System Design

  Various types of sensors can be provided early warning of trouble from the threats described above. While the specific type and number of sensors may vary depending upon budget, threat risk, and the business cost of a breach, there is a minimum essential set of sensors that makes sense for most data centers. Table 2 shows guidelines for this basic recommended set of sensors.

  Placement of the sensor

| NO. | Alarm Sensor Type | Description |
|---|---|---|
| 1 | Temperature & Humidity sensor | Monitor the temperature and humidity at critical points of data center; |
| 2 | Water leak sensor | Water leakage alarm; |
| 3 | Smoke or heat sensor | Fire alarm signal; |

| | | |
|---|---|---|
| 4 | Generator signal integration | Generator status monitor |
| 5 | Fuel level detector | Generator diesel fuel level monitor; |
| 6 | Switchgear signal integration | Switchgear status monitor; |
| 7 | UPS signal integration | UPS status integration; |
| 8 | Door switch | Door status monitor; |
| 9 | Door alarm | Alarm when door open; |
| 10 | EPO function | Emergency stop for generator, UPS and other keys; |

Aggregating Sensor Data

With the sensors selected and placed, the next step is the collection and analysis of the data received by the sensors. Individual sensors do not typically connect individually to the IP network. Instead, the aggregators interpret the sensor data and send alerts to the central system and/or directly to the notification list. This distributed monitoring architecture dramatically reduces the number of network drops required and reduces the overall system cost and management burden. Aggregators are typically assigned to physical areas within the data center and aggregate sensors from a limited area in order to limit sensor wiring complexity.

So in the data center, in order to eliminate the single-point-of-failure risk of a single central aggregation point, and supports point-of-use monitoring of remote server rooms, there are aggregation points distributed throughout the data center per floor, with alert and notification capabilities at each aggregation point.

## 11.9 Access Control System

Huawei can supply total solution for access control system based on the bidding documents;

- Requirement Analysis

  In order to prevent unauthorized people to enter the data center freely, per entrance is designed to install access control equipment. The system should control and allow any staff to get access to specified area using the same proximity card with different user group defined by the system administrator,.

  All doors should have break glass panic button which can release the door lock in case of emergency. Double interlock to control people access to core room, battery room, etc.

  Access control system will be installed for specified door and entrance, password, IC card and fingerprint type can be selected;

- System Design

  System Overview

  Access to the site should be secured by identification and authentication systems. Additional access control should be provided for crucial areas such as the core room, UPS room, battery room, electrical rooms and etc. Data centers should be provided with a dedicated security room to provide central monitoring for all security systems associated with the data center.

  Design Principle

  - Stability

System support industrial standard card-reading technologies, and ensure access control system can work stability.

- Expandability

  The system is in modular design, which means the system functions can be expanded as required, depending on the market situation and user demand.

## 11.10 Data Center Networking Scheme

### 11.10.1 Monitoring Management System

管理系统基于统一架构进行设计，1 个 L1 机房和 4 个 L2 机房接入同一个 NetEco 机房管理系统实现统一管理。

4 个 L2 机房的设备接入本地的监控单元，监控单元北向通过网络接入 L1 机房的 NetEco 机房管理系统。

NetEco 机房管理系统提供 Web 服务平台，相关维护人员可通过 Web 方式访问 NetEco 机房管理系统管理平台，完成系统状态查看、告警查看、性能统计查看、系统配置管理、视频管理、机房维护等操作。

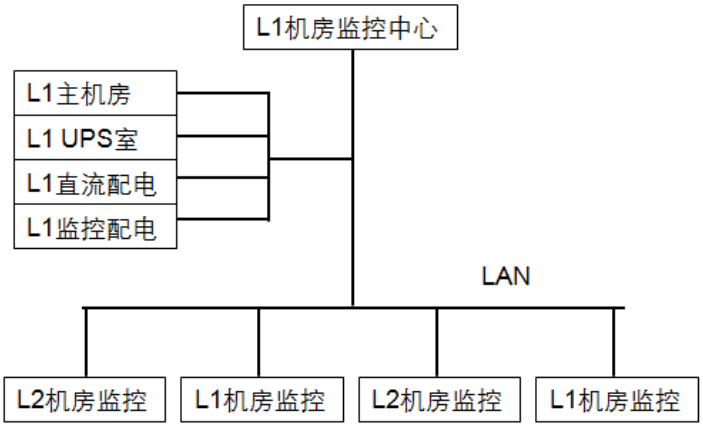



Figure 37 Monioring Diagram of Engine Room

- L1 机房

L1 主机房监控需要部署在四个部分，包括 1 个主机房、1 个 UPS 室、1 个直流配电室和 1 个监控中心配电室。监控逻辑图如下：

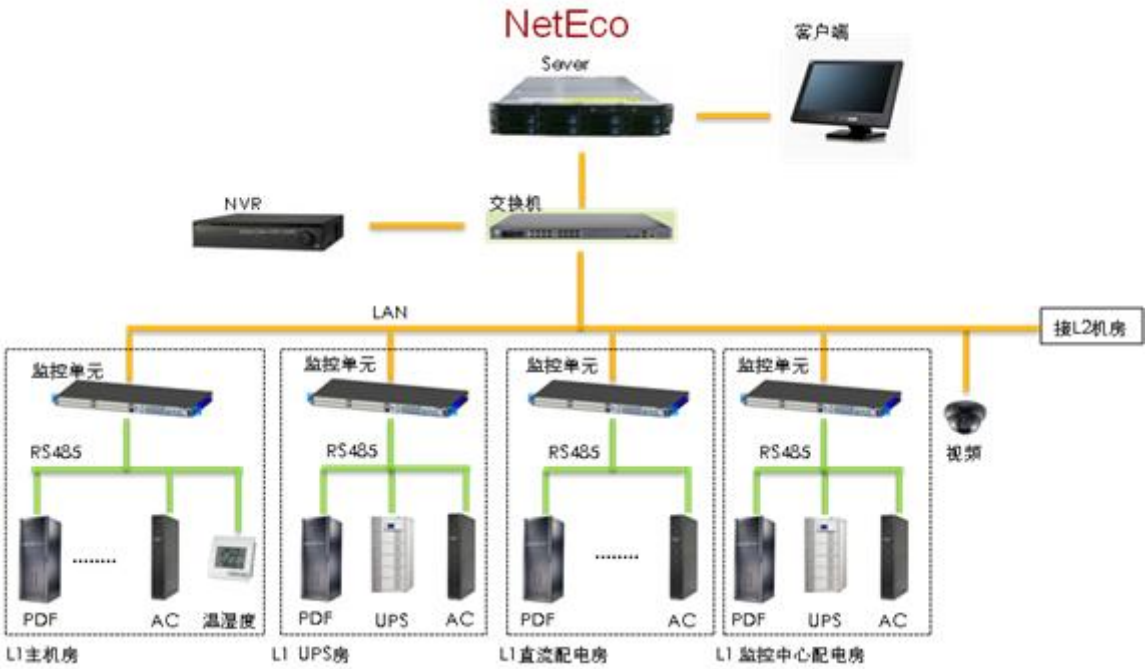



Figure 38 L1 Monitoring Logical Diagram

- L2 机房

L2 机房共有四个，每个都具备一个主机房和一个配电室。四个 L2 机房中的主机房和配电室的设备配置保持一致。

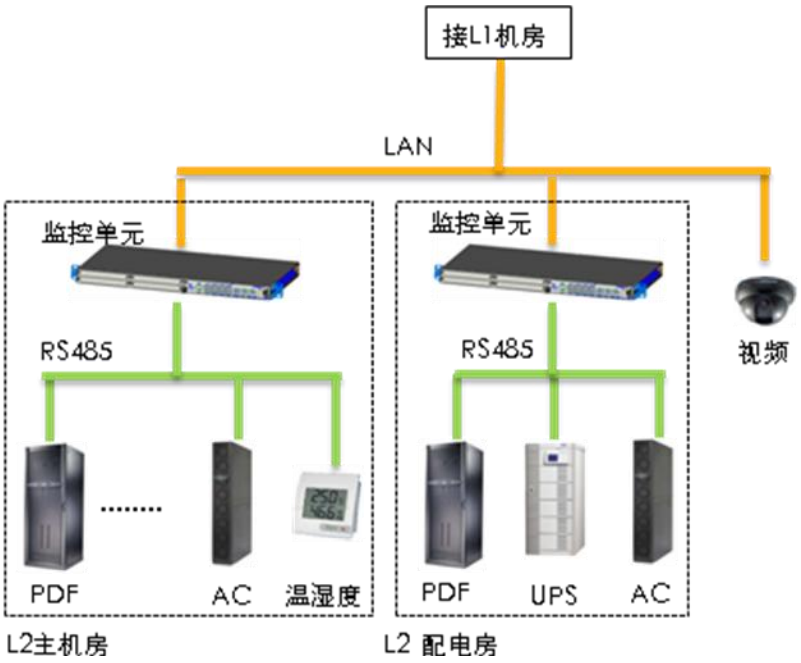



Figure 39 Monitoring Logical diagram of L2 Single Engine Room

### 11.10.2 Access Control System

Access control system is mainly made of management computer, management software, access controller, card reader, card-issuing reader, lock, out-of-door button and so on.

Access controller is the core of access control system, it performs access control management and such value-added functions as online patrol and real time attendance check. The access control system is managed by adopting the RS485 bus inter-working.

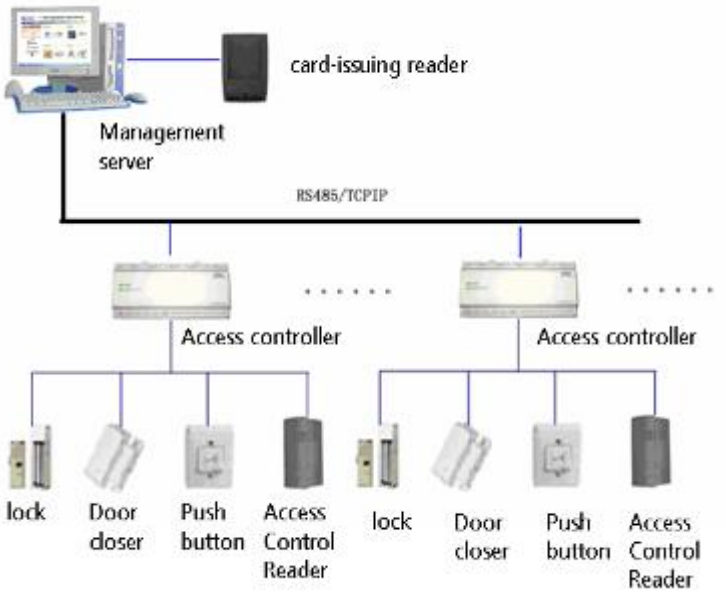



Figure 40 Access control system whole frame

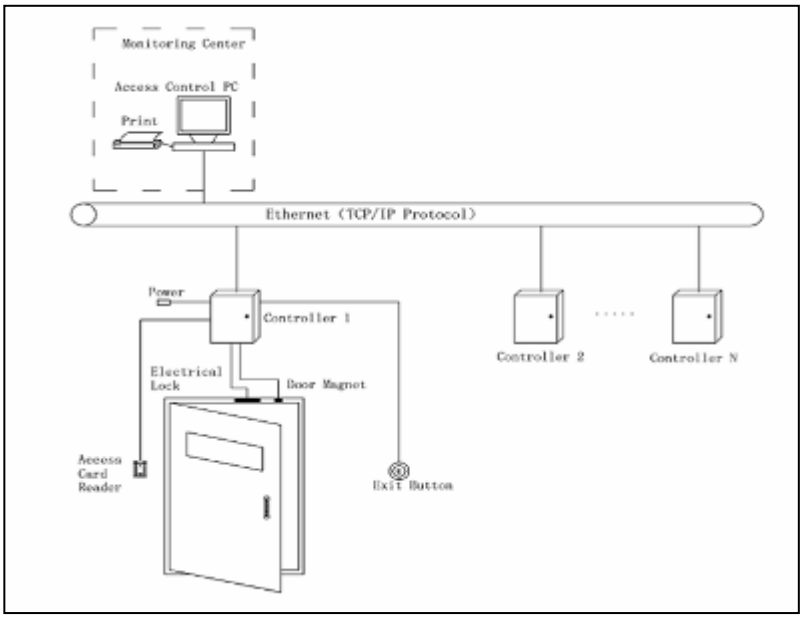



Figure 41 Schematic Diagram of Access Control System

### 11.10.3 Power Supply and Distribution Architecture

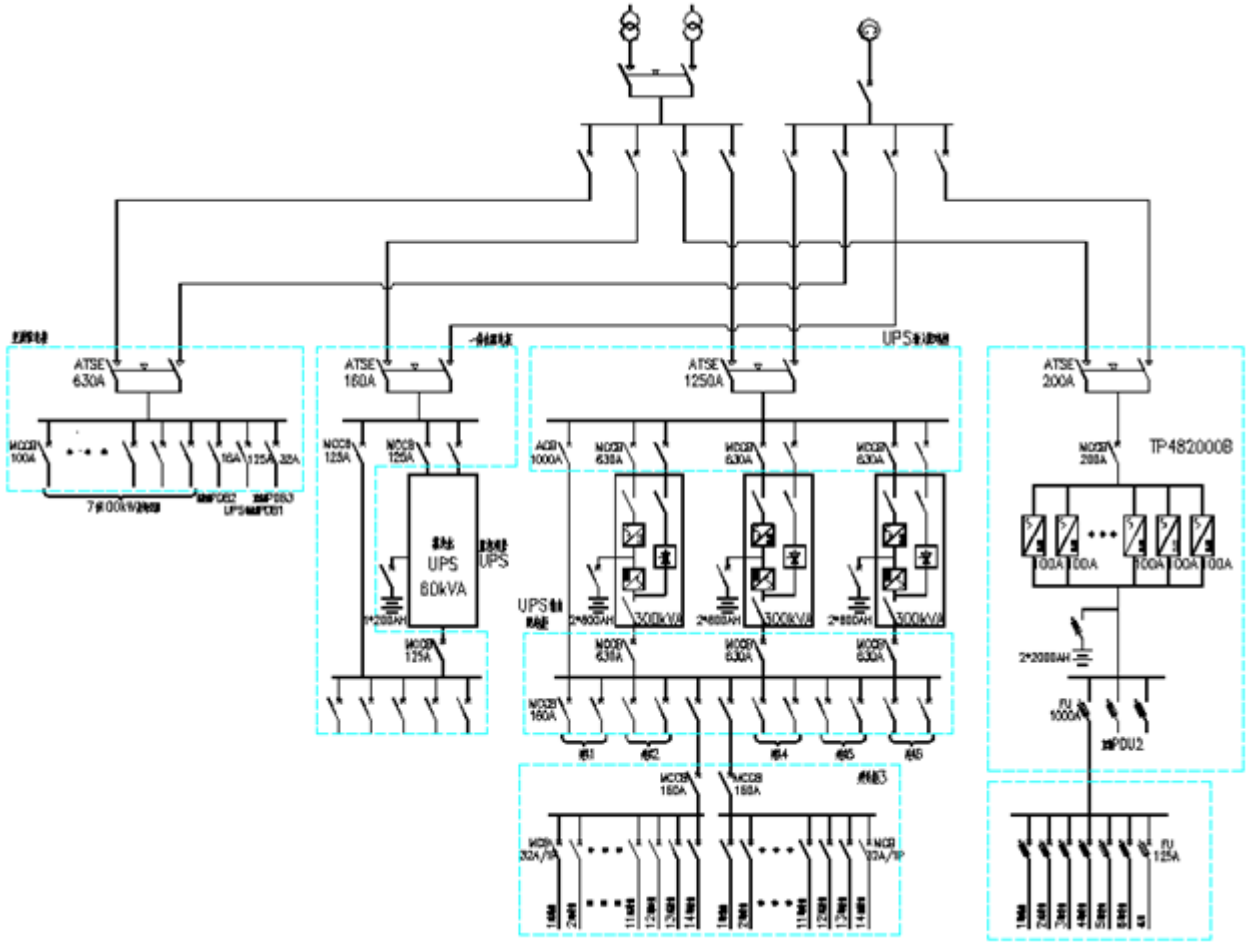



Figure 42 L1 Distribution structure Program Figure

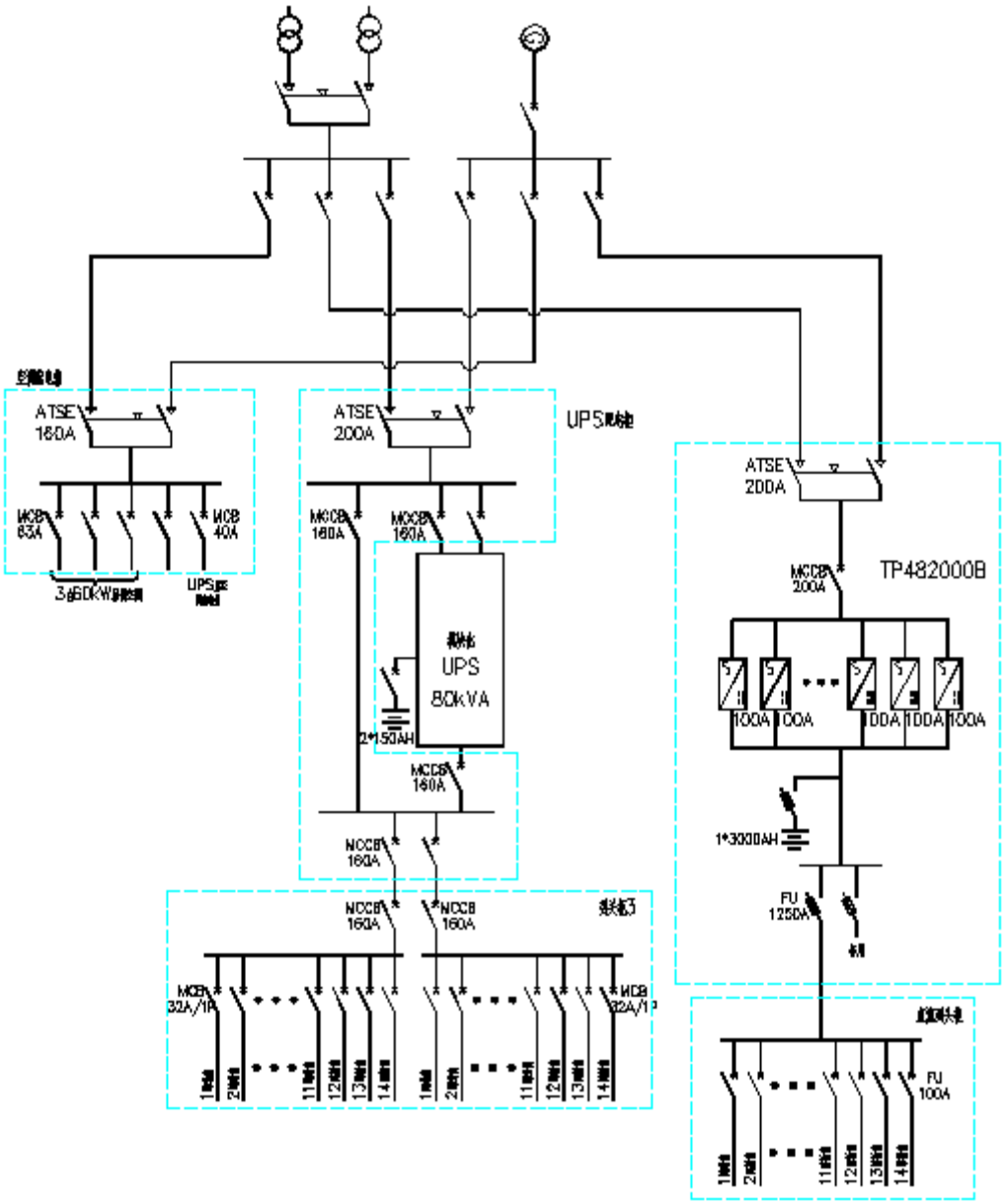



Figure 43 Distribution structure Program Figure  of Single L2 Command Room

## 11.11 Key Parameters

### 11.11.1 L1 Data Center

主机房等级：Tier3;

交流设备备电时间：2h;

机柜数量与功耗：64 个交流机柜，12 个直流机柜;

功耗：交流功率需求 400KW，直流功率需求 52KW；

交流机柜最大功耗：6.25kW；

直流机柜最大功耗：4.33kW；

监控：L1 机房内设置一套动环监控系统对机房内环境及设备进行监控，设置 2 个网络摄像机对机房内模块进行视频监控。

### 11.11.2 L2 Data Center

主机房等级 Tier3；

交流设备备电时间：2h；

IT 机柜数量：14 个交流机柜，12 个直流机柜；

IT 机柜功耗：交流功率需求 50kW，直流功率需求 42kW；

交流机柜最大功耗：3.6kW；

直流机柜最大功耗：3.5kW；

监控：每个 L2 机房内设置一套动环监控系统对机房内环境及设备进行监控，设置 2 个网络摄像机对机房内进行视频监控，视频监控系统可支持扩展至 7 个网络摄像机。设置 2 个温湿度传感器对机房内温湿度进行监控。

### 11.11.3 Air Condition Capacity Calculation

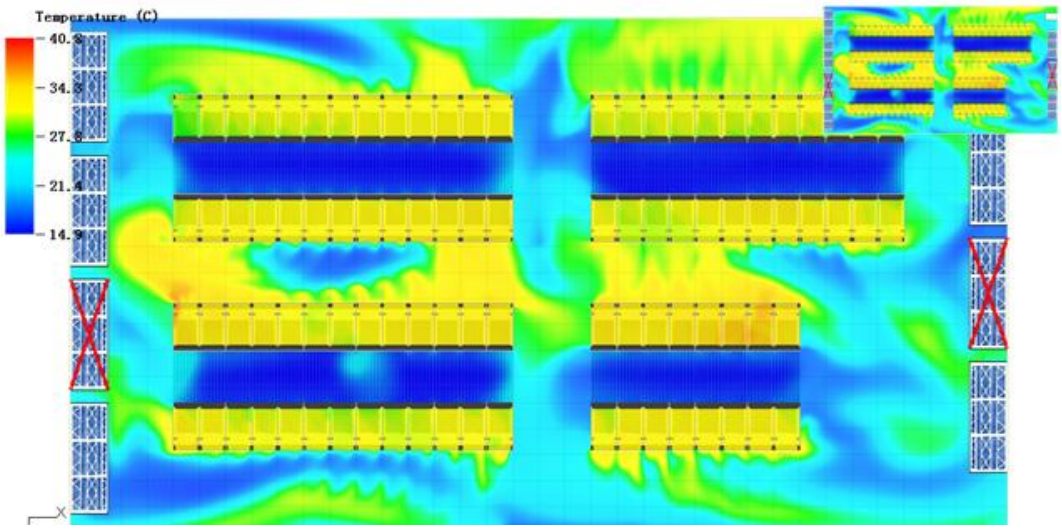
- L1 主机房制冷负荷计算

Table 15 Cooling Load Calculation

| 类别 | 数值 | 备注 |
|---|---|---|
| 机房面积（$m^2$） | 264 | |
| 机房表面积（$m^2$） | 536 | |
| 交流 IT 设备总功率（kW） | 400 | |
| 直流 IT 设备总功率（kW） | 52 | |
| 配电、布线柜散热 | 9.1 | |
| 机房漏热（kW） | 13.4 | 机房按 4 米高计算 |
| 照明散热（kW） | 5.28 | 不常开 |
| 人员散热（kW） | 0.4 | 默认机房内 2 维护人员 |
| IT 设备使用系数 | 0.67 | |
| 安全系数 | 1.15 | |
| 空调输出总冷量（kW） | 380.7 | |
| 修正后空调输出总冷量（kW） | 543.8 | 显冷比按 70%(T3) |

空调选型：选用 7 台 100kW 空调，2 台备份（5＋2）

仿真模拟分析如下：




- L1 UPS 房制冷负荷计算

Table 16 L1 UPS Room Cooling Load Calculation

| 类别 | 数值 | 备注 |
|---|---|---|
| 机房面积（$m^2$） | 216 | |
| 机房表面积（$m^2$） | 462.4 | |
| 交流 IT 设备总功率（kW） | 400 | |
| UPS、配电、电池散热 | 26.8 | |
| 机房漏热（kW） | 11.6 | 机房按 4 米高计算 |
| 照明散热（kW） | 4.3 | 不常开 |
| 人员散热（kW） | 0.4 | 默认机房内 2 维护人员 |
| IT 设备使用系数 | 0.67 | |
| 安全系数 | 1.15 | |
| 空调输出总冷量（kW） | 49.5 | |
| 修正后空调输出总冷量（kW） | 70.8 | 显冷比按 70%(T3) |

空调选型：选用 2 台 60kW 空调，1 台备份（1＋1）

- L1 直流配电房制冷负荷计算

Table 17 L1 DC Power Distribution Room Cooling Load Calculation

| 类别 | 数值 | 备注 |
|---|---|---|
| 机房面积（$m^2$） | 43.2 | |
| 机房表面积（$m^2$） | 154.4 | |
| 直流 IT 设备总功率（kW） | 52 | |
| 配电、布线柜散热 | 1.7 | |
| 机房漏热（kW） | 3.9 | 机房按 4 米高计算 |
| 照明散热（kW） | 0.9 | 不常开 |
| 人员散热（kW） | 0.4 | 默认机房内 2 维护人员 |
| IT 设备使用系数 | 0.67 | |
| 安全系数 | 1.15 | |
| 空调输出总冷量（kW） | 7.9 | |

| | | |
|---|---|---|
| 修正后空调输出总冷量（kW） | 11.3 | 显冷比按 70%(T3) |

空调选型：监控中心配电房选用 2 台 12.5kW 空调，1 台备份（1＋1）；

- L1 监控中心配电房制冷负荷计算

Table 18 L1 Monitoring center power distribution room cooling load calculation

| 类别 | 数值 | 备注 |
|---|---|---|
| 机房面积（$m^2$） | 50.4 | |
| 机房表面积（$m^2$） | 112.3 | |
| 配电、布线柜散热 | 1.1 | |
| 机房漏热（kW） | 2.8 | 机房按 4 米高计算 |
| 照明散热（kW） | 1.0 | |
| 人员散热（kW） | 0.4 | 默认机房内 2 维护人员 |
| 安全系数 | 1.15 | |
| 空调输出总冷量（kW） | 6.1 | |
| 修正后空调输出总冷量（kW） | 8.7 | 显冷比按 70%(T3) |

空调选型：监控中心配电房选用 2 台 7.5kW 空调，1 台备份（1＋1）；

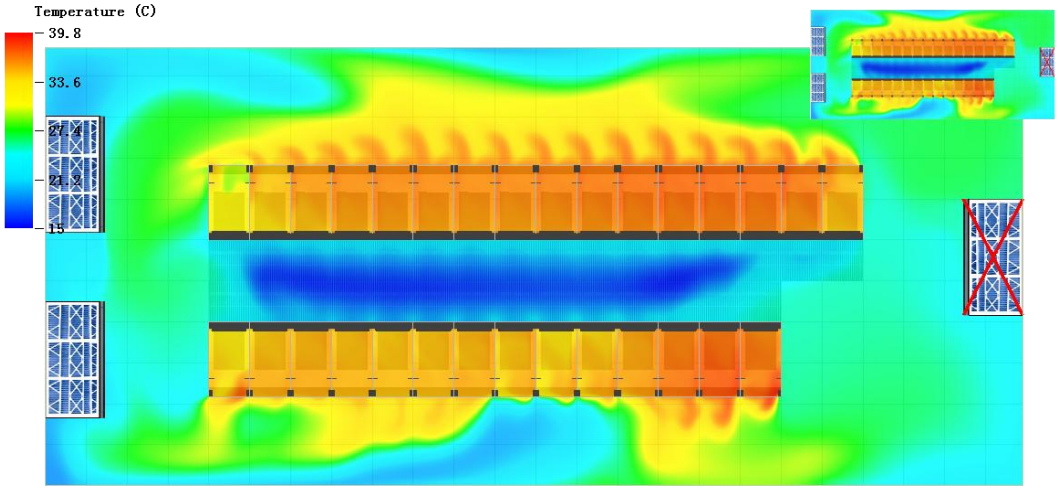
- L2 主机房制冷负荷计算

Table 19 L2 Host room cooling load calculation

| 类别 | 数值 | 备注 |
|---|---|---|
| 机房面积（$m^2$） | 97.5 | |
| 机房表面积（$m^2$） | 269.5 | |
| 交流 IT 设备总功率（kW） | 50 | |
| 直流 IT 设备总功率（kW） | 42 | |
| 配电、布线柜散热 | 1.8 | |
| 机房漏热（kW） | 6.7 | 机房按 4 米高计算 |
| 照明散热（kW） | 1.95 | 不常开 |
| 人员散热（kW） | 0.4 | 默认机房内 2 维护人员 |
| IT 设备使用系数 | 0.67 | |
| 安全系数 | 1.15 | |
| 空调输出总冷量（kW） | 83.5 | |
| 修正后空调输出总冷量（kW） | 119.2 | 显冷比按 70%(T3) |

空调选型：选用 3 台 60kW 空调，1 台备份（2＋1）

仿真模拟分析如下：




- L2 配电房制冷负荷计算

Table 20 L2 Distribution room cooling load calculation

| 类别 | 数值 | 备注 |
|---|---|---|
| 机房面积（$m^2$） | 54.8 | |
| 机房表面积（$m^2$） | 174.0 | |
| 交流 IT 设备总功率（kW） | 50 | |
| 直流 IT 设备总功率（kW） | 42 | |
| UPS、配电、电池散热 | 4.9 | |
| 机房漏热（kW） | 4.3 | 机房按 4 米高计算 |
| 照明散热（kW） | 1.1 | 不常开 |
| 人员散热（kW） | 0.4 | 默认机房内 2 维护人员 |
| IT 设备使用系数 | 0.67 | |
| 安全系数 | 1.15 | |
| 空调输出总冷量（kW） | 12.4 | |
| 修正后空调输出总冷量（kW） | 17.7 | 显冷比按 70%(T3) |

空调选型：选用台 12.5kW 空调，1 台备份（1＋1）

### 11.11.4 UPS&Storage Battery Capacity Calculation

- L1 机房
  - L1 UPS 房
    - UPS 容量：L1 机房交流 IT 设备总功耗为 400kW；经计算，UPS 容量需求约为 600kVA，选 300kVA 容量的塔式 UPS，数量 3 台（2＋1）；
    - 电池容量：L1 机房备电时间要求 2h，UPS 母线电压 480V，经计算每台 UPS 需要 3 组 650AH，2V 电池，每组 240 节，3 台 UPS 供需 9 组；
  - L1 直流配电房

- 电池容量：备电时间要求 2h，直流电压 48V，经计算需要 4 组 48V，2000AH，2V 电池，每组 24 节；

➢ L1 监控中心配电房

- UPS 容量：UPS 容量需求 40kVA，选择 120kVA 的模块化 UPS，配置 3 个（2＋1）20kVA 模块；
- 电池容量：备电时间要求 2h，UPS 母线电压 480V，经计算每台 UPS 需要 2 组 150AH，12V 电池，每组 40 节；

➢ L2 机房

➢ UPS 容量：由前述可知，L2 机房交流 IT 设备总功耗为 52kW；经计算，UPS 容量需求约为 70kVA，选最大容量 120kVA 的模块化 UPS，模块配置数量 5 个（4＋1）；

➢ 电池容量：由前述可知，L2 机房备电时间要求 2h，UPS 母线电压 480V，选择 3 组 150AH，12V 电池，每组 40 节；

### 11.11.5 Power Cabinet Selection Calculation

1. L1 主机房
   - 列头柜（交流配电柜）选择 160A,380V,50/60Hz，30 路（单 15 路），32A/1P 的配电柜；
   - 空调配电柜选择 630A,380V,50/60Hz，输出标配 10 路 100A/3P 的配电柜，带 ATS；
   - 直流配电柜：two power input:(630A*2)*2,output:(100A*12+160A*12)*2；
2. L1 UPS 房
   - UPS 输入配电柜：选择 1250A，标配 6 路 630A/3P 的配电柜，带 ATS；
   - UPS 输出配电柜：选择 630A*3+250A*12 的配电柜；
3. L1 监控中心配电房
   - 空调配电箱：380V,50/60Hz,ATS :40A/4P,output:20A/3P*4+16A/3P*6；
   - UPS 输入配电柜：选择 1250A，标配 6 路 630A/3P 的配电柜，带 ATS；
   - UPS 输出配电柜：选择 630A*3+250A*12 的配电柜；
4. L1 直流配电房
   - 空调配电柜：380V,50/60Hz,ATS :160A/4P,output:80A/3P*4+100A/3P*4
   - 系统电源（整流柜）：TP481000D-Z4X0-1100A
   - AC 配电柜：380V,45Hz-65Hz,600000mA,Chinese and English Data,APDF380-600 AC Distribution Cabinet and Delivery Accessories

- DC 配电柜：48V,2500000mA,Chinese and English Data,DPDF48-2500 DC Distribution Cabinet and Delivery Accessories

5. L2 主机房
   - 列头柜（交流配电柜）：选择 160A,380V,50/60Hz,160000mA，30 路（单 15 路），20A/1P 的配电柜；
   - 列头柜（直流配电柜）：two power input:(630A*2)*2,output:(100A*12+160A*12)*2；
   - 空调配电箱：PDB, 160A,380V,50/60Hz,160000mA，30 路（单 15 路），20A/1P 的配电柜；
6. L2 配电房
   - UPS 配电柜（输入）：Power Distribution Cabinet,APDF-L-I-1000,380V,50/60Hz,1000000mA
   - UPS 配电柜（输出）：Power Distribution Cabinet,APDF-L-I-800,380V,50/60Hz,800000mA
   - 空调配电箱：PDB, 380V,50/60Hz,ATS :160A/4P,output:80A/3P*4+100A/3P*4

## 11.12 Equipments Configuration

### 11.12.1 L1 Data Center Equipments

1. L1 主机房主要设备

   制冷： 7 台（5＋2）100kW 房间空调；

   配电： 160A 交流配电柜（列头柜）；

   1 个带 ATS 的空调配电柜；

   2 台 630A 的直流配电柜；

2. L1 UPS 室主要设备

   UPS： 3 台（2＋1）300kVA 的塔式 UPS；

   制冷： 3 台（2＋1）60kW 房间空调，房间制冷；

   配电： 1 个 UPS 输入配电柜；

   1 个 UPS 输出配电柜；

   1 个电池汇流柜；

3. L1 直流配电室主要设备

   制冷： 2 台（1＋1）12.5kW 房间空调，房间制冷；

   配电： 1 个系统电源（整流柜）；

1 个交流电源配电柜；

1 个直流电源配电柜；

1 个空调配电箱；

4. L1 监控中心配电室主要设备

UPS： 1 台 120kVA 的模块化 UPS 主柜；配置 3 个 20kVA 模块；

制冷： 2 台（1＋1）7.5kW 房间空调，房间制冷；

配电： 1 个 UPS 输入配电柜；

1 个 UPS 输出配电柜；

### 11.12.2 L2 Data Center Equipments

1. L2 主机房主要设备包括：

1 台交流配电柜

1 台直流配电柜

制冷：3 台 60kW 房间空调，地板下送风，房间制冷；

配电：1 台 250A 交流配电柜（列头柜）；

2. L2 配电室主要设备包括：

UPS： 1 个 UPS 机柜（配置 3 个 20kVA 的模块化 UPS）；

制冷： 4 台 12.5kW 房间空调，水平下送风，房间制冷；

配电： 1 个 UPS 输入配电柜，1 个 UPS 输出配电柜，1 个空调配电箱；

# 12 Interface Description

## 12.1 Interface of Front-End System

前端子系统主要与无线 CPE 子系统和能基站点供电子系统存在接口关系，各个接口具体描述如下:

- 与无线 CPE 子系统接口

  CPE 为前端 IPC 提供 1.5M 图像上行回传、摄像机控制及版本升级等主要数据通道，CPE 下行通过 FE 端口连接太阳能适配模块，IPC 上行通过 FE 接口连接太阳能适配模块，由太阳能适配模块实现 CPE 和 IPC 的数据互联；

- 对无线 CPE 子系统输入需求

  IPC 工作于 CPE NAT 网关内部，CPE 需要支持透过 NAT 网关实现 IPC 与 IVS 平台之间媒体和信令交互通信；CPE 需要透传网管平台的远程管理和批量部署协议及数据，支持 IPC 远程管理和批量部署

- 与能基供电子系统接口

  IPC 通过能基供电系统提供 DC12V 接口提供设备供电，通过能基提供的 FE 数据接口与 CPE 实现数据互通

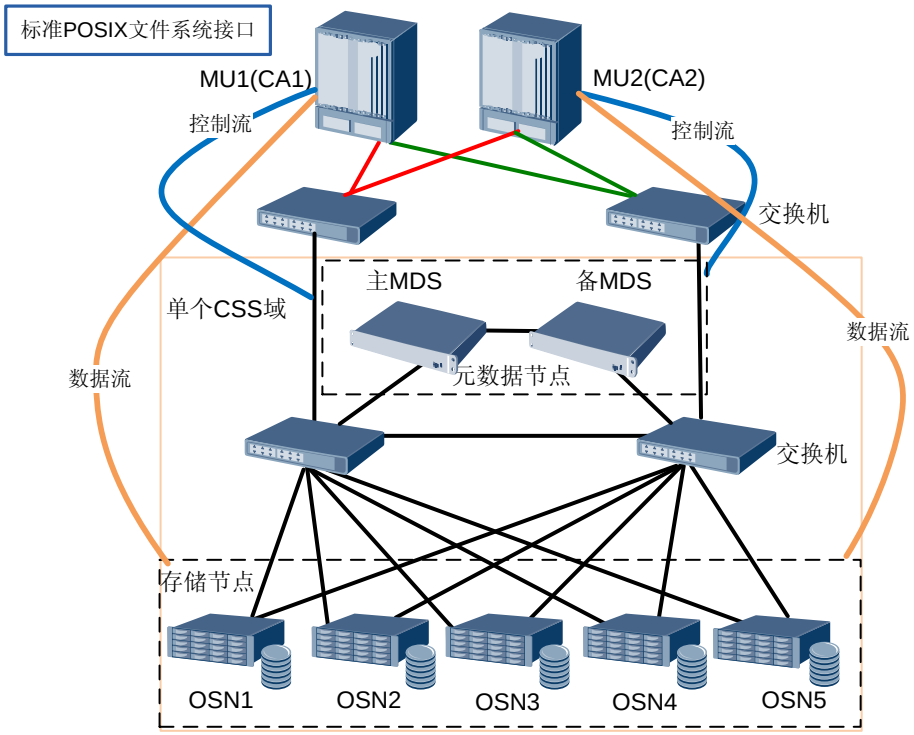
- 对能基供电子系统输入需求

  IPC 的工作电压波动范围在 DC12V±10%，能基供电电池容量需要满足不同站点模型下 IPC72 小时的备电时间

## 12.2 Interface of IVSPlatform System

- 与 CSS 子系统接口

  IVS 平台录像数据采用 CSS 存储方案，IVS 平台与 CSS 云存储之间存在录像数据写入和读取接口，CSS 通过在 IVS 平台 MU 上部署 CA 客户端代理实现对存储数据的读写操作，CSS CA 客户端与 MU 之间采用 POSIX 协议接口进行对接，接口的具体描述如下图所示：




CA（客户端代理）：客户端代理是云存储系统和上层应用交流的门户，主要通过文件系统的各种接口向用户提供文件操作服务。客户端代理主要功能是向业务应用系统提供文件系统驱动，各种应用系统就如同对本地文件系统一样对云存储进行读写。主要功能如下：

- 对外提供基于文件系统的文件和目录的共享服务，通过标准POSIX 接口，提供文件系统mount 和umount 功能，实现文件和目录的共享。
- 提供文件和目录的基本操作功能，包括文件和目录的创建、删除、属性设置、重命名、读、写、软链接、硬链接等操作。
- CA 服务的状态可以提供检查接口，为上层使用CA 的服务提供软件接口或脚本。

- 对 CSS 子系统输入需求

满足 L1CC 和 L1backup 13116 路摄像机并发存储录像需求、满足 CU 及解码器录像回放并发需求；满足每个 L2CC 3500 路摄像机并发录像存储需求，满足 L2CC 和 L3CC 的 CU 及解码器录像回放并发需求。

## 12.3 Interface of NE Router System

数据网主要与微波子系统，安全子系统以及交换机存在接口，各个接口具体描述如下:

- 与微波子系统接口

  数据网在 L3 光节点的设备（单个 NE40E）的 N * 1GE 电接口与微波设备的 N * 1GE 电接口互连，采用 LAG 方式对接。其中 N 根据具体的微波站点可取值 1，2 或 3。另外，每个 L3 光节点的设备额外提供 1 个 GE 电接口，为微波系统提供网管接口。

- 与安全子系统接口

  数据网 L1 Command Center 设备（单个 NE40E）通过 3 个 10GE 光接口与安全设备的 3 个 10GE 光接口互连。

  数据网 L2-South Command Center 设备（单个 NE40E）通过 3 个 10GE 光接口与安全设备的 3 个 10GE 光接口互连。

- 与 Command Center 内部系统接口

  数据网在 L1 Command Center 设备（单个 NE40E）通过 14 个 10GE 光接口与交换机的 12 个 10GE 光接口互连。

  数据网在 L2-South Command Center 设备（单个 NE40E）通过 3 个 10GE 光接口与交换机的 3 个 10GE 光接口互连。

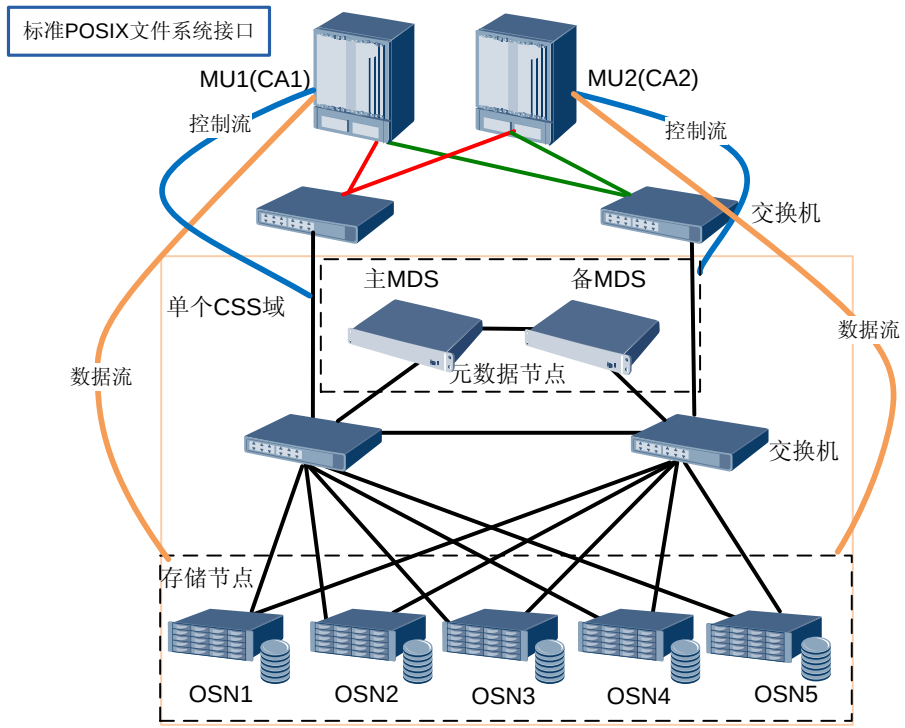
  数据网在其余 L2 和 L3 Command Center 设备（单个 NE40E）通过 2 个 10GE 光接口与交换机的 2 个 10GE 光接口互连。

## 12.4 Interface of Cloud Storage System

存储子系统主要与 IVS 系统，传输系统存在接口，各个接口具体描述如下:

- 与 IVS 子系统接口

  存储子系统的客户端代理 CA 需要部署在 IVS 子系统的录像单元 MU 上，MU 通过 CA 采用 POSIX 协议接口，对存储系统进行数据读写访问。具体示意图如下：




备注：CA（客户端代理）：客户端代理是云存储系统和上层应用交流的门户，主要通过文件系统的各种接口向用户提供文件操作服务。客户端代理主要功能是向业务应用系统提供文件系统驱动，各种应用系统就如同对本地文件系统一样对云存储进行读写。主要功能如下：1）对外提供基于文件系统的文件和目录的共享服务，通过标准 POSIX 接口，提供文件系统 mount 和 umount 功能，实现文件和目录的共享。2）提供文件和目录的基本操作功能，包括文件和目录的创建、删除、属性设置、重命名、读、写、软链接、硬链接等操作。3）CA 服务的状态可以提供检查接口，为上层使用 CA 的服务提供软件接口或脚本。

存储子系统的相关告警需要集成到 IVS 子系统的网管中，通过 IVS 的管理界面来查看存储相关的告警状态，存储自己的 ISM 网管仅负责存储相关的配置及部署。

- 与传输子系统接口

存储子系统配置了多模的光模块，需要通过多模光纤连接到上层汇聚交换机网络中。具体 IP 地址、汇聚交换机端口及网络带宽需求汇总如下表所示：

| 数据中心名称 | IP 地址规划需求 | 汇聚交换机端口需求 | 带宽要求 |
|---|---|---|---|
| P1-L1 指挥中心 | 306 个内网业务 IP<br>266 个内网 IPMI 管理 IP<br>1 个管理 IP（管理网络） | 数据流网段：40 个 10G 光口（汇聚层）<br>管理流网段：1 个 1G 以太口（管理网络） | 80Gb |
| P1-L2 南指挥中心 | 28 个内网业务 IP<br>25 个内网 IPMI 管理 IP<br>1 个管理 IP（管理网络） | 数据流网段：6 个 10G 光口（汇聚层）<br>管理流网段：1 个 1G 以太口（管理网络） | 20Gb |

| | | | |
|---|---|---|---|
| P1-L2 北指挥中心 | 28 个内网业务 IP<br>25 个内网 IPMI 管理 IP<br>1 个管理 IP（管理网络） | 数据流网段：6 个 10G 光口（汇聚层）<br>管理流网段：1 个 1G 以太口（管理网络） | 20Gb |
| P2-L1 备份指挥中心 | 306 个内网业务 IP<br>266 个内网 IPMI 管理 IP<br>1 个管理 IP（管理网络） | 数据流网段：40 个 10G 光口（汇聚层）<br>管理流网段：1 个 1G 以太口（管理网络） | 80Gb |
| P2-L2 东指挥中心 | 28 个内网业务 IP<br>25 个内网 IPMI 管理 IP<br>1 个管理 IP（管理网络） | 数据流网段：6 个 10G 光口（汇聚层）<br>管理流网段：1 个 1G 以太口（管理网络） | 20Gb |
| P2-L2 西指挥中心 | 28 个内网业务 IP<br>25 个内网 IPMI 管理 IP<br>1 个管理 IP（管理网络） | 数据流网段：6 个 10G 光口（汇聚层）<br>管理流网段：1 个 1G 以太口（管理网络） | 20Gb |

## 12.5 Interface of Switch System

数据网主要与防火墙子系统、存储子系统、核心网子系统、IVS 子系统、办公区子系统存在接口，各个接口具体描述如下:

- 与路由器子系统接口

  S97 通过 10GE 链路二层透传业务；
  S67 与核心网侧的防火墙通过 10GE 链路二层互联，二层透传防火墙与核心网的流量；

- 办公区 S97 与防火墙直接接口

  为 10GE 接口+三层 vlanif 接口实现三层转发；

- 办公区 S97 与私网 S97 之间为 10GE 接口+Eth-Trunk+vlanif 接口实现三层转发

- 与存储子系统接口

  S67 与存储系统采用 10GE 链路二层互联，二层透传存储子系统的流量；

- 与核心网子系统接口

  S57 给核心网区域提供 GE 链路二层互联，二层透传核心网的流量；
  S67 与存储系统采用 10GE 链路二层互联，二层透传核心网的流量；

- 与 IVS 子系统接口

  S67 与存储系统采用 10GE 链路二层互联，二层透传 IVS 子系统的流量；

- 与办公区子系统接口

  S57 与存办公子系统采用 GE 链路二层互联，二层透传办公子系统的流量；

## 12.6 Interface of Security System

防火墙主要与 NE40E-X16 路由器，AR 路由器和 S9712，S6748 交换机子系统存在接口，各个接口具体描述如下:

- E8160E 与 NE40E-X16 接口

  E8160E 与 NE40E-X16 通过 3 个 10GE 光接口互连
- E8160E 与 S9712 接口

  E8160E 与两台堆叠的 S9712 分别通过 2 个 10GE 光接口互连
- E8160E 与 S6748 接口

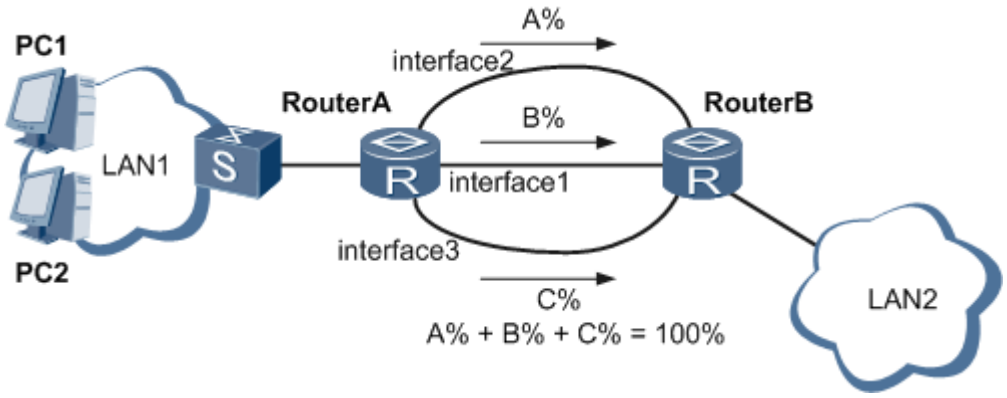
  E8160E 与两台堆叠的 S6748 分别通过 2 个 10GE 光接口互连
- E1000E-X3 与 AR 路由器接口

  E1000E-X3 与 AR 通过 1 个 GE 光接口互联;
- E1000E-X3 与 S9712 接口

  E1000E 与两台堆叠的 S9712 分别通过 2 个 10GE 光接口互连

## 12.7 Interface of AR Router System

AR 3260 通过 4 个 GE 口上行接入 internet,承载内部用户上网业务，上行不同接口间可配置接口备份，做负载分担，当个接口出现故障时，可以将流量快速的切换到备份接口，从而提高了数据设备通信的可靠性。如下图所示




interface1 作为主接口，interface2、interface3 作为备份接口，应用负载分担功能时，分为以下情况：

- 系统定时检测主接口 interface1 流量是否超过设置的门限阈值，当主接口 interface1 的数据流量达到负载分担门限的上限阈值时，优先级最高的可用备份接口将被启用，同主接口 interface1 一起传输业务，进行负载分担。
- 负载分担后流量还是超过上限，优先级次高的另一个可用的备份接口将被启用，在这三个接口间进行负载分担，以此类推，直至流量不超限。
- 负载分担后流量低于设定的下限阈值时，优先级最低的在用备份接口将被关闭。以此类推，直到仅有主接口 interface1 承担业务流量。

各呼叫中心 AR 3260 上行 4 个 GE 口进行负载分担，设置 75%的流量上限以保证接口断开后能够由其他接口进行负载分担。

AR 3260 下行通过 GE 口与防火墙设备相连，组成双归属网络，增加一倍可靠性。

## 12.8 Interface of Microwave System

- 与 NodeB 对接接口

  eNodeB 通过 1GE 电口与微波 RTN910/950/980 1GE 电口对接。

- 与数据网子系统对接接口

  RTN950/980 微波业务通过 GE 电口与 NE 路由器 GE 电口对接，接口数量需要视容量需求来定（<=3GE），如果需要超过 1GE，需要配置 RTN 和 NE 路由器分别配置 LAG。

  RTN980/950/910 网管通过 1FE 电口与 NE 路由器 1FE 电口对接。

## 12.9 Interface of UC System

UC 主要与交换机子系统存在接口，接口具体描述如下:

- 与交换机子系统接口

  每台 U1910 支持 2 个 10M/100M 自适应网口
  每台 U1980 支持 3 个 GE 口

## 12.10 Interface of Telepresence System

与交换机系统接口：

1） 高清终端的上联交换机端口建议全部强制 100M/全双工。

2） MCU8660 的上联交换机建议使用 1000M 交换机。

## 12.11 Interface of LTE System

### 12.11.1 eNodeB

- 与微波子系统接口

  微波子系统为 eNodeB 提供以太网通道接入到 IP 承载网中，并支持为不同业务提供差异化的 Qos 服务。

  eNodeB 与接入侧微波设备按照 1:1 方式连接。

  eNodeB 的 UMPT 单板的千兆电口，通过以太网线与接入侧微波设备的 IDU 的千兆电口互连。
  eNodeB 与微波间不设置 VLAN。

### 12.11.2 EPC

EPC 与其它系统的接口有 S1-MME、S6a、S1-U、S11、S5/S8、SGi 和 OM。

- 与数通子系统的接口

  EPC 子系统通过 S9303 交换机与数通子系统相连，其中 SGi 和 S1 接口各需要提供 30Gb/s 带宽，S6a、S5/S8_s、S5/S8_p、S10/S11、OM 各需要 1Gb/s 带宽。

  - VPN 划分

  根据 VPN 的规划原则，需要将接口划分不同的 VPN。需要在路由器上与核心网划分同样的 VPN，具体划分如下表所示：

| 接口 | VPN |
|---|---|
| S1-MME | VPN_S1 |
| S1-U | |
| S6a | VPN_S6a |
| S5/S8_s | VPN_CN |
| S5/S8_p | |
| S10/S11 | |
| SGi | VPN_GI |
| OM | VPN_OM |

- 接口划分

EPC 核心网内部 CE（S9303）和 PE（NE40E）之间需要出如下接口：

| 接口 | 需求接口数 |
|---|---|
| S1-MME | 2*2*GE |
| S6a | 2*2*GE |
| S1-U | 2*2*3*10GE |
| S5/S8_s、S5/S8_p、S10/S11 | 2*2*GE |
| OM | 2*2*GE |

其中，S1-U 接口在 PE 上需要 3 个 10GE 口绑 Trunk。S5/S8_s、S5/S8_p、S10/S11 合用接口。SGi 接口中 CE（S9303）侧至防火墙之间需要各出 3 对 10GE 接口绑 Trunk。

| 接口 | 需求接口数 |
|---|---|
| SGi | 2*2*3*10GE |

- OSPF 规划

在 EPC 核心网到无线侧的组网中，建议 CE（S9303）与 PE（NE40E）之间 OSPF 的 area 设置为 0.0.0.0，且 CE 和 PE 之间使用等价路由。

建议 SGi 接口的防火墙和 PE（NE40E）的 OSPF 的 area 规划为 0.0.0.0，且 CE（S9303）与防火墙、防火墙与 PE（NE40E）之间使用不等价路由，这样可以满足防火墙的主备模式。

- IP 地址规划

CE（S9303）与 PE（NE40E）或者防火墙对接需要的 IP 地址如下表所示：

| 接口 | 网元 | 物理 IP 网段网段 |
|---|---|---|
| S1-MME | S9303 | 4*/29 |
| | NE40E | |
| S6a | S9303 | 4*/29 |
| | NE40E | |
| S1-U | S9303 | 4*/29 |
| | NE40E | |
| S5/S8_s、S5/S8_p、S10/S11 | S9303 | 4*/29 |
| | NE40E | |
| SGi | S9303 | 4*/29 |
| | 防火墙 | |

### 12.11.3 M2000

- 与数通子系统接口

  数通子系统为 M2000 提供以太网通道接入到 IP 承载网中，并支持为不同业务提供差异化的 Qos 服务。

  M2000 自带的 2 个 3328 交换机分别与数通子系统的 2 个交换机通过 100M 以太网线一对一对接，无需配置 VLAN。

### 12.11.4 CPE

- 与能基子系统接口

  能基子系统为 CPE 提供以太网通道接入到 IPC。

  CPE 的 POE 接口，通过工业以太网线与能基的 POE 适配器的微波设备的 POE 互连。

### 12.11.5 ACS

- 北向接口：

  ACS 通过以太网交换机，连接运行订单系统、或 ACS 客户端的 PC 机。

  订单系统、ACS 客户端允许运行在同一台 PC 机。

  PC 机的数量取决于实际需求。

  PC 机 web 浏览器要求 ie 8.0 或以上。

  硬件依赖：PC 机、以太网交换机。

- 南向接口：

  ACS 通过以太网交换机，连接 EPC 的 SGI 口。

  硬件依赖：以太网交换机。

- 与 DNS 服务器的接口：

  ACS 通过 DNS 取得 NTP 服务器的 IP 地址。

  CPE 通过 DNS 取得 ACS 的南向接口 IP 地址、NTP 服务器的 IP 地址。

  硬件依赖：运行 DNS 服务的服务器。

- 与 NTP 服务器的接口：

  ACS 通过 NTP 或 SNTP 与 NTP 服务器作时间同步。

  CPE 通过 SNTP 与 NTP 服务器作时间同步。

  硬件依赖：运行 NTP 服务的服务器。

## 13 Summary

In this document, Huawei provides a comprehensive technical design of security surveillance, including LTE TDD eNodeB base station site, LTE TDD EPC, transmission, datacom, command center, cloud storage, PowerCube, solar solution. Overall descriptions on system design and dimensioning are given, following with equipment features and highlight of solution proposed.

As an leading ICT and securityn vendor, Huawei has much experience in implementing and maintaining surveillance solutions.

Huawei earns reputations of being a fast-growing, innovative, responsible and experienced vendor in this field, especially in the leading position in many technology aspects. Huawei is confident that the offered

products can bring an advanced, tailored and most cost-effective mobile network to the customer. Together with our professional technical services, more benefits to customer can be expected. We hope this offered package will lead to a long-term cooperation between Huawei and A country government. As an innovative and reliable vendor in A COUNTRY, Huawei is dedicated to deliver a robust, future-oriented and cost-effective surveillance system for our customer with the state-of-the-art technology. A stable and long-term cooperation is the commitment that Huawei always believes in.

We believe the solution suits your demand, and it will bring very reliable experience to your network, in additional, the solution also brings long term benefit for the customer.