

What is the Maximum Number of Users per CMTS?

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Introduction

Before You Begin

Conventions

Prerequisites

Broadband CMTS Routers

Number of CMs per Upstream Port

Example

Homes Passed and Penetration

Related Information

Introduction

The following is an engineering and network deployment guideline which outlines specific performance factors that should be taken into account for all Broadband Service Providers when deploying the Cisco CMTS product line, specifically the uBR72xx family of broadband routers.

Before You Begin

Conventions

For more information on document conventions, see the Cisco Technical Tips Conventions.

Prerequisites

There are no specific prerequisites for this document.

Broadband CMTS Routers

The three models of Cisco broadband CMTS router that this document discusses are the:

- uBR7223
- uBR7246
- uBR7246-VXR

All three are based on a Peripheral Component Interconnect (PCI) bus architecture.

The first two are based on a single PCI backplane that is rated at 1 Gbps, however it will normally operate at 600–800 Mbps due to PCI arbitration overhead.

The VXR uses two PCI backplanes, at 600 Mbps each to give 1.2 Gbps throughput. This is a conservative estimate, and true performance may exceed this figure.

The uBR and uBR-VXR models support the Data over Cable System Interface Specification (DOCSIS) 1.0/1.1 protocol and are meant to inter operate with DOCSIS based Cable Modems. A software upgrade is all that is required in a Cisco CMTS to enable DOCSIS 1.1 capability. The hardware is fully DOCSIS 1.1 compliant.

The DOCSIS 1.0 Radio Frequency Interface (RFI) Specification SP–RFI–I05–991105 specifies that there shall be support for 8191 Service IDentifiers (SID) per downstream CMTS transmitter, but that 16 are reserved for future use. This yields 8175 usable SIDs per downstream on the uBR CMTS. In the case of the 4 slot 7246 this means there is a theoretical limit of 32,700 SIDs. Each Cable Modem will require at least one SID but can have multiple SIDs allocated to it for various types of transmission such as Data or Voice, as an example.

There is no implementation restriction in the Cisco uBR7200 MAC code that would put any further limit on the number of CMs per line card. The DOCSIS protocol limit of 8175 (max unicast SID limit) will be limited in a real HFC network by: HFC/RF plant quality(return path quality), #'s of HHP in the combining plan, and DHCP/ToD/TFTP performance capability.

Number of CMs per Upstream Port

It is strongly recommended that the provider keep the number of CMs per upstream port reasonable. This again is not a Cisco implementation restriction. A DOCSIS upstream channel is a multiple access time–aligned contention based communication channel. We do not want the contention level on any single upstream to be so high as to cause excessive multiplicity of collisions with ill effects of laser clipping, etc. Another by product of excessive collisions are latency of recovery times for Cable Modems when contending for a small amount of ranging opportunities when a large number of Cable Modems are already transmitting data. The Cisco CMTS uses dynamic ranging to ensure modems will always get a chance to register, but the number of opportunities decreases as the load detected on the upstream increases to ensure we are granting the data requests.

If the upstream is excessively loaded with too many modems then it may take longer for modems to recover to online state which can impact customer satisfaction.

Note: It is also extremely important to traffic engineer the number of simultaneously active subscribers on each upstream (US) channel/line card such that service remains consistent and adequate during peak busy hour.

With above points in mind, Cisco recommends two numbers.

- Recommended max CMs per line card = approximately 1000–1200 modems per line card primarily dictated by worst case download speeds customer wishes to tolerate for its subscribers during peak activity time.
- Recommended max CMs per US receiver = Not greater than 200 per upstream port primarily dictated by return path Noise,SNR, collision level control.

To calculate we assume the following are TRUE (Please see Cisco's traffic engineering white paper Multimedia Traffic Engineering for HFC Networks. This is a 1.27MB pdf file.)

Example

- Out of the given pool of subscribers, 40% are logged on during busy hour.
- Out of the 40% subscribers that are logged–on during busy hour, only 25% might be downloading data simultaneously and contributing to the peak activity.

Thus, peak data demand during busy hour is 10% ($.4 * .25$) of the subscriber base.

Let us assume that a service provider wishes to limit the worst case data throughput per user at peak busy hour to not less than 256 Kbps. Thus it means that for a given line card with a single one 27 Mbps usable 64QAMdownstream channel bandwidth, the total number of simultaneously active subscribers has to be

limited to 27000000/256000 ~ = 100.

Since simultaneously active subscribers are assumed to be 10% of total subscriber base, we end up with a number of around 1000 subscribers per line card. Cisco strongly recommends this number not be stretched beyond 1500 subscribers per line card, since service will be severely degraded during the busy hour. This could lead to disconnection, offline status, extremely erratic performance from the cable modem customer point of view, longer than average ranging time for modems attempting to re-register, as well as other system and performance anomalies.

Given a fairly uniform distribution of these subscribers across all 6 upstreams, assuming the use of a MC16c card, the customer will end up with a total of about 200–250 subscribers per US port.

Another way to look at it is to try to limit the number of contending users per US port during peak activity time. Cisco recommends the average number of simultaneously active/contending CMs per US be kept around 10–20. These recommendations are also based on how the multiplicity factor of colliding modems on each US receiver can lead to saturation and clipping on the HFC network. Once we have a limit on max contending CMs per US port, we can get total max CMs per US port by roughly multiplying the number by 10 (10% peak demand assumption). Cisco has thousands of DOCSIS CMTS units operating world wide. Using engineering data combined with real world field experience Cisco has proven that, based upon the DOCSIS protocol and how it operates, deployments enjoy maximum success when subscribers per US does not exceed 250.

Of course every service offering is different and the customer must determine, based upon techniques discussed here as well as other traffic engineering sources, what the proper number of modems for their situation should be. Cisco can only make recommendations as determining the maximum or proper number of cable modems per upstream/linecard is highly subjective based upon a multitude of factors.

Homes Passed and Penetration

Cisco has found that customers who wish to successfully deploy data over cable networks based upon the DOCSIS standard must take into account many factors for success. One fundamental point that will ensure success is keeping customer return domains within reason. Cisco has found that keeping the homes passed (HHP) per upstream port to a reasonable level can significantly improve deployment success, maintenance costs, and improve customer satisfaction. Cisco has found that 2,000 homes passed per US port with ~10% penetration. Using 2000 homes as a threshold for maximum HHP per US port is a cost effective design guideline which allows the operator to deploy rapidly while keeping maintenance areas reasonable. The operator needs to remember that combining large areas, such as 4,000–10,000 Homes Passed means that any one section of that return path network that induces noise will funnel to the given US receiver and affect service for ALL subscribers. The above information must be looked at under even more scrutiny when considering Voice deployments. A network wishing to run Voice will have a much greater chance for success when deployment thresholds are maintained under those recommended in this document.

Given the previous information, Cisco highly recommends 2,000 homes passed per US receiver port as a maximum with ~10% penetration. Cost of adding upstream ports is far cheaper than regular outages and unexplainable or irregular network behavior due to return path over utilization. This recommendation would be further reduced and the provider highly encouraged to use the HFC design White Paper above to lay out their return path HHP based upon the specific network parameters they expect/observe in their network.

Related Information

- [Cable FAQ](#)
- [Broadband/Cable Solutions documentation](#)
- [Troubleshooting uBR Cable Modems Not Coming Online](#)
- [Cable Product Support Page](#)

- **Connecting the Cisco uBR7200 Series Router to the Cable Headend**
 - **Technical Support – Cisco Systems**
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