Stitcher Capacity Analysis: Charter Internal Note. Draft Version 0.0.0

Brad Schoenrock
Video Operations Engineering
Charter Communications
Greenwood Village, CO

July. 2019

Contents

1 Introduction

Stuff and things...

Spec-Guide QAM bandwidth was initially a conern brought up as a possible cause of Guide Unavailable, Failure to Tune messages, and a potentially call volume generating problem. Spec-Guide QAM bandwidth is a limited resource, which scales with the number of customers, so the capacity of the Spec-Guide QAMs were also a concern to be investigated. The architecture of the platform dictates that each service group gets exactly two Spec-Guide QAMs to serve it, with no more or less. This creates a situation where the RF bandwidth of the QAMs dictate the maximum number of customers a service group can support. Since the QAMs themselves can't output more bandwidth (They are fixed devices that don't lend themselves to upgrades) and our architecture dictates that we can't add more than two QAMs per service group, this means that the only lever that is available to resolve such issues is managing the size and number of our service groups. We (ISP) does this routinely with service group splits and merges. When service groups get too large they are split into two different service groups, and when small service groups are near each other they are collapsed into one service group.

On a service group by service group level the QAM bandwidth is managed on the CSM by the QAM Resource Manager (QRM). The QRM is set up through configuration files, topology.xml and programs.xml. These config files define the total bandwidth output capability of the QAM for the QRM, the output frequency of the QAM, and the bandwidth expected for each type of stream (SD vs. HD, etc...) in both steady state operations as well as a maximum bandwidth usage. In this way we can monitor estimated QAM usage and ensure there aren't any overruns. As overruns would be approached, the QRM uses smartmuxing in order to serve extra sessions when current sessions are not using up their allotted bandwidth.

2 QAM Bandwidth Availability & Analysis

Stuff and things...

Each QAM has 38.8MBps of bandwidth, 37.5MBps is usable for delivery of Spec-Guide sessions. With two QAMs per service group this means each service group has 75MBps of bandwidth for delivery of Spec-Guide sessions.

The QRM is configured based on actual session usage, a sample configuration can be seen in Appendix /refAPPENDIX-QRMConfig. The highest definition mpeg streams allocate 2.5MBps steady state, and a peak of 6MBps of RF bandwidth. By monitoring the throughput of the APEX by eye in prime time these settings are matching usage. Average session bandwidth is between 2-2.5MBps which is below 2.5 since not every session is HD.

In order to define a functional capacity we need to ensure enough bandwidth to serve another session. For this reason 6MBps of bandwidth should be reserved on each QAM. The remaining 63MBps of QAM bandwidth on the service group

can then serve 26 HD sessions at the configured 2.5MBps each. Maximum concurancy rate of our customer base was measured to be 4% in stitcher capacity analysis, and while that would fluctuate more on a service group basis, it still serves as a baseline for system usage. This leads to a capacity calculation of:

$$Capacity = \frac{QAM_{BWTotal} - 2 * MAX_{BWSess}}{SS_{BW} * Concurancy}$$

Where $Capacity$ is the number of customers a service group can handle defined by QAM bandwidth, $QAM_{BWTotal}$ is the total usable QAM bandwidth available on the service group, MAX_{BWSess} is the max bandwidth used for a session (typically during session set up), SS_{BW} is the steady state bandwidth usage, and $Concurancy$ is the concurancy rate of users in the service group.

This calculation leads to a capacity of approximatly 720 customers per service group. There are several reasons why this is a low estimate.

1. The average usage is lower than an HD stream would dictate. This means more sessions can be allocated to a QAM than if they were all HD streams

2. The allocation of keeping max bandwidth in reserve per QAM is overkill. Not every session will use the max bandwidth on setup, so it is possible that less can be reserved for new sessions.

3. A 4% concurancy rate is on the high end of measured usages. Fluctuations to that value would be possible, but the majority of cases would be lower, and more users could be supported at lower concurancy rates.

4. The QRM uses smartmuxing which "Recycles" unused bandwidth in order to serve out more sessions than this analysis would indicate.

These factors provide significant leeway in capacity concerns. Operating at 720 customers per service group would be operationally ideal, but these factors would easily allow us to reach 800-1000 customers per service group without concerns to the customer experience. If we were to reach 1200-1500 customers per service group then the customer experience would begin to suffer due to Spec-Guide QAM bandwidth.

Customers per service group was measured through the CSM logs (but is also tracked in other ways by other groups) in order to determine if any service groups were over the relevant thresholds. Table 1 lists service groups to watch. It is noteworthy that the average number of customer per service group is INSERTNUMBERHERE, (which is BLAHBLAHBLAH lower than the first threshold) so overall we have plenty of QAM bandwidth to go around so long as it is properly allocated.

3   Conclusion

Stuff and things...

If sessions begin to overrun the Spec-Guide QAM bandwidth beyond what smartmuxing could handle, the customer experience would be affected in a few ways. First the QRM will send a few frames of lower quality for sessions in order to limit the bandwidth usage. Next, users would experience pixelation of the guide interface, delayed frames, and/or droped frames in order to maintain the integrety of the Spec-Guide QAM. As a last resort the QRM will deny new sessions outright. The QRM will not allow sessions to be sent to a QAM once the bandwidth has been entirly allocated. All of these behaviours would be recorded in CSM logs.

Stuff and things...

There are no significant Spec-Guide QAM bandwidth related concerns.

The best way to ensure we are not overrunning our QAM bandwidth is to limit the number of customers per service group, and perform service group collapses and splits as needed.

Direct measurements of RF bandwidth in an automated fasion would be time consuming, costly, and unnessicary. The number of customers per service group serves the same purpose in this case, and requires no further monitoring.

A Appendix A Example QRM Configuration

Stuff and things...

```
<resolution height="480">
<mpeg2>
<bitrateProfile name="Default_SD">1000000</bitrateProfile>
<bitrateProfile name="Low_SD">1000000</bitrateProfile>
<bitrateProfile name="MediumLow_SD">1200000</bitrateProfile>
<bitrateProfile name="Medium_SD">1500000</bitrateProfile>
<bitrateProfile name="High_SD">2000000</bitrateProfile>
<bitrate>4000000</bitrate>
<quant>3</quant>
<aquant>4</aquant>
<txtquant>2</txtquant>
</mpeg2>
<h264>
<bitrate>4000000</bitrate>
<quant>14</quant>
<aquant>14</aquant>
</h264>


<resolution height="720">
<mpeg2>
<bitrateProfile name="Default_HD">1600000</bitrateProfile>
<bitrateProfile name="Low_HD">1600000</bitrateProfile>
<bitrateProfile name="MediumLow_HD">1800000</bitrateProfile>
<bitrateProfile name="Medium_HD">2000000</bitrateProfile>
<bitrateProfile name="High_HD">2500000</bitrateProfile>
<bitrate>6000000</bitrate>
<quant>3</quant>
<aquant>5</aquant>
<txtquant>2</txtquant>
</mpeg2>
<h264>
<bitrate>10000000</bitrate>
<quant>10</quant>
<aquant>14</aquant>
</h264>
```

Market	SGID	Customer Count

Table 1: Service groups with customer counts over 720.

B   Appendix B Customers by SGID

CustPerSG/edprmnResults.txt
    744 40019
    819 30003
    850 41010
    1006 40017
    1079 30006
    1083 30001
    CustPerSG/knwdmiResults.txt
    726 49011
    736 37025
    748 21032
    766 48076
    799 28022
    805 13010
    1222 48075
    CustPerSG/mddcwiResults.txt
    731 14034
    740 42028
    741 24011
    771 52031
    786 29002
    791 36021
    817 27017
    833 23004
    877 42035
    1014 13029
    1212 50002

CustPerSG/pldcorResults1.txt
729 40225
739 40956
755 14022
763 40186
766 20017
779 20019
789 40114
794 40518
802 15001
806 27068
815 27070
828 14018
834 27022
836 40116
842 20012
843 20003
908 14023
991 14026
992 40154
1048 14030
1049 14016
1087 14035
1413 14020
1415 14019
1878 14007
CustPerSG/pldcorResults2.txt
723 28011
727 38023
733 25005
733 26003
737 25002
740 38034
746 25006
747 28009
749 28008
767 28006
768 19002
768 43017
774 38035
782 43016
791 43013
793 25019
798 25020
811 34004
822 25008

827 19004
837 43035
843 43011
849 25011
858 25021
864 19012
880 26002
882 25010
901 34002
902 43012
921 25012
940 38014
959 19008
1006 38030
1014 25004
1073 19007
1077 34005
1159 28002
1200 43015
1382 34003
CustPerSG/renonvResults.txt
721 11018
728 11101
730 12029
730 14015
741 12005
741 12010
749 10031
749 11150
752 17001
757 16010
760 10005
760 11126
766 14016
769 11134
770 16015
775 17002
782 11142
789 11175
797 11149
797 11156
797 12013
804 11147
804 15011
813 11044
815 12018

817 11141
823 11068
830 11094
832 10050
840 11151
842 11045
848 11165
857 15022
866 11114
869 11174
876 11179
881 12020
897 16001
904 11140
931 11123
952 12024
956 11059
973 12025
1008 17010
1013 11144
1017 12009
1023 16016
1038 11028
1122 11104
1208 12008
CustPerSG/sldclaResults.txt - -
CustPerSG/sldcmoResults.txt
3628 24090
CustPerSG/spdcscResults.txt
720 61105
734 26077
737 22033
737 26024
752 24061
757 26089
758 32093
782 30015
794 22028