KENWOOD

Technical Manual

IP-bandwidth of KAIROS TIER III System

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1.1. Abstract

Network bandwidth capacity is an important information and for most of the cases the information regarding the volume of bandwidth how much it can support is required preliminarily by our customers. Knowing/fulfilling their requirements will boost commercial prospects and help us to acquire new projects. In the first part of this document you can find the formula and the explanation that helps you to have a foundation for evaluating the value of bandwidth. In the appendix of this document, you can find the result of in-house network bandwidth testing. We believe that showing the result of testing could contribute to increasing reliability of product which is the ultimate objective of this document. We wish that this document can help our partners to make more persuasive presentation of KAIROS in their sales activities.

1.2. Formula for evaluating bandwidth value per site

Figure-1 describes KAIROS Multi-site DMR TIER III Trunking System. Each site has several Payload Channels where one Payload Channel is used for one call. Therefore, in the case of multi-site communication, it requires:

one call's bandwidth X total number of Sites which receive Group Calls

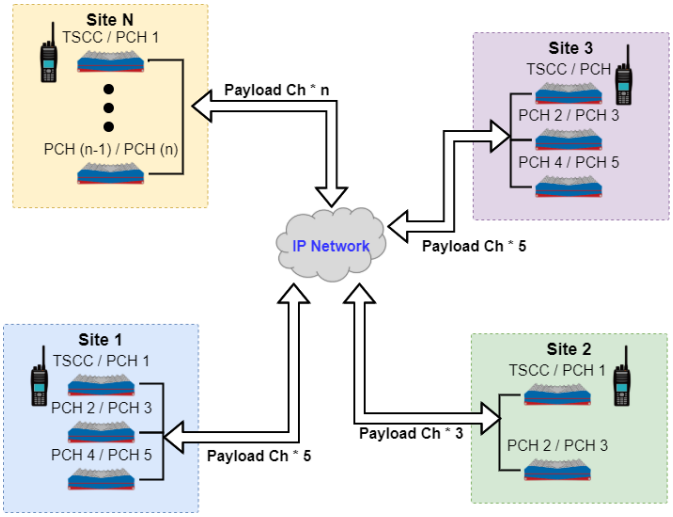

Figure 1

When Group Call is transmitted, the number of communication lines which is equivalent to the number of receiving sites will be generated accordingly. Therefore, the total data amount can be simply calculated by the above formula. When receiving a call from another site, one Payload Channel is assigned to one call, therefore the upper limit for each site to receive calls equals to the number of Payload Channels. The maximum bandwidth required by each site is calculated as following:

V (kbps): *Bandwidth for one Voice call (*1)*
N : *Number of sites*
P : *Number of payload channels for the Site "x"*
C (kbps): *Constant value that is used control for the call (*2)*

$$Bandwidth\ of\ Site\text{"x"} = [P \times (N-1) \times V] + C$$

*1: This constant value is "12 kbps"
*2: This value is about "3 kbps"

1.3. Bandwidth Evaluation Exercises

1.3.1. Exercise 1: Three sites, three payload channels per site

Please find herewith below a sample. Figure 2 describes KAIROS DMR TIER III Truking System. This system structure consists of three multi-site and each site has three payload channels. If one of your projects is going to be realized with this kind of system structure, you can estimate the bandwidth of each site by referring to the parameters and the value indicated in the table below. In this example, the calculation is made on the assumption that when three voice calls happen simultaneously. You can find the result at the bottom of the table, the bandwidth of Site "x" .

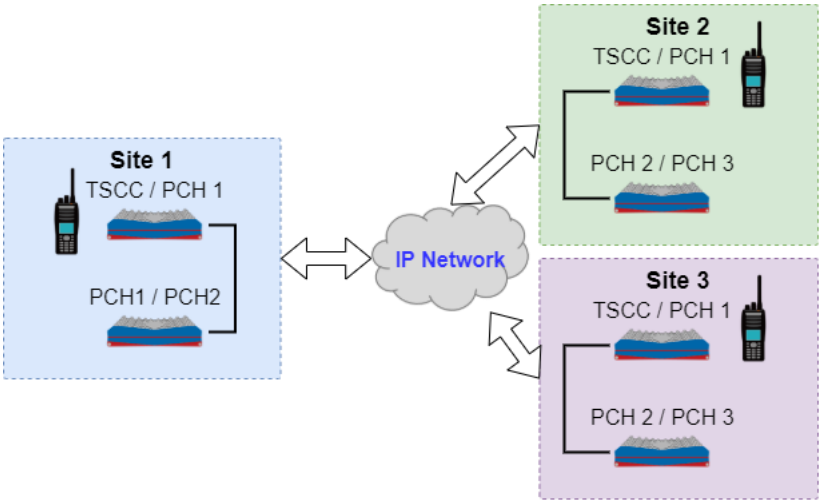

Figure 2

Parameter	Site "x"
N (Number of sites)	3 sites
P (Number of payload channels)	3 Payload channels
V (Bandwidth of one voice call)	12 kbps
C (Constant value for the control)	3 kbps
Bandwidth of Site "x"	[(3-1)x3x12]+3 = **75 kbps** (*1)

*1: The outcome of measurement in actual use performed through our in-house testing is available in Appendix.

1.3.2. Exercise 2: Seven payload channels (system structure on a larger scale)

The picture below describes the image when designing KAIROS system on a larger scale. Figure 3 describes the multi-site system that is structured with "N" site and each site is configured with seven payload channels. Please find below the figure 3, the table in which you can verify the max bandwidth of each case with 2, 3 and 5 sites.

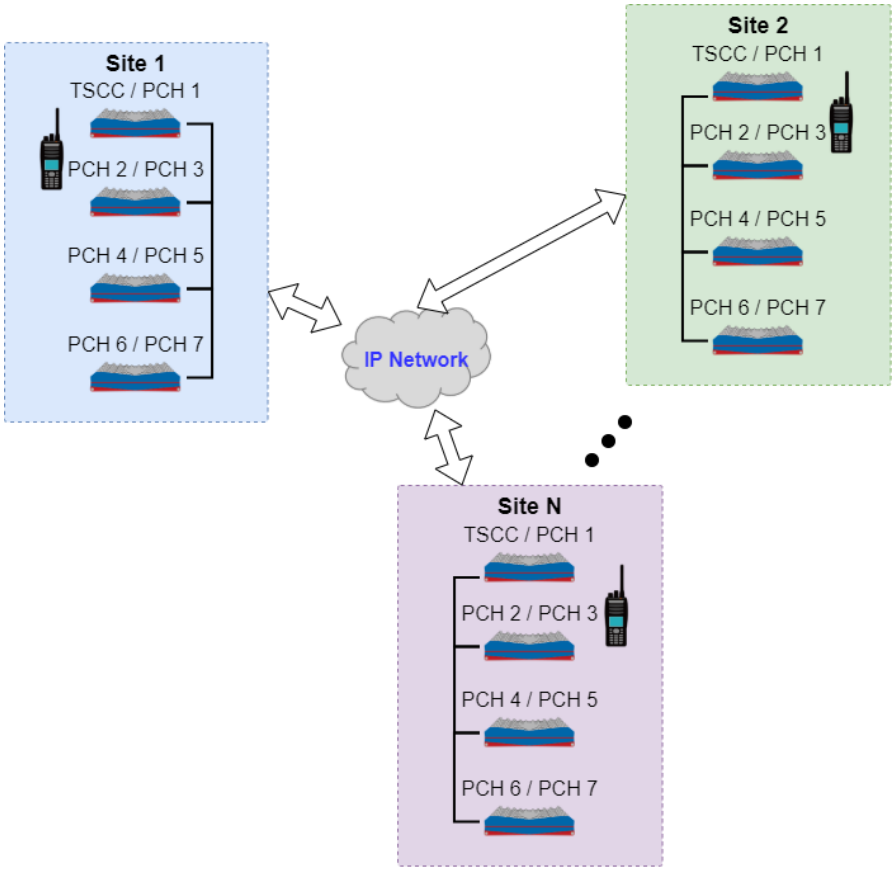

Figure 3

Parameter	N = 2 Site	N = 3 Sites	N = 5 Site
N (Number of sites)	2 sites	3 sites	5 sites
P (Number of payload channels)	7 Payload channels		
V (Bandwidth of one voice call)	12 kbps		
C (Constant value for the control)	3 kbps		
Maximum Bandwidth	[(2-1)x7x12]+3 = **87 kbps**	[(3-1)x7x12]+3 = **171 kbps**	[(5-1)x7x12]+3 = **339 kbps**

2. Appendix:

2.1. Result of in-house testing

We undertook an in-house testing and measured the bandwidth of each site with the following condition. Below is the actual result referring to the sample introduced in the previous chapter of this document in the aim of measuring the maximum bandwidth of each site. You can check the measurement pattern in Figure 5. The testing method is as follows: Mobile stations of Site 1 occupy all Payloads and send 3 group calls, one group call will be transmitted to each receiving site consequently the bandwidth of site 1 will be occupied at maximum. To check the max capacity of bandwidth, we therefore created that phenomenon (3 channels- Group 3 calls) in real and measured the actual maximum bandwidth.
Below graph is the result of measurement of this call pattern.

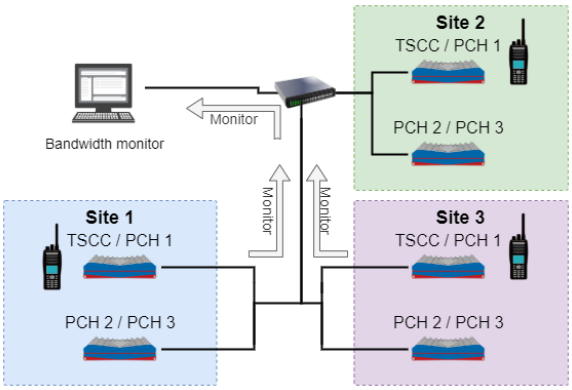

Figure 4

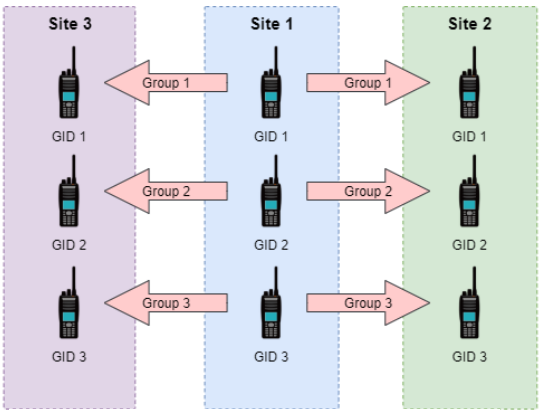

Figure 5

- Result of measurement
  Maximum bandwidth: **70 kbps~75 kbps**

Conclusion: This value is almost equal with the value presented in 1.3.1