A Carbon Footprint Evaluation for CCN and IP

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Evaluation

Seetharam et al. in [1] provide a carbon footprint analysis for a DVD shipping service compared to an IP video streaming service. We take the motivation from the work of Seetharam et al. and estimate the carbon footprint values for our analysis. Carbon footprint of CCN and IP-based networks can be determined by calculating the amount of carbon dioxide emitted due to manufacture and operation of network equipment used in both kind of networks. The carbon footprint is the product of the carbon dioxide emission coefficient and the energy consumed. The mean value of the carbon coefficient for electricity is 0.585kg/kWh as given in [2]. We use this value in our calculations. The method of electricity generation assumed in [2] while calculating the carbon coefficient is hydro-electricity generation. In situations where electricity generation is done using nuclear plants in addition to hydro-electric, the carbon footprint of electricity generation is much lower [3]. We note that the reductions in carbon loading would be experienced by both networks so this does not effect our analysis. Recycling of the IT equipment also helps to recover the carbon cost incurred due to manufacturing. We observe in [4] that the carbon cost recovered due to recycling for a laptop computer is approximately 15%. We apply the same value to all network equipment (server and routers) due to unavailability of data.

Carbon footprint of network devices during manufacture

The energy required to manufacture a 10TB memory is 5853 MJ (calculated in the previous reports). The carbon footprint of a memory device using the definition is calculated as 0.585kg/3600kJ $\times$ 5852 MJ. The final value is calculated after subtracting the 15% carbon cost reduction due to recycling. Same method is applied to estimate the carbon footprint for all sizes of cache memory used in the network. The carbon footprint for a network router and server's manufacture is estimated from [2]. The carbon foot print values for the server and routers used in our analysis are provided in Table 1. S_m and M_{CCN} are estimated by taking into account the effect of storage and cache memories in the case of server and routers respectively.

Device	Carbon footprint (Kg)
S_m	910
M_{IP}	175
M_{CCN} 256, 128, 96, 64 GB	$235, 200, 180, 175$

Table 1: Carbon footprint for devices due to manufacture

Carbon footprint of network devices during operation

We are considering that our system is deployed for three years. The carbon footprint is estimated by taking the product of operating power of all the devices with the carbon coefficient over the duration of the network deployment. Table 1. describes the estimated values of carbon footprint due to the operation of the network devices.

Device	Carbon Footprint (Kg)
S_O	4740
O_{IP}	1550
O_{CCN} 256, 128, 96, 64 GB	$1650, 1600, 1600, 1560$
C_M 256, 128, 96, 64 GB	700
C_S	260

Table 2: Carbon footprint for devices due to operation

Results

We have used the values presented in Table 1 and 2 to calculate the carbon footprint for the three scenarios we have considered for our analysis i.e., Ideal Rate Adaptation (RA), Practical RA and No RA. The cache size is assumed to be 128 GB. Fig 1. presents the comparison of carbon dioxide emission in grams for both IP and CCN-based networks. The carbon footprint due to manufacturing in case of CCN is higher as compared to IP. This is due to the presence of cache memory in CCN routers. CCN only out performs IP in terms of lesser carbon dioxide emission if we consider ideal RA. In case of practical and no RA IP produces less carbon dioxide.

Note that the term usage in Fig 1. is used to represent the carbon footprint due to the operation of the devices for the duration of network deployment.

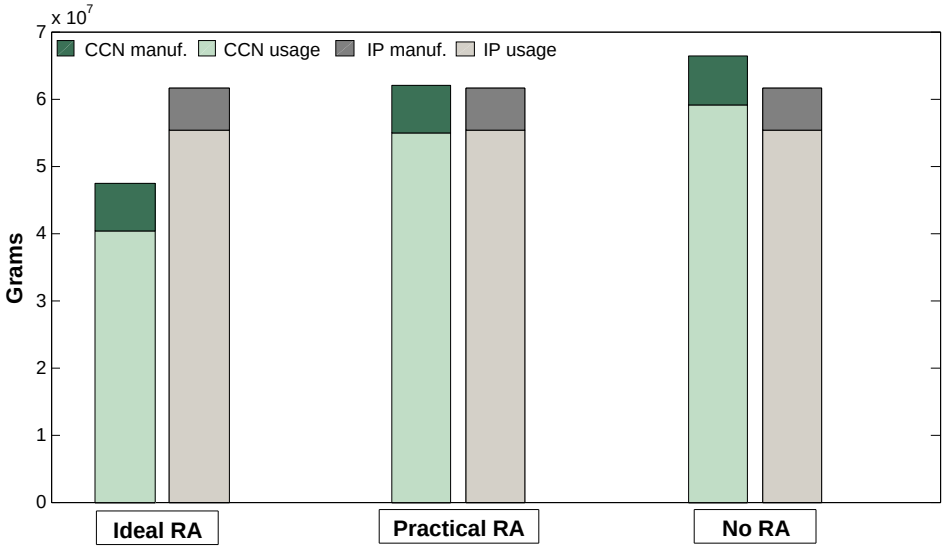

Figure 1: Carbon footprint for CCN and IP-based networks

Bibliography

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